Ministry of Education, Culture, Sports, Science and Technology
21st Century Center of Excellence Program

The Science of Institutional Management of Technology

Elucidation of Japan-Indigenous Co-Evolutionary Dynamism and Its Accrual to Global Assets

5-Year Project Report

2004 – 2008

March, 2009

Tokyo Institute of Technology

Ministry of Education, Culture, Sports, Science and Technology

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The Science of Institutional Management of Technology: SIMOT – A Five-Year Endeavor for Global Co-Evolution

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The five years of this 21st century Center of Excellence (COE) program were really an epitome of the transition of the paradigm from an industrial society to an information society and to a post-information society. With the strong expectation that reactivation of the Japanese economy was indispensable for revitalization of the global economy, this ambitious endeavor for establishing a new innovative science, the "Science of Institutional Management of Technology (SIMOT)," was undertaken in October 2004.

Co-evolutionary dynamism between innovation and institutional systems is decisive for an innovation driven economy, and Japan indigenously incorporates an explicit function for inducing such dynamism. Attainment of fundamental understanding that enables elucidation, conceptualization, operationalization and then the accrual of this dynamism to global assets was the prime objective of the program.

In order to accomplish this objective, SIMOT undertook a four-dimensional program consisting of (i) Fundamental research, (ii) Human resources development, (iii) International joint research collaboration, and (iv) Publication and dissemination of information.

This report demonstrates the outcomes of the activities of this program over the last five years, including:

(1) Fundamental research by 20 core members aiming at elucidating, conceptualizing and operationalizing a co-evolutionary dynamism between innovation and institutions by means of three-dimensional approaches corresponding to a postulate that institutions nurture emerging innovation by means of (i) national strategy and socio-economic systems, (ii) entrepreneurial organization and culture, and (iii) historical perspectives.

(2) Development of human resources to create global leaders, particularly of (i) MOT leaders contributing to the advancement of firm MOT, (ii) international business leaders contributing to the transfer of Japan's explicit systems to the global community, and (iii) young research leaders contributing to the advancement of SIMOT as a new innovative science. In addition to 20 core members, 16 experts with first-hand experience in business and policy-making as well as social sciences expertise were invited to contribute particularly to human resources development as SIMOT specific professors.

(3) International joint research collaborations for identification of the similarity and disparity of co-evolutionary dynamism depending on the institutions of nations, joint symposiums and workshops, as well as exchanges of researchers and students.

(4) Dissemination of information supportive to understanding and learning of the SIMOT contribution to the global community.

Looking back on this ambitious endeavor to establish a new innovative science, it can be agreed that although the last five years were really long, they passed by very quickly. Our work was often very tough, but it was also productive and stimulating. The coordination and administrative work needed for the program was considerable, but on the other hand it presented an exciting challenge. So, our work was difficult as well as exciting, and this duality enabled us to leverage our capability and resources to produce a meaningful outcome. As a result, we were able to achieve the following:

(1) First, a new innovative discipline named Institutional Management of Technology was postulated based on the concept of the decisive role of co-evolution between innovation and institutions.

(2) Second, an approach was developed to address the comprehensive dynamic systems of institutional systems by means of (i) national strategy and socio-economic systems, (ii) entrepreneurial organization and culture, and (iii) historical perspectives.

(3) Third, several noteworthy findings relevant to today's global stagnation were demonstrated so as to shed light on Japan's potential explicit function to transform external crises into a springboard for new innovation and also identify Japan's leading role in instilling in customers an exciting story with their own initiatives that thrills them with gratification.

(4) Fourth, a significant number of global leaders was created, including (i) MOT leaders for firm MOT, (ii) international business leaders for the global community, and (iii) young research leaders for the advancement of SIMOT. Fifty-one Ph.D. students graduated, and 11 post-doctoral students were involved and contributed to SIMOT's activities over the last five years. They published 69 research papers in international refereed journals and initiated 70 presentations at international academic conferences. The number of research papers and presentations doubled in comparison with the state before undertaking SIMOT.

(5) Fifth, the significance of co-evolution between advancement of fundamental research and development of human resources was demonstrated.

(6) Sixth, a highly qualified international joint collaboration network in the MOT field was developed with the US; Europe, including the UK, Germany, France, the Netherlands, Spain, Switzland, Finland, Austria and Russia; Asian countries, including China, Korea, Thailand and India; and Australia.

(7) Seventh, a considerable amount of information that supports understanding and learning of the SIMOT contribution to the global community was published and distributed by holding 60 monthly evening forums during the five years of SIMOT's activities. Moreover, 50 issues of a monthly newsletter, 270 research papers in international academic journals, and several books as well as special issues of journals were published. Presentations at the academic conference amounted to 580.

In addition, we were fortunate to achieve such significant organizational output as not only establishing the SIMOT Research Center in March 2005 but also inducing the establishment of a new graduate school for MOT, the Graduate School of Innovation Management, in April 2005.

We are very proud to have been able to take a leading role in this ambitious and comprehensive effort to establish a new innovative science, the Science of Institutional Management of Technology (SIMOT), in the particular year of the start of national university reform from April 2004, and also during the historical period of transition of the paradigm from an industrial society to an information society and to a post-information society, and at the exact time when all nations of the world are looking for a new development trajectory.

We hope that our pioneering efforts will trigger a broad range of endeavors toward establishing the Science of Institutional Management of Technology. Advice from external circles such as discussions during annual international symposiums and workshops has provided very useful insight with respect to realization of our ambitious goal. We must also not overlook the invaluable advice provided by the external evaluation committees chaired by Dr. Tsuneo Nakahara. Without their support, our five-year endeavor would have been less productive.

It should be noted that the President of Tokyo Institute of Technology has decided to continue this intellectual endeavor as the SIMOT Research Center for another five years. This clearly demonstrates how Tokyo Institute of Technology values further continuation and advancement of the positive outcome achieved to date by SIMOT, and that it considers SIMOT's domestic and overseas human resources networks to be important intangible assets.

I very muchreally hope that all of you will continue your could further support in order to realize to the further advancement development of SIMOT as an innovative science.

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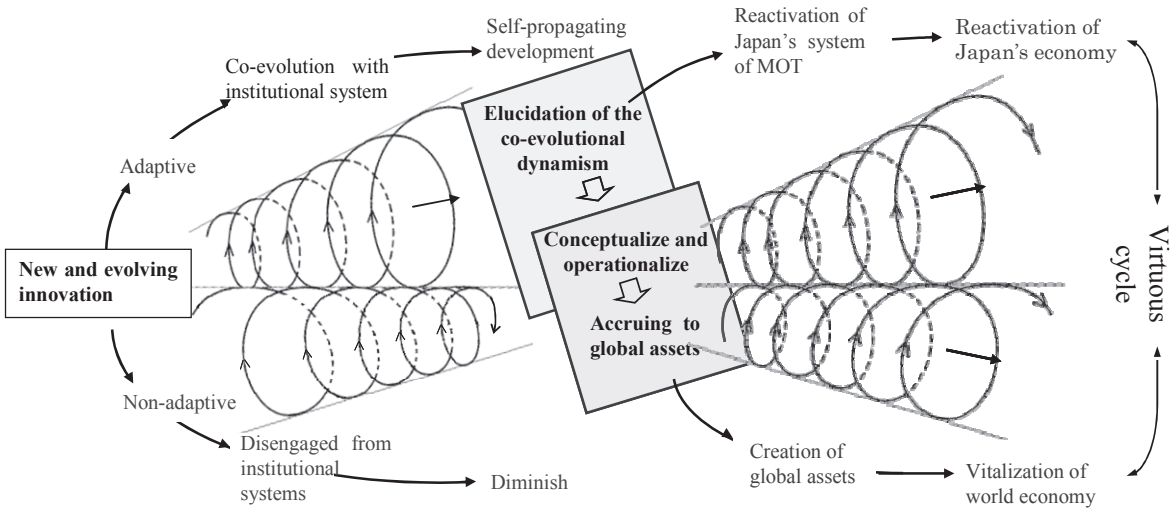
1. Prime Objective of SIMOT

The Science of Institutional Management of Technology (SIMOT) 21st Century COE Program was undertaken to conduct theoretical and empirical analyses on dynamism leading to reactivation of an indigenous function of the Japanese system of management of technology for accrual to global assets.

SIMOT's work program was based on the fundamental understanding that co-evolutionary dynamism between innovation and institutional systems is decisive for an innovation driven economy, and that Japan indigenously incorporates an explicit function for inducing such dynamism. This then led to the understanding that this dynamism moved in the opposite direction in the 1990s, resulting in a lost decade due to a systems conflict between institutional systems in an industrial society and those in an information society.

The foregoing then led to the identical postulate that institutions nurture emerging innovation by means of (i) national strategy and socio-economic systems, (ii) entrepreneurial organization and culture, and (iii) historical perspectives.

Based on the above, SIMOT targeted the establishment of a new innovative science to elucidate, conceptualize and operationalize Japan's explicit dynamism so as to enable the accrual of such dynamism to global assets.



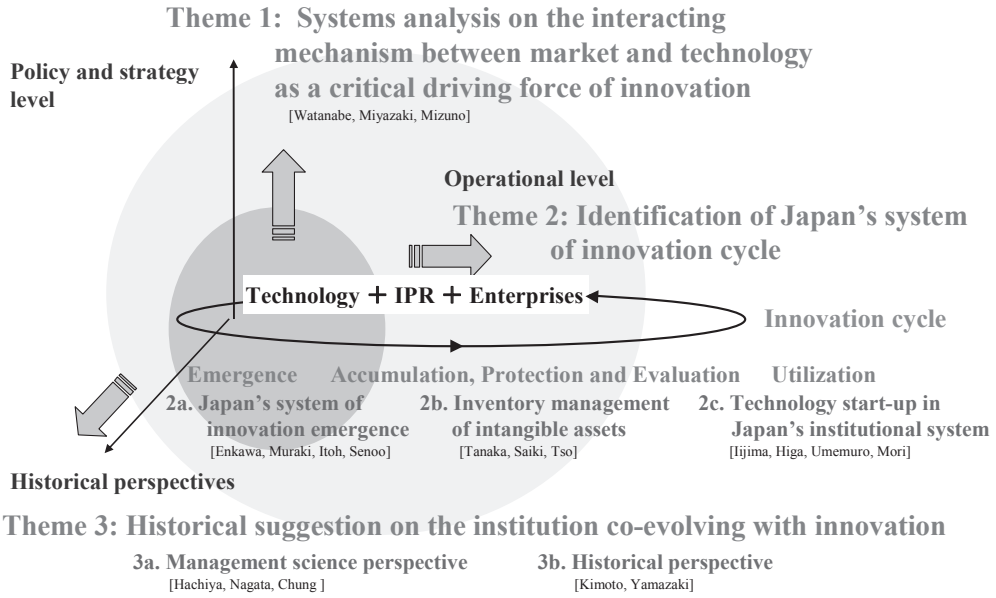
This led to the establishment of a new innovative science, the "Science of Institutional Management of Technology (SIMOT)," and induced the following three approaches corresponding to the three dimensions of institutions:

(i) From the policy and strategy level, examine "Systems analysis on the interacting mechanism between market and technology as a critical driving force of innovation" – *Macro and top-down approach*

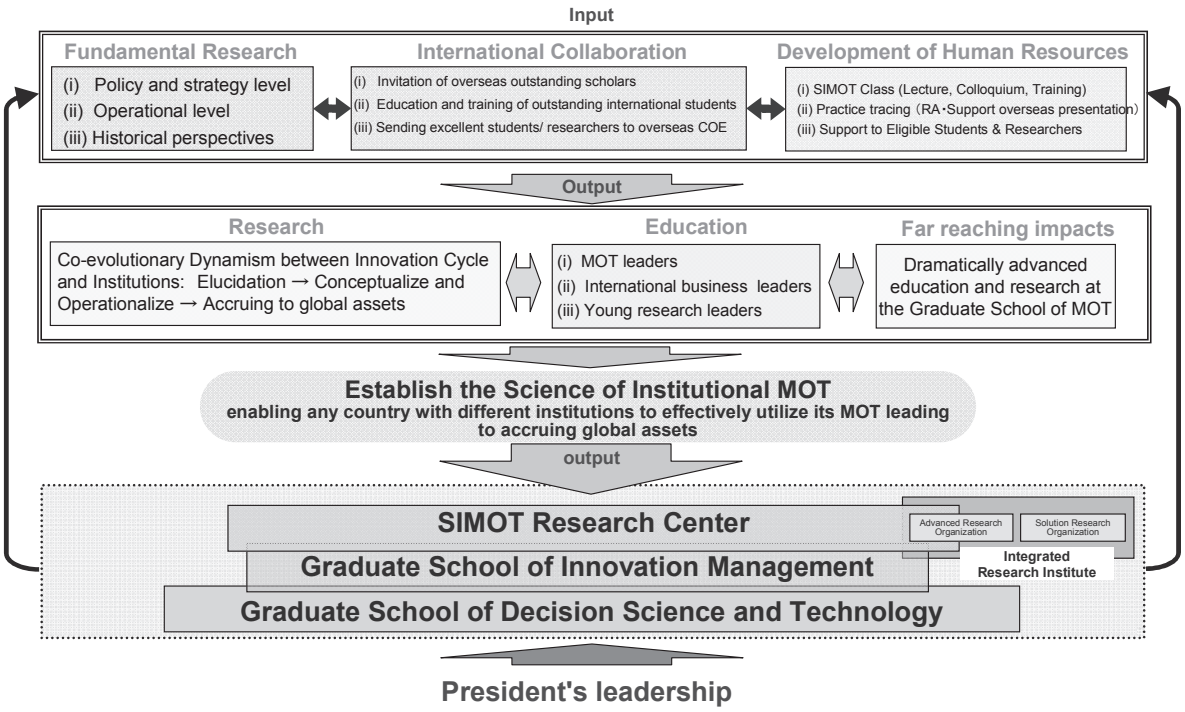
(ii) From the operational level, investigate "Identification of Japan's system of innovation" – *Micro and bottom-up approach*

(iii) From the historical perspective level, explore "Historical suggestions on institution co-evolution with innovation" – *Historical perspective approach*

On the basis of the foregoing, SIMOT utilized the three-dimensional approach shown in the figure.



SIMOT attempted to elucidate the dynamism of recovery of Japan's indigenous functions and of its accrual to global assets through the comprehensive approach outlined below. For this purpose, the Tokyo Institute of Technology established the Science of Institutional Management of Technology Research Center in March 2005.



2. Research and Education Program

2.1 Research Plan

2.1.1 Fundamental Research

For substantial analysis of the source of Japan's explicit co-evolutionary dynamism between innovation and institutions, the following three dimensional approaches with six themes were endeavored:

(1) Policy and strategy level: Systems analysis on the interacting mechanism between market and technology as a critical driving force of innovation.

(2) Operational level: Identification of Japan's system of innovation

(2a) Japan's system of innovation emergence

(2b) Inventory management of intangible assets

(2c) Technology start-up in Japan's institutional systems

(3) Historical perspective: Historical suggestion on the institution co-evolution with innovation

(3a) Management science perspective into social institution

(3b) Historical perspective into social institution

2.1.2 International Joint Research Collaboration

(i) Establish a joint research collaboration system by inviting researchers involved with the world's advanced research institutes

(ii) Establish a world-leading research center by accepting prominent young scientists from Japan and other countries

(iii) Encourage Ph. D. students to contribute to SIMOT's joint research activities and similar activities initiated abroad

2.1.3 Integrated Activities with the Graduate School of Innovation Management

Findings obtained from SIMOT are utilized for advancing the educational program for the Graduate School of Innovation Management. Graduate school students also participate in SIMOT educational program research subjects as SIMOT core project members.

Member of the Project Team

Dimension I　Systems Analysis on the Interacting Mechanism between Market and Technology as a Critical Driving Force of Innovation

WATANABE, Chihiro (Co-evolutionary analysis)
MIYAZAKI, Kumiko (International comparative analysis)
MIZUNO, Shinji (Optimal theory)
MIYAGAWA, Masami (Causality model analysis)
YAJIMA, Yasutoshi (Operational analysis for resources of management)

Dimension II　Identification of Japan's System of Innovation Cycle

II- a) Japan's System of Innovation Emergence

ENKAWA, Takao (Innovation emergence)
MURAKI, Masaaki (Environmental management)
ITOH, Kenji (Technology risk)
SENOO, Dai (Knowledge creation)

II- b) Inventory Management of Intangible Assets

TANAKA, Yoshitoshi (Organizational impeding factor)
SAEKI, Tomoko (State of intangible assets utilizati)
TSAO, De-bi (Inventory management analysis)

II- c) Technology Start-up in Japan's Institutional System

IIJIMA, Junichi (Analysis of information services)
HIGA, Kunihiko (Start-up process)
UMEMURO, Hiroyuki (Products market)
MORI, Kinji (Technology management framework)

Dimension III　Historical Suggestion on the Institution Co-evolving with Innovation

III- a) Management Science Perspective into Social Institution

HACHIYA, Toyohiko (Business management analysis)
NAGATA, Kyoko (Evaluation of intangible assets)
CHUNG, Sulin (Sociological analysis)

III- b) Historical Perspective into Social Institution

KIMOTO, Tadaaki　(History of Technology)
YAMAZAKI, Masakatsu (History of Science)

2.2 Education and Development of Human Resources

Findings obtained from SIMOT are utilized for advancement of the educational program for the Graduate School of Innovation Management. Students from the school also participated in the SIMOT educational program.

Research subjects of SIMOT core project members.

(1) Integrated Activities with the Graduate School of Innovation Management

(i) Activated interaction both in education and research

(ii) Development of an MOT program identical to the Tokyo Institute of Technology

(2) System Advancement and Scope of Education

(i) Co-evolutionary development of the core classes "SIMOT I" and "SIMOT II" by developing contributors with first-hand experience in business and policy making

(ii) Advancement of the discipline of industrial engineering and management as an elaborated interdisciplinary science

(iii) Strengthening internships and field work whereby integration of theory and business experience is strengthened

(iv) Tie-ups with the activities of academic associations by holding monthly forums together with them

(3) Internalization of Internships and Studies Abroad

(i) Establish strong links with leading firms and academic institutes in Japan and abroad

(ii) Learn from collaborating firms and institutes and also strengthen positive contributions to them

(4) Super Doctor Track

(i) Encourage selected Ph. D. students to accelerate their graduation

(ii) Expect selected students to contribute to the advancement of the SIMOT program

(5) Strengthening Financial Support to Ph. D. Candidates and Postdoctoral Students

(i) Provide prioritized support in competitive circumstances

(ii) Establish an organic link with the Super Doctor Track

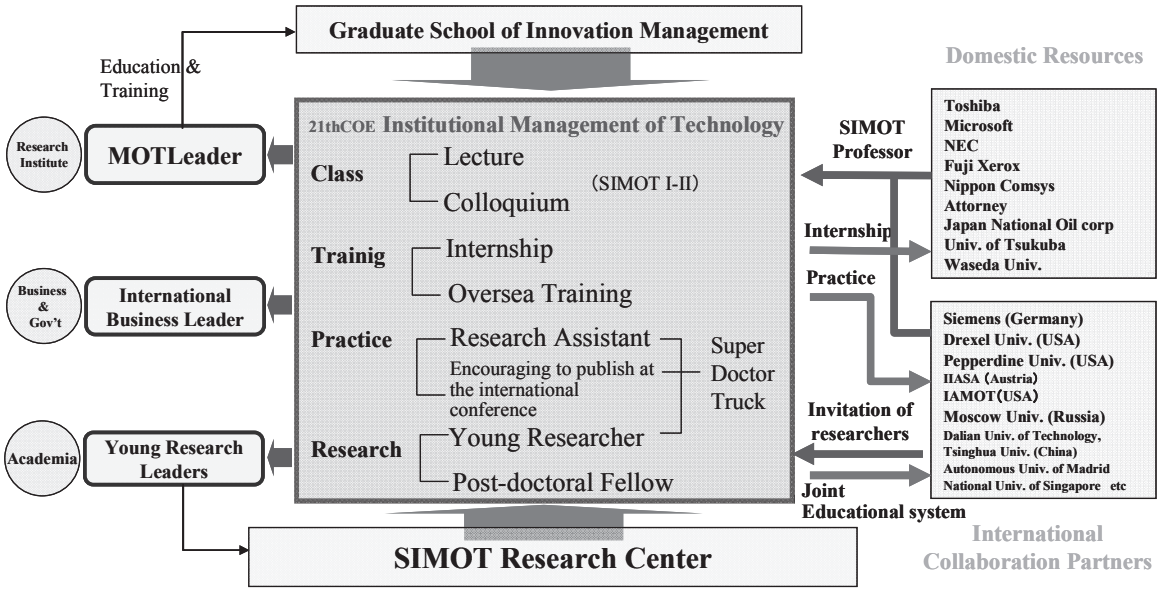
(6) Advancement of Education Linking with International Joint Collaboration

(i) Promote a joint educational system with international collaboration partners

(ii) Encourage students to publish at international conferences

(iii) Support advancement of analysis for in-depth understanding of the institutional systems of international collaboration partners

■ SIMOT Educational System



Lectures : Institutinaol Management of Technology I, II (since Apri. 2005 ～ Mar. 2009)

Outside Activities : Young Scientist Summer Program (IIASA), Internship (Bloomberg, Boston Consulting Group, General Erectric, The Institute of Statistical Mathematics, etc)

■ SIMOT Lecturer (SIMOT Professors/Assistant Professor)

Name	Affiliation
KIKUCHI, Takashi	COE-Dedicated, Tokyo Institute of Technology
HOBO, Masayo	Operating Officer, Oracle Corporation Japan
SAMEJIMA, Masahiro	Attorney at Law, Patent Attorney, Uchida-Samejima Legal Office
ADACHI, Toshiyuki	Associate Senior Vice President, NEC Personal Products, Ltd.
HIRANO, Masaaki	Professor of Information Management, Waseda Business School
Peter Mertens	General Manager, Corporate Technology Dept., Siemens K.K.
YAMADA, Taro	President and Representative Director, Nextech Corporation
Pekka Neittaanmäki	Professor, University of Jyväskylä
TOU, Yuji	Assistant Professor, Tokyo Institute of Technology

Name	Affiliation
YASUDA, Hiroshi	Director,Strategic Alliance on Semi-Conductor, Toshiba
Roland Kircher	General Manager, Technology Dept., Siemens K.K.
MASUDA, Tatuo	Executive adviser, SOC Corp. former Vice President, Japan National Oil Corp.
KOBAYASHI, Shinichi	Professor, University of Tsukuba
NOMURA, Takahiko	Senior Manager, KDI, Fuji Xerox Co., Ltd.
MINAKAWA, Tatsuya	NEC Personal Products, Ltd.
USHIODA, Kunio	Nippon COMSYS
KUROKAWA, Susumu* (Passed away)	Associate Professor, Drexel University

* Passed away on April 6, 2008.

Part II. Activity Report

1. Research Outcomes

1.1 Overview

Targeted outcomes were accomplished by focusing on the following three prioritized dimensions, thereby maximizing the multiplier effects:

(1) Fundamental Research, Individually and also SIMOT as a System

(i) Programmed research by 20 core members in line with a three-dimensional approach to six subjects maximized the effects of synergy with a certain consolidated structure.

(ii) Effective utilization of complementary support by external contributors from business, government and academia, particularly with social sciences expertise, involved designated professors collaborating with SIMOT.

(iii) The Research Center of SIMOT was established in March 2005 to function as a coordinator for SIMOT members as well as multi-dimensional missions.

(2) International Joint Research Collaboration by Mastering Global Brains of MOT

(i) An international collaboration network with the USA; Europe, including the UK, Germany, France, the Netherlands, Spain, Switzland, Finland, Austria and Russia; Asian countries, including China, Korea, Thailand and India; and Australia was established.

(ii) Joint research for identification of the similarity and disparity of co-evolutionary dynamism depending of the institutions of nations, joint symposiums and workshops, as well as exchanges of researchers and students were carried out.

(iii) Excellent contributors were invited as SIMOT professors (from Drexel University of the USA and the University of Juvaskyla in Finland) and leading researchers (two from Moscow State University and one from the University of Juvaskyla). In addition, postdoctoral students (from France, Switzerland, Argentina, the USA and China) were employed and selected students were sent to international CEOs (15 to IIASA and others).

(iv) Three-dimensional co-evolution between research, education and international collaboration was maximized.

(3) Prioritized Education and Human Development Program through Collaboration with the Graduate School of Innovation Management

(i) With the collaboration of the Graduate School of Innovation Management and by maximizing the effects of co-evolution with research and international collaboration, education and human resources development to create global leaders was carried out.

(ii) Financial support for research grants, teaching assistants, internships and international study was made available.

(iii) Many opportunities were provided for students to give presentations and participate in symposiums, workshops and conferences of notable academic associations in Japan and abroad. Students were also able to initiate their own conferences.

1.2 Noteworthy Accomplishments

On the basis of intensive interdisciplinary programmed research by 20 core members in line with a three-dimensional approach to six subjects based on a comprehensive program consisting of fundamental research, education and human resources development, and international joint research collaboration, the following noteworthy findings relevant to today's global economic stagnation were obtained:

Japan has constructed a sophisticated co-evolutionary dynamism between innovation and institutional systems by transforming external crises into a springboard for new innovation. This can largely be attributed to the unique features of the nation, such as having a strong motivation to overcoming fear based on xenophobia and uncertainty avoidance as well as abundant curiosity, assimilation proficiency, and thoroughness in learning and absorption.

Such explicit dynamism was typically demonstrated by technology substitution for energy in the 1970s, leading Japan to achieve the world's highest energy efficiency improvement. Moreover, broad advancement of Japan's manufacturing technology led to what was widely called a high-technology miracle in the 1980s.

While this dynamism moved in the opposite direction in the 1990s, resulting in a lost decade due to a systems conflict between indigenous institutional systems and a new paradigm in an information society, a swell of reactivation emerged in the early 2000s. This can largely be attributed to hybrid management fusing indigenous strength in manufacturing, and learning from global best practice, particularly from a digital economy.

Although reactivated firms have multi-polarized during the current period of global economic stagnation, Japan's model for transforming a crisis into a springboard for new innovation and developing resilient firms capable of combating successive crises has drawn global concern.

At the same time, it has become an urgent strategy for Japan's firms to maintain sustainable growth and also to activate the global economy as a necessary condition to shift from a competition-oriented model to "cooperation and competition (coopetition)", and further to an "activate and competition (actipetition)" model by endeavoring to activate competing partners.

Confronting the current global economic stagnation resulting in diminishing consumption, and corresponding to the new stream of consumption that will emerge after the current stagnation, Japan's indigenous institutional strength based on uncertainty avoidance and explicit learning ability contributing to utmost gratification of consumption by means of supra–functionality which instills in customers an "exciting story with their own initiative as heroes/heroines" and thrills them with gratification has drawn strong worldwide expectation.

Experiencing the dramatic increase in oil prices in mid-2008, this endeavor may lead to reactivation of Japan's indigenous explicit function in transforming "utmost fear" into a springboard for new innovation toward a post-oil society. Japan's explicit co-evolutionary dynamism between innovation and institutional systems can thus be activated.

This validates the significance of global co-evolution corresponding to SIMOT's aim. SIMOT's activities over the last five years have not only contributed to reactivating Japan's economy by identifying the path to hybrid management of technology, they have also shed light on Japan's sophisticated indigenous function for transforming external crises into a springboard for new innovation.

In addition, the SIMOT endeavor has provided roadmaps for the creation of new sciences for (i) pursuing a supra-function encompassing social, cultural, aspirational and emotional needs beyond economic value based on an integrated approach of production, diffusion and consumption functions, (ii) institutional supply chain management (ISCM) which identifies optimal supply chain management based on three-dimensional institutional systems, (iii) postulation of an utmost fear hypothesis based on a habit persistence hypothesis, and (iv) development of collaborating management of technology which dramatically advances the generation and effective utilization of new innovative knowledge incorporating new value products, services, industries and businesses by means of a breakthrough of institutional impediments.

1.3 Noteworthy Accomplishments by Dimension

Dimension I　Systems Analysis on the Interaction Mechanism between Market and Technology

Japan had capabilities to overcome crises based on its xenophobia and high uncertainty avoidance. In the 90's, however, an institutional mismatch with the information society weakened its economy. But Japan was about to reactivate itself with its unique hybrid management style. In the current global economic recession, Japan is again tested for its crisis overcoming potential. A hierarchical structure of an institution dictates analyses on a "sector" level. Japanese institution was found to be a bottleneck for diffusion of the wind power, whereas nanotechnology sector suggests the strength that the institution inherently possesses. Numerical models connect both, being effective to clarification of the phenomena depending on institutions. Tie-ups between theory and verification are the key.

Dimension II　Identification of Japan's System of Innovation Cycle

II-a　Japan's System of Innovation Emergence

Sophisticated quality management of Japanese companies is based on high uncertainty avoidance. Their strengths have been enhanced at every crisis through down-to-the-earth efforts and Japanese corporations have made themselves into crisis-resilient composition. Side effects, however, of excessive pursuit for high quality have surfaced. While energy efficiency is outstandingly high in the industry sector, it is low in the residential and transport sectors due to an institutional slack. While Japanese patients tend to view doctor's error reporting actions and interactions with patients after a medical accidents relatively more harshly, in the healthcare risk management, where accumulated efforts mitigate such criticism, Japanese institution again draws attention. HQ's isomorphism and local differentiation orientation cause an institutional dilemma. But learning changes it into co-evolution.

II-b　Inventory Management of Intangible Assets

The roots of SCM is traced back to the integrated system of production, distribution and consumption that met a severe criticism by the US as structural impediments in late 80's and SCM has developed from the integrated decision making across different divisions to the one across different organizations. To raise competitiveness further, micro and macro methods should be combined and firms' capability to evolve according to environmental changes needs to be enhanced. Lack in cooperation between divisions led to the large amount of dormant patents, indicating a huge loss of intellectual resources. Based on the good cooperation between IP division and others, Japanese corporations need to raise a ratio of basic patents to an optimal level according to industrial characteristics.

II-c　Technology Start-up in Japan's Institutional System

Japan's IT investment level is not inferior to that in the US, but IT utilization level is desperately low, attributable to insufficient process-orientation. Indispensable are process visualization and changes of company soil through organizational reformation. In the future product market, affective (=being capable to evoke affects in people's mind or being capable to deliberate affects to be invoked in people's mind) technological products and services are decisively important, the key for consumption in the post global recession era. The concept can be expanded to the management, high-quality-orientation and the societal values. A case of successful venture indicates that in order for Japan-style e-commerce to be rooted, dynamism of interactions between value and trust need to work well.

Dimension III　Historical suggestion on the institution co-evolving with innovation

III-a　Management Science Perspective in Social Institution

From the viewpoints of finance and investment, the changes of governance structure of Japanese firms were examined in the comparison of abnormal returns between the companies where monitoring by stockholders works well and the ones where it does not, indicating global corporations maintain institutional complementarity although it may be indirect. Institutional effects on the relationship between firms' financial activities and the market were also observed based on the earnings management activities at IPO to indicate the characteristics clearly contrasted with the US market. The retail internationalization in Taiwan was analyzed through both the micro-aspect and the macro aspect to show the path where business know-how is transferred to China after merger with its domestic strength.

III-b　Historical Perspective into Social Institution

In order to capture the essence of technological developments, it is insufficient only to account for the mere accumulation of individual improvements. Instead, the historical trajectory can be understood by studying relationship in technologies and relationship between technologies and social institutions. Post-war technological developments were not necessarily rational, being under the heavy constraint of the social institution. Regarding the arguments on the correlations between science-technology and military-economic activities, the history of science policies of the Cold War America and post babble economy Japan were explored and a mathematical model for analyzing economic impact of basic research was introduced.

Dimension I Systems Analysis on the Interacting Mechanism between Market and Technology as a Critical Driving Force of Innovation

Dimension II Identification of Japan's System of Innovation Cycle

II - a) Japan's System of Innovation Emergence

II - b) Inventory Management of Intangible Assets

II - c) Technology start-up in Japan's Institutional System

Dimension III Historical suggestion on the institution co-evolving with innovation

III - a) Management Science Perspective into Social Institution

III - b) Historical Perspective into Social Institution

Co-evolutionary Dynamism between Innovation and Institutional Systems

- The Rise and Fall of the Japanese System of Management of Technology

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Abstract— **Japan has constructed a sophisticated co-evolutionary dynamism between innovation and institutional systems by transforming external crises into a springboard for new innovation. This can largely be attributed to the unique features of the nation such as having a strong motivation to overcoming fear based on xenophobia and uncertainty avoidance as well as abundant curiosity, assimilation proficiency, and thoroughness in learning and absorption. Such explicit dynamism was typically demonstrated by technology substitution for energy in the 1970s, leading Japan to achieve a high-technology miracle in the 1980s.**

While this dynamism shifted to the opposite direction in the 1990s due to a systems conflict with the rise of the information society, it became reactivated in the early 2000s by a hybrid management of technology between indigenous strength and learning from global best practice. Although reactivated firms have multi-polarized during the current period of global economic stagnation, Japan's model for transforming a crisis into a springboard for new innovation has drawn global concern and its application to supra-functionality for new consumption behavior is of interest around the world. Since the dramatic increase in oil prices during mid-2008 has signaled the possibility of a paradigm shift to a post-oil society, Japan's notable dynamism, based on an "utmost fear" hypothesis expected to be derived from supra-functionality may lead to a new entrepreneurial strategy toward such a society.

An empirical analysis is attempted to demonstrate this hypothetical view.

Index Terms— Innovation, Institutions, Co-evolution, Hybrid management, Functionality development, Open innovation

1. INTRODUCTION

1.1 Hypothetical Views

With the understanding that co-evolutionary dynamism between innovation and institutional systems is decisive for an innovation driven economy, careful observation of the rise and fall of the Japanese system of management of technology prompts the following hypothetical views:

(i) Based on xenophobia and uncertainty avoidance together with abundant curiosity, assimilation proficiency, and thoroughness in learning and absorption, Japan indigenously incorporates a sophisticated function in transforming external crises into a springboard for new innovation which can largely be attributed to a high level of technology productivity enabled by a virtuous cycle of a growth-oriented trajectory in an industrial society.

(ii) A paradigm shift to an information society based on a functionality development (FD) initiated trajectory reveals the limit of the traditional model and leverages the significance of FD that can be expected within the scope of the integration of the production, diffusion and consumption functions.

(iii) Provided that FD incorporates a declining nature, its sustainability is decisive to firm strategy to which IT's self-propagating development through earlier FD emergence in successive innovation based on the effective utilization of learning from preceding innovation is suggestive.

(iv) Such learning effects suggest the significance of follower substitution for a leader in the diffusion process corresponding to an open innovation stream.

(v) Such a stream highlights the significance of the hybrid management of technology fusing indigenous strength and learning from a digital economy enabled by co-evolutionary domestication.

(vi) Confronting the current global economic stagnation resulting in diminishing consumption, utmost gratification of consumption by means of supra –functionality which instills in customers an "exciting story with their own initiative as heroes/heroines" and thrills them gratification is essential for activating co-evolutionary domestication dynamism.

(vii) Experiencing the dramatic increase in oil prices in mid-2008, this endeavor may lead to reactivation of Japan's indigenous explicit function in transforming "utmost fear" into a springboard for new innovation toward a post-oil society. Japan's explicit co-evolutionary dynamism between innovation and institutional systems can thus be activated.

1.2 Structure

Aiming at demonstrating the foregoing hypothetical views, the following seven dimensional analyses were attempted:

(i) Japan's system in transforming external crises into a springboard for new innovation,

(ii) Limit of substitution model in a production function in a new paradigm of an information society,

(iii) Co-evolutionary domestication for sustainable FD,

(iv) Open innovation for sustainable FD,

(v) Hybrid management of technology,

(vi) Supra-functionality leading to an utmost fear hypothesis, and

(vii) New innovation dynamism toward a post-oil society.

2. JAPAN'S SYSTEM IN TRANSFORMING CRISES INTO A SPRINGBOARD FOR INNOVATION

Japan's Co-Evolution and Development Cycle - Learning and Assimilation

As demonstrated in **Fig. 1**, Japan accomplished conspicuous X-efficiency during the period of an industrial society. The contribution of learning to TFP (Total Factor Productivity) amounted to 50% in this period. This can largely be attributed to Japan's intensive cumulative learning efforts with its unique function as (i) motivated by xenophobia and uncertainty avoidance [29], and (ii) abundant curiosity, assimilation proficiency, thoroughness in learning and absorption [58] <1, 2>. Based on this unique function, Japan's system of MOT achieved co-evolutionary development by learning and assimilating advanced innovation and advancement of its own institutional systems and indigenous innovation, which in turn further accelerated more qualified learning (see Appendix A) leading to high performance (much higher than the US as demonstrated in Figs. 1 and 2) in terms of technological development in an industrial society [74], [75], [77] (see ***Appendix A***).

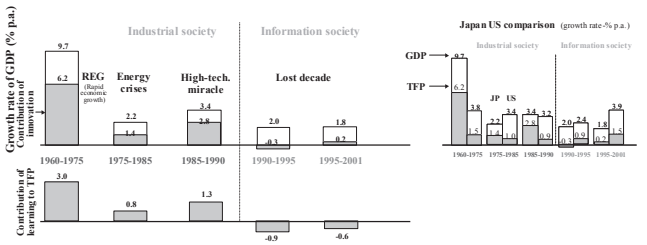


Fig. 1. Trend in Contribution of Learning to TFP and Consequent GDP Growth Rate in Japan *(1960-2001) - % p.a.*.

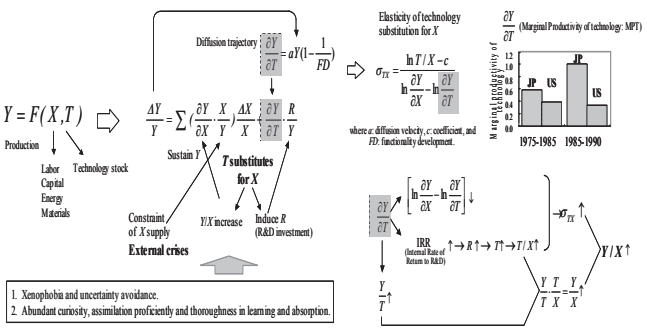


Fig. 2. Japan's Notable Dynamism in Transforming External Crises into a Springboard for New Innovation.

This high performance technological development, together with a strong motivation for overcoming fear based on xenophobia and uncertainty avoidance, constructed a sophisticated system in transforming external crises into a springboard for new innovation. Fig. 2 illustrates this notable dynamism.

Japan's foregoing unique institutional system led to a high level of MPT (Marginal Productivity of Technology) leveraging a conspicuously high level of elasticity of technology substitution for energy (σTX) [76], [80] leading to a shift from energy to technology *(T/E),* and increased technology productivity (*Y/T*) which generated a notable energy productivity as a multiplier effect of these accomplishments (*Y/E = (T/E)(Y/T)*). Enhanced energy productivity relaxed energy constraints and enabled sustainable growth which again induced higher MPT leading to constructing a virtuous cycle between the foregoing improvement.

2.2 Technology Substitution for Energy

This explicit dynamism was typically demonstrated by technology substitution for energy in the 1970s that led Japan to achieve the world's highest level of energy efficiency improvement as demonstrated in Figs. 3 and 4 [79] (***Appendix B***) <3>.

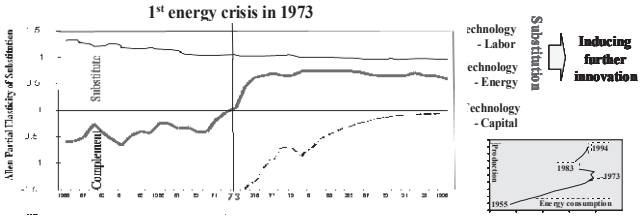


Fig. 3. Trends in Technology Substitution for Production Factors in the Japanese Manufacturing Industry *(1955-1997) - Allen Partial Elasticity of Substitution*.

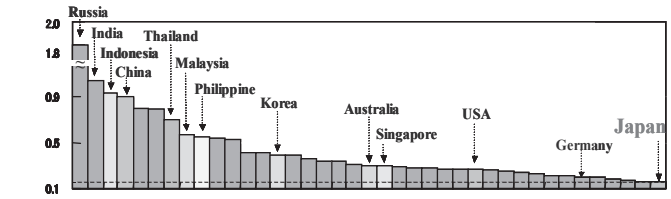


Fig. 4. Energy Consumption per GDP in 40 Countries *(2004)*.

Noteworthy is that such conspicuous energy efficiency can be attributed to similar substitution efforts in the 1960s, technology substitution for labor and cross sector technology spillover as demonstrated in Fig. 5 [82] that suggests a coopetition (cooperation and competition) strategy in the 1990s [9].

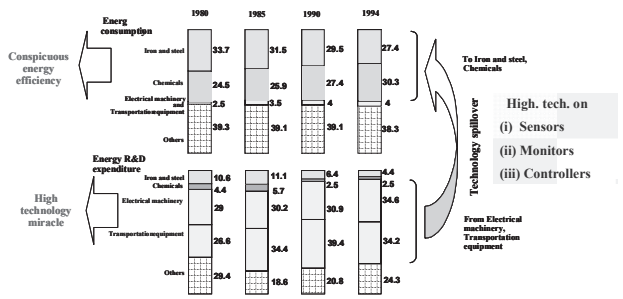


Fig. 5. Technology Spillover from Electrical Machinery and Transportation Equipment to Iron and Steel and Chemical in Japan *(1980-1994)*.

2.3 Limit of Substitution Model

However, due to feature differences between MT and IT [86], Japan's notable dynamism moved in the opposite direction in an information society of the 1990s as demonstrated in Fig. 6.

This reveals the limit of substitution model in a production function and leverages the significance of production, diffusion and consumption integration.

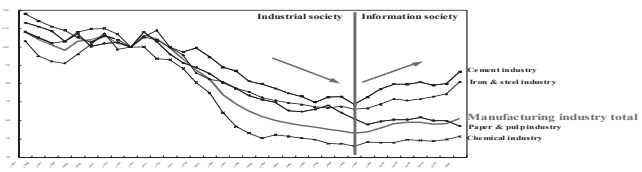


Fig. 6. Trend in Unit Energy Consumption in the Japanese Manufacturing Industry *(1965-1998)* – Index: 1973 = 100.

3. LIMIT OF SUBSTITUTION MODEL IN A PRODUCTION FUNCTION

3.1 Functionality Development in Innovation

Table 1 compares features of manufacturing technology (MT) and IT with respect to an industrial society and an information society, respectively. While the former leads with a growth oriented trajectory, the latter initiates functionality development (FD) with an initiated trajectory [86].

Table 1 Comparison of Features between Manufacturing Technology and IT

	1980s	1990s
Paradigm	**Industrial society**	**Information society**
Core technology	**Manufacturing technology (MT)**	**IT**
1. Key features formation process	Provided by suppliers	Formed through the interacting with institutions
2. Fundamental nature	As given at the development stage	Formed in a self-propagating way during the course of diffusion
3. Development trajectory	**Growth oriented trajectory**	**Functionality development initiated trajectory**

Fig. 7 demonstrates diffusion trajectories in Japan's fixed and mobile phones (MP). MP as a crystal of IT, demonstrates self-propagating development with enhancement of FD [10], [11].

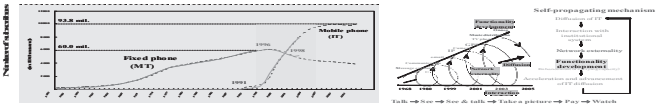


Fig. 7. Diffusion Trajectories in Japan's Fixed and Mobile Phones.

FD plays a decisive role in an information society and it can be depicted by the following diffusion trajectory [95].

(i) Diffusion trajectory can be depicted by an epidemic function.

$$\frac{dY}{dt} = aY\left(1-\frac{Y}{N}\right) \quad \blacksquare \quad Y = \frac{N}{1+be^{-at}}$$

where Y: Production of innovative goods; N: Carrying capacity; and a: Velocity of diffusion.

(ii) FD can be defined as follows:

Y continues to diffuse as far as it incorporates

"Ability to improve performance of production processes, goods and services by means of innovation" = FD

(iii) FD can be measured by the following way:

Y terminates to diffuse when it reaches *N*

(i) $Y \rightarrow N$ ■ $\frac{dY}{dt} = 0$ **(obsolescent stage of FD)**

(ii) FD can be defined as "Potential capacity before reaching obsolescent stage"

(iii) Degree of FD = $N/Y = 1+be^{-at}$ ■ **Declining nature**

(iv) Firm competitive strategy should focus on sustaining FD.

Efforts to prolong higher level of FD ■ **Sustainable FD** ■ **Self-propagating FD**

3.2 FD for Firm Sustainable Growth

Fig. 8 compares growth options and identifies that FD could be the only option for sustainable growth in an information society.

$$Y = F(X,T) \quad \Rightarrow \quad \frac{\Delta Y}{Y} = \sum\left(\frac{\partial Y}{\partial X}\cdot\frac{X}{Y}\right)\frac{\Delta X}{X} + \frac{\partial Y}{\partial T}\cdot\frac{R}{Y}$$

$$\frac{\partial Y}{\partial T} = aY\left(1-\frac{Y}{N}\right) = aY\left(1-\frac{1}{FD}\right), \quad FD = \frac{N}{Y} \quad \Rightarrow \quad Y = \frac{N}{1+e^{-aT-b}}$$

Y: Product of innovative goods; L: Labor; K: Capital; T: Technology; R: R & D investment; N: Carrying capacity; b: Diffusion at the initial stage

Growth
- **Traditional production factors** (Labor, Capital)
- **TFP**
  - **R&D intensity**
  - **Marginal productivity of technology (MPT)**
    - **GDP**
    - **Diffusion velocity**
    - **FD**

Economic growth dependent model: Depend on *Y*
- Growth Oriented Trajectory

Contribution to labor and capital — TFP growth rate (technological progress)

$$\frac{\Delta Y}{Y} = \sum_{X=L,K,M,E}\left(\frac{\partial Y}{\partial X}\cdot\frac{X}{Y}\right)\frac{\Delta X}{X} + \frac{\partial Y}{\partial T}\cdot\frac{R}{Y}$$

$$\frac{\partial Y}{\partial T} = aY\left(1-\frac{1}{FD}\right)$$

Marginal productivity of technology

New functionality development model: Stimulate *FD*
- New Functionality Development Initiated Trajectory

$$\frac{\Delta Y}{Y} = \sum_{X=L,K,M,E}\left(\frac{\partial Y}{\partial X}\cdot\frac{X}{Y}\right)\frac{\Delta X}{X} + \frac{\partial Y}{\partial T}\cdot\frac{R}{Y}$$

$$\frac{\partial Y}{\partial T} = aY\left(1-\frac{1}{FD}\right)$$

Japan (1980s, 1990s) US (1980s) → **US (1990s)**

System conflict — System match

Fig. 8. Contrast of Growth Option.

Fig. 9 compares development paths in Japan and the US. Japan's systems conflict with an information society led to institutional inelasticity, resulting in a dramatic decrease in FD. The decrease in FD then led to reduced MPT which resulted in a TFF decrease [89] (see ***Appendix C***) <4>.

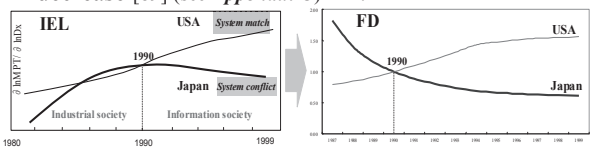


Fig. 9-1. Institutional Elasticity of Manufacturing Technology - Elasticity of the Shift to an Information Society to Marginal Productivity of Technology *(1980-1999) - Index: 1990 =100.*

Fig. 9-2. Functionality Development *(1987-1999) - Index: 1990 =1.*

$$V = F(L,K,T)$$

$$\ln V = A + \alpha\ln L + \beta\ln K + \gamma_1\ln T + \gamma_2 D_x\ln T$$

where A: scale factor; α, β, γ_1, and γ_2: elasticities; D_x: coefficient dummy variable representing the trend in shifting from an industrial society to an information society ($D_x = \frac{1}{1+e^{-a+b}}$, a, b: coefficients).

$$MPT = \frac{\partial V}{\partial T} = \frac{\partial \ln V}{\partial \ln T}\cdot\frac{V}{T} = (\gamma_1+\gamma_2 D_x)\cdot\frac{V}{T}$$

$$MPT = F(V,T,D_x)$$

$$\ln MPT = B + \alpha_1\ln V + \alpha_2\ln T + \alpha_3\ln D_x + \beta_1\ln V\cdot\ln T + \beta_2\ln V\ln D_x + \beta_3\ln T\ln D_x$$

where B: scale factor; α_i and β_i ($i = 1\sim3$): elasticities.

$$IEL\ (\text{Institutional Elasticity}) = \frac{\partial \ln MPT}{\partial \ln D_x}$$

$$MPT = aV\left(1-\frac{1}{FD}\right),\ FD = \frac{1}{1-(MPT/aV)}$$

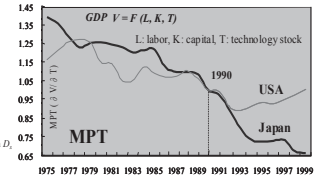


Fig. 9-3. Marginal Productivity of Manufacturing Technology *(1975-1999) - Index: 1990 =1.*

TFF change rate (ΔTFP/TFP) = R&D intensity (R/V) × Marginal productivity of technology (MPT)

Innovation to GDP growth

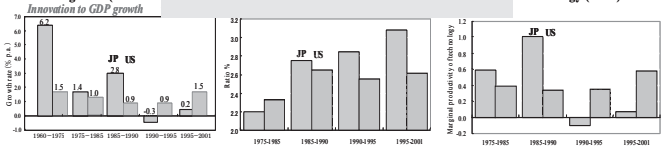


Fig. 9-4-1. TFP Growth Rate *(1960-2001).* **Fig. 9-4-2. R&D Intensity** *(1975-2001).* **Fig. 9-4-3. Marginal Productivity of Technology** *(1960-2001).*

3.3 Integration of Production, Diffusion and Utility Functions

As the paradigm shifts to an information society, the place where innovation occurs shifts from production sites to diffusion and consumption processes leading to a great signi-ficance of production, diffusion and consumption integration. Fig. 10 demonstrates the significance of this integration for sustainable growth in an information society. FD enhances utility which induces consumption leading to increased GDP (Y). Increased Y induces R&D investment leading to a technology stock (T) increase. Increased T enhances the carrying capacity (N) of diffusion trajectory leading to an FD increase. Increased FD increases MPT which induces a higher elasticity of T substitution for X (other production factors). Higher elasticity induces an X productivity increase as $Y/X = Y/T \times T/X$ contributing to sustainable growth <5>.

(i) Production Function

$$Y = F(X,T) \Rightarrow \frac{\Delta Y}{Y} = \sum\left(\frac{\partial Y}{\partial X}\cdot\frac{X}{Y}\right)\frac{\Delta X}{X} + \frac{\partial Y}{\partial T}\cdot\frac{R}{Y}$$

MPT — R&D intensity

(ii) Diffusion Function (Cumulative Y diffuses as a function of T)

$$\frac{\partial Y}{\partial T} = aY\left(1-\frac{Y}{N}\right) = aY\left(1-\frac{1}{FD}\right) \qquad FD = N/Y$$

Functionality development

(iii) Production Diffusion Integration — *Innofusion*

Growth rate — Traditional production factors — TFP increase rate

$$\frac{\Delta Y}{Y} = \sum\left(\frac{\partial Y}{\partial X}\cdot\frac{X}{Y}\right)\frac{\Delta X}{X} + \frac{\partial Y}{\partial T}\cdot\frac{R}{Y}$$

$$\frac{\partial Y}{\partial T} = aY\left(1-\frac{1}{FD}\right)$$

Functionality development

In order to maintain sustainable FD, further integration of utility function is indispensable.

(iv) Production, Diffusion and Utility Integration — *Innofumption*

Technology substitution for constrained production factors

$$\sigma_{TX} = \frac{\ln T/X - c}{\ln\frac{\partial Y}{\partial X} - \ln\frac{\partial Y}{\partial T}}$$

ETS — σ_{TX}: Elasticity of technology substitution (ETS) for X, and c: coefficient.

$$\frac{\Delta Y}{Y} = \sum\left(\frac{\partial Y}{\partial X}\cdot\frac{X}{Y}\right)\frac{\Delta X}{X} + \frac{\partial Y}{\partial T}\cdot\frac{R}{Y}$$

$$\frac{\partial Y}{\partial T} = aY\left(1-\frac{1}{FD}\right)$$

MPT

Utility function

$U(FD) \rightarrow C \rightarrow Y \rightarrow R \rightarrow T \rightarrow N \rightarrow FD$

1. ***FD* enhances utility which induces *C* (consumption) leading to *Y* increase.**
2. **Increased *Y* induces *R* (R&D) leading to *T* (technology stock) increase.**
3. **Increased *T* enhances *N* (carrying capacity) leading to *FD* (= *NY*) increase.**
4. **Increased *FD* increases MPT which induces higher ETS.**
5. **Higher ETS induces *X* productivity increase ($\frac{Y}{T}\frac{T}{X} = \frac{Y}{X}$)**

Fig. 10. Integration of Production, Diffusion and Utilization Functions.

While such co-evolution in an integrated system is decisive for firm competitiveness in an information society, the mecha-nism enabling such dynamism remains a black box <6>.

4. CO-EVOLUTIONARY DOMESTICATION FOR SUSTAINABLE FUNCTIONALITY DEVELOPMENT

4.1 Emergence of FD in a Diffusion Trajectory

Aiming at elucidating the foregoing black box, a key to sustainable FD in mobile phone (MP) diffusion was elucidated as its development is typical of Japan's institutions, similar to the way that elephant tortoises have developed in the unique environment of the Galapagos islands. Fig. 11 depicts the timing of FD emergence and the level at that timing in the diffusion trajectory of innovation that is identified as $3+\sqrt{3}$ by Mahajha et al. [38], [49], [60].

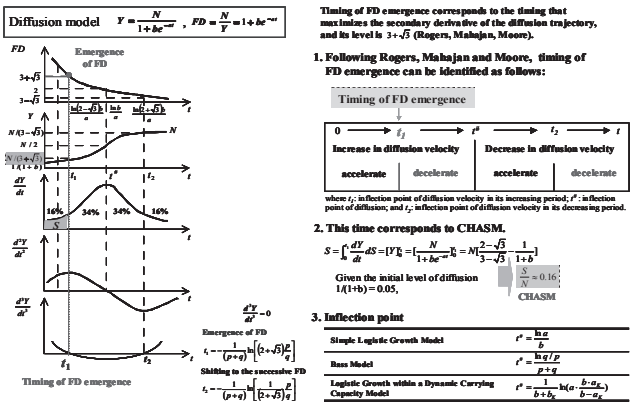


Fig. 11. Level and Timing of Inflection in Diffusion Trajectory.

The monthly diffusion trajectory of Japan's mobile phones (MP) over the last decade can be traced by a bi-logistic growth model. This suggests that Japan's MP diffusion in the last decade was initiated by two waves Y_1 and Y_2. Figs. 12, 13 and Table 2 demonstrate the decomposed trajectories.

$$Y = Y_1 + Y_2 = \frac{N_1}{1+b_1 e^{-a_1 t}} + \frac{N_2}{1+b_2 e^{-a_2 t}}$$

$Y(t)$: cumulative number of MP diffusion at time t;

N_1, N_2: carrying capacities; a_1, a_2: velocity of diffusion;
b_1, b_2: initial stage of diffusion; and t: time trend by month (Dec. 95 =0, Jan. 96 =1).

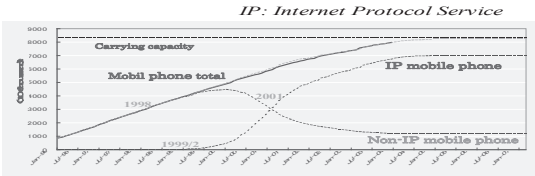


Fig. 12. Diffusion Trends in Japanese Mobile Phones *(Jan. 1996-Dec. 2006)*.

Table 2 Estimation of Japan's Mobile Phones Diffusion by the Bi-logistic Growth Model *(Jan. 1996-Dec. 2006)*

	N_1	a_1	b_1	N_2	a_2	b_2	*adj.* R^2
Parameter	35.147	0.074	5.198	65.418	0.036	14.028	0.999
t-value	2.25	4.59	3.26	3.81	6.74	1.33	

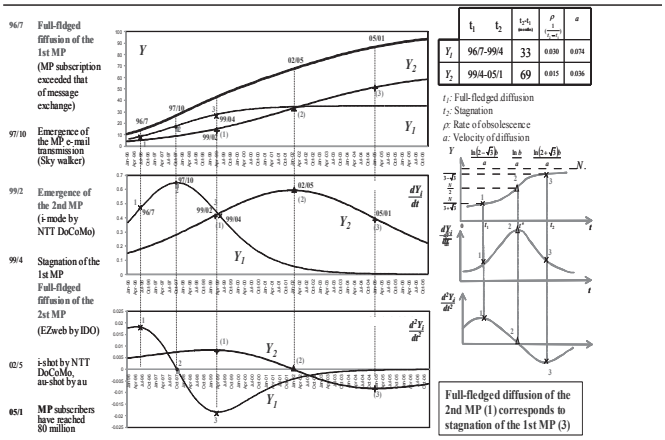


Fig. 13. Diffusion Dynamism of Japan's Mobile Phones *(Jan.. 1996 – Dec. 2006)*.

4.2 Earlier Emergence of FD Based on Learning

Corresponding to full-fledged diffusion of the 1st MP (96/7), FD emerged. Its level was $3+\sqrt{3}$. The 2nd MP FD emerged at 99/2 with a level of 5. This can be attributed to the earlier emergence of FD (2months earlier than full-fledged diffusion of the 2nd MP (99/4)) based on the effects of cumulative learning of the preceding innovation as illustrated in Fig. 14. Thus, sustainable FD was realized and the FD function can be depicted thereon <7>.

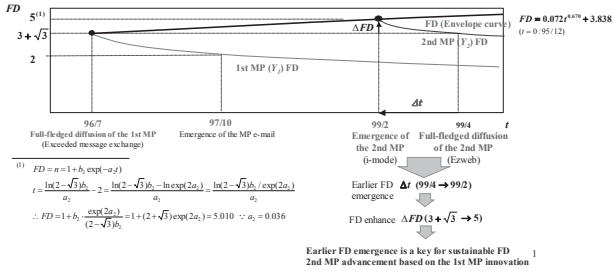


Fig. 14. Functionality Development Trajectory of the Successive Innovation in Japan's Mobile Phones.

Based on this function, the MP price function can be identified and governing factors were estimated as tabulated in Table 3.

$$P = A \cdot FD^{\alpha} \cdot N^{\beta} \cdot e^{\gamma t + \delta D} \qquad \ln P = \ln A + \alpha \ln FD + \beta \ln N + \gamma t + \delta D_1$$

$$\ln P = -718.181 + 589.339 \ln FD - 39.199 \ln N - 0.606 t + 0.031 D_1$$
(-6.58) (6.65) (-6.73) (-6.72) (12.55)

$adj.\ R^2 = 0.998,\ DW = 1.53$

P: Prices of mobile phone handsets (Bank of Japan),
A: Scale factor,
FD: Functionality development,
N: Number of subscribers (TCA: Telecommunication Carriers Association)
t: Monthly trend
D: Dummy variables depicting the events of mobile phones development.
$\alpha, \beta, \gamma, \delta$: elasticity.

Table 3 Factors Contributing to Change in Prices of Japan's Mobile Phones Handset *(Jan.1996-Dec.2006)*

	P	*FD*	*N*	*time*	*residuals*
00/1-02/5	-0.12	12.90	-6.07	-7.26	0.32
02/5-05/1	-0.14	10.37	-3.26	-7.26	0.02
05/1-06/12	-0.09	10.30	-1.74	-7.26	-1.39

4.3 Co-evolutionary Domestication

Fig. 15 demonstrates the driving forces of MP development which suggests that (i) FD increases prices, (ii) learning corres-ponding to subscribers increase and economics of scale decrea-se prices, and (iii) dynamism between these factors plays the role of an engine in MP development.

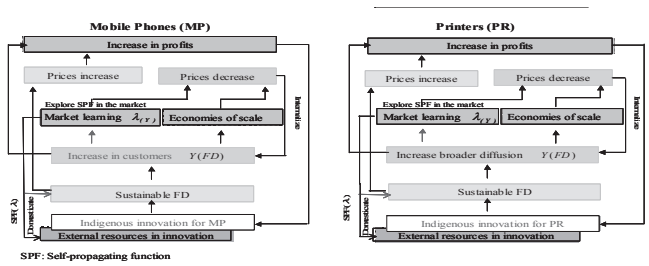


Fig. 15. Contrast of Co-evolutionary Domestication between MP and Printers.

Noteworthy is that an FD increase induces subscribers to increase, which supports market learning and restores the effects of learning as innovation resources for succeeding MP innovation in a co-evolutionary way. This dynamism can be called co-evolutionary domestication [98] as it enables MP co-evolutionary development in production, diffusion and consumption integration [97]. Coopetition (cooperation and competition) dynamism [9] initiated by the development of Canon printers development demonstrates a similar dynamism as contrasted in Fig. 15 ***(see Appendix D and E).***

5. OPEN INNOVATION FOR SUSTAINABLE FUNCTIONALITY DEVELOPMENT

5.1 Innovator Imitator Dynamics in a Diffusion Trajectory

Inspired by the preceding findings on the earlier emergence of FD by means of effective utilization of learning of preceding innovation, by utilizing the Bass model, innovator and imitator dynamism accelerating earlier FD emergence was analyzed as illustrated in Fig. 16.

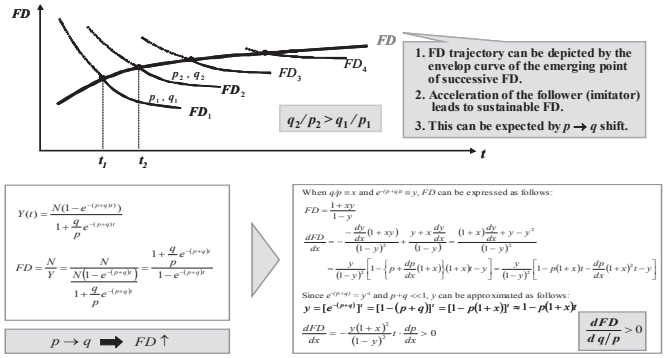


Fig. 16. Scheme of Functionality Development of the Successive Innovation in a Bass Model.

By utilizing a newly developed Bi-Bass model, innovator (p) and imitator (q) interaction in the transition from Web 1.0 to Web 2.0 was analyzed as demonstrated in Table 4 and Fig. 17. It could be demonstrated that FD increases as the ratio of q/p increases corresponding to the shift from innovator to imitator.

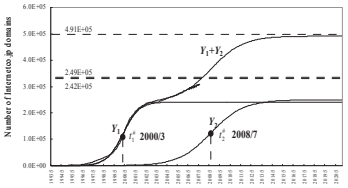
Table 4 Estimation of Japan's Internet co.jp Domains by Bi-Bass Model (*May 1993 – June 2006*)

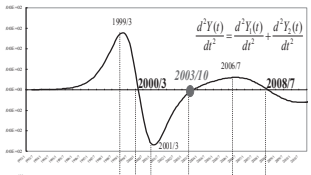
$$Y(t)=\frac{N_1(1-e^{-(p_1+q_1)t})}{1+\frac{q_1}{p_1}e^{-(p_1+q_1)t}}+\frac{N_2(1-e^{-(p_2+q_2)t})}{1+\frac{q_2}{p_2}e^{-(p_2+q_2)t}}$$

Parameter	Estimate	t-value	*adj. R^2*	*AIC*
N_1	2.42×10^5	145.87	0.999	17.08
N_2	2.49×10^5	75.66		
p_1	1.38×10^{-5}	8.35	$q_1/p_1=0.78\times10^4$	
q_1	1.08×10^{-1}	58.33		
p_2	0.25×10^{-5}	2.60	$q_2/p_2=2.20\times10^4$	
q_2	0.55×10^{-1}	22.74		

Shift from p to q: $q_1/p_1 < q_2/p_2$ ➡ **Innovator (leader) → Imitator (follower)**, **Transition from Web 1.0 to Web 2.0**

Transition to Web 2.0 (Inflection time): Y_1 $t_1^*=\frac{\ln q_1/p_1}{p_1+q_1}$ 82.9 (2000/3) ➡ Y_2 $t_2^*=\frac{\ln q_2/p_2}{p_2+q_2}$ 182.9 (2008/7)





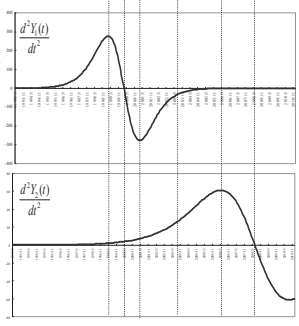


Fig. 17. Estimation of Japan's Internet co.jp Domains by Bi-Bass Model (May 1993- Dec. 2010)[a]

[a] May 1993 - Jun. 2006: actual, and Jul. 2006–Dec. 2010: estimate.

1. Inflection points of Web 1.0 and Web 2.0 are 2000/3 and 2008/7, respectively.
2. Transition from Web 1.0 to Web 2.0 was occurred between them which was identified as 2003/10 when $\frac{d^2Y}{dt^2}=\frac{d^2Y_1}{dt^2}+\frac{d^2Y_2}{dt^2}=0$

Fig. 18. Trend in Trend in Inflection Points in Japan's Internet co.jp Domains (*May 1993 – Dec. 2020*).

Based on Fig. 11, Fig. 18 analyzed the transition from Web 1.0 to Web 2.0 and demonstrated that this transition emerged in 2003/10.

5.2 Emergence of FD in a Diffusion Trajectory

However, similar to i-mode in MP, a substantial transition was initiated by RSS 2.0 in 2003/7, leading to an increasing envelope curve as illustrated in Fig. 19, which demonstrates a substantial FD increase by shifting from Web 1.0 to Web 2.0. Table 4 demonstrates that such an increase was enabled by imitator substitutes for innovator as the q/p increased 3 times.

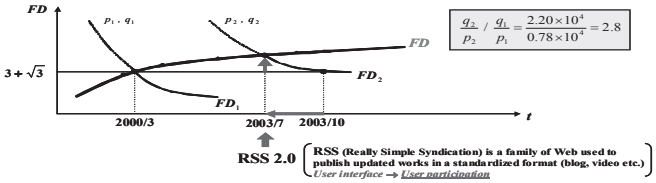


Fig. 19. Earlier Emergence of Functionality Development in Web 2.0.

Aiming at identifying the impact of this substitution on an FD increase, utilizing the timing of FD emergence (t_1) as analyzed in Table 11, and inducing the impacts of a q/p increase on the acceleration of t_1 emergence leading to an FD increase was analyzed as demonstrated in Fig. 20 (***Appendix L***).

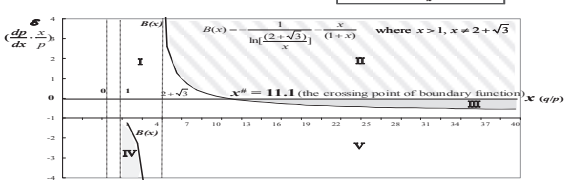


Fig. 20. Areas Satisfying Earlier FD Emergence.

5.3 Follower Substitution for a Leader

Based on the foregoing finding, an empirical analysis on the impact of a q/p increase on FD emergence was then conducted based on printers, software, MP, LCD and the Web as demonstrated in Table 5 and Fig. 21 [93] (see ***Appendix H and I***).

Table 5 Diffusion Parameters in Major Innovative Goods

		N	*p*	*q*	*adj. R^2*
Printer	LLBP (1975-1994)	1581 (19.33)	5.43×10^{-5} (15.13)	5.8×10^{-2} (9.94)	0.999
	LBP/BJ (1987-2003)	97205 (166.87)	1.47×10^{-5} (2.27)	2.9×10^{-2} (37.96)	0.999
SW	Software (1990-2006)	999.9 (97.11)	0.73×10^{-5} (13.30)	3.6×10^{-2} (3.37)	0.998
MP (1990-2006)	MP 1	38216 (149.48)	0.70×10^{-5} (8.388.9)	0.8×10^{-1} (2616.7)	0.999
	MP 2	65741 (170.24)	0.37×10^{-5} (1270.1)	0.15×10^{-1} (435.3)	0.999
LCD (2000-2008)	LCD 1	2.4×10^5 (1684.3)	0.3×10^{-5} (1684.3)	0.2×10^{-1} (1684.3)	0.999
	LCD 2	2.4×10^5 (686.1)	0.4×10^{-5} (1684.3)	0.8×10^{-1} (1684.3)	
Web (1993-2006)	Web 1.0	2.42×10^5 (148.87)	1.38×10^{-5} (8.38)	1.08×10^{-1} (88.33)	0.999
	Web 2.0	2.49×10^5 (75.66)	0.25×10^{-5} (2.60)	0.55×10^{-1} (22.74)	

[a] LLBP: Large-scale Laser Beam Printer; LBP: Laser Beam Printer; BJ: Bubble Jet Printer; SW: Japan's software outsourcing to China; LCD: Liquid Crystal Display; MP: Mobile phone; and Web: Internet dependency based on the number of co.jp domains.

Figures in parentheses indicate *t*-value. All demonstrates statistically significant at the 5% level.

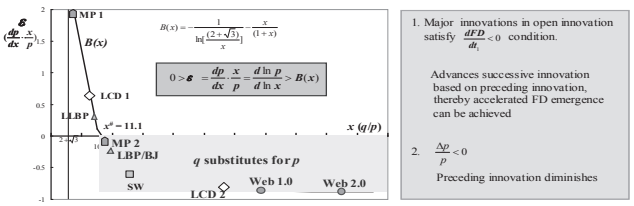


Fig. 21. Sustainable Functionality Development Condition.

All demonstrated that imitator (follower) substitutes for innovator (leader) contribute to greater FD leading to increased firm competitiveness increase in corresponding to an open innovation stream.

6. HYBRID MANAGEMENT OF TECHNOLOGY

6.1 Canon's Success in Hybrid Management

Canon has developed a similar sustainable FD strategy as demonstrated for MP and the Web depending on a technological diversification strategy which maximizes the effect of intra-firm technology spillover such as camera to copying machines, print -ers and digital cameras as demonstrated in Fig. 22 [87], [88], [94] <8>.

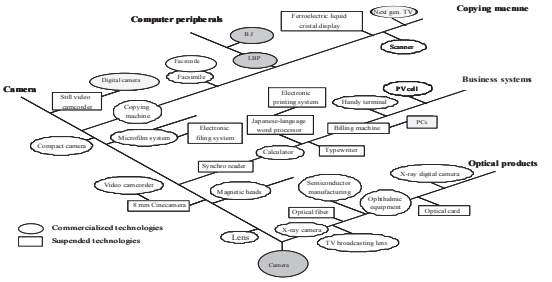


Fig. 22. Canon's Technological Diversification Paths.

Canon has thus constructed a co-evolutionary trajectory between printers and PCs called coopetition, cooperation with a competitor, as demonstrated in Fig. 23 [9], [95].

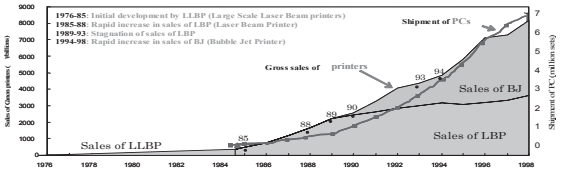


Fig. 23. Co-evolutionary Trajectory between Canon Printers and PCs *(1976-1998)*.

6.2 Functionality Development by Fusing

Consequently, Canon has thus constructed sophisticated hybrid management that enabled smart fusing between its strength and learning from external competitors thereby sustainable FD was enabled [95]. Basic scheme of this management can be depicted as follows (see ***Appendix F***):

Sustainable functionality development condition

$$\frac{d}{dT}FD > 0 \Rightarrow \frac{d\ln\kappa}{d\ln T} > 1 \quad \begin{cases} \dfrac{d\ln\kappa}{d\ln T} < 1 & P = A_1 T^{\kappa} \quad \text{Can not satisfy} \\ \dfrac{d\ln\kappa_2}{d\ln T} > 1 & \begin{cases} P = AT^{\kappa_1}/PC^{\gamma} = AT^{\kappa_1}/\kappa_2 \\ T = B \cdot PC^{\phi} \end{cases} \end{cases}$$

Can be satisfied by: Two factors learning; Inducement by PC

where $\kappa = \dfrac{\partial \ln P}{\partial \ln T}$: elasticity of technology to relative prices; T: technology stock; and P: relative price.

Sustainable FD requirement can be satisfied only by two factors learning and effective technology inducement by the advancement of PC as demonstrated in Fig. 24 and Table 6.

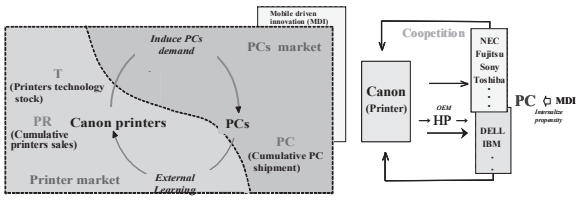


Fig. 24. Virtuous Cycle between Canon Printers and PCs.

Table 6 Coopetition between Canon Printers and PCs *(1986-1998)*

Relative prices of printers technology	Printers technology stock	Cumulative PC shipment	1986, 2000-05=1, other years=0.		
$\ln P = 3.34 + 0.08 \ln T + 0.40 \ln PC - 0.25 D$				$adj.R^2$	0.997
(165.75)	(67.66)	(67.66)	(-8.14)	DW	1.60
	Internal learning	External learning			
$\ln P_V = 1.04 - 0.33 \ln PR - 0.18 \ln PC$				$adj.R2$	0.999
(1.74)	(-5.01)	(-5.14)		DW	2.55
Price of printers	Cumulative printers sales	Cumulative PC shipment			

6.3 Co-evolutionary Domestication from the Market

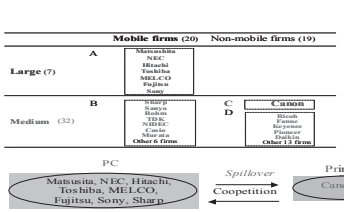
Canon's coopetition strategy enables it effective utilization of its indigenous strength in assimilating external technology not only directory from its rivals but also indirectly through market.

MP driven innovation can be attributed to both Japan's indigenous institutional systems and effects of fusing its indigenous strength in MT and the cumulative learning from digital technology as demonstrated in Table 7 [11]. Broad firms involved in this development as tabulated in Table 8 [10], [97].

Table 7 Core Technologies in Mobile Innovation Spillover

1. Semi conductor	2. Electronics	3. Sensor	4. Materials
5. Battery	6. Wireless Communication	7. IC card	8. Liquid Crystal
9. Optics	10. Acoustic	11. Micro Devices	12. High Density
13. Application	14. Plat form	15. Security	16. Compression

Table 8 Impacts of Mobile Driven Innovation on Electric Machinery Firms *(2000-2005)*



R&D intensity — Spillover effects

$$OIS = a + b \ln R/S + c\sum_{j=1}^{38} R_j \Big/ R + dD$$

	Constant	ln R/S	$\sum R/R$
A	0.089	0.034	0.15E-03
B	0.660	0.194	0.15E-03
C	0.097	0.030	5.08E-03
D	0.097	0.030	0.15E-03

$$OIS = 0.097 + 0.563\,D_{ma} + 0.287\,D_{lg} - 0.571\,D_{sp} + 0.039\,D_{c}$$
$$(1.89)\ (5.18)\ \ (10.87)\ \ (-2.44)\ \ (3.36)$$
$$+ 0.030 \ln R/S + 0.164\,D_{ma} \ln R/S - 0.160\,D_{sp} \ln R/S$$
$$(1.76)\ \ (4.76)\ \ (-1.94)$$
$$+ 0.153\times10^{-4}\sum R/R + 4.850\times10^{-11} D_{ca}\sum R/R$$
$$(6.20)\ \ (2.40)$$
$$adj.\ R^2 = 0.782$$

where D_{ma}: Mobile firms = 1, non-mobile firms = 0; D_{sp}: Large firms = 1, medium firms = 0; D_c: 2003~2005 = 1, 2000~2002 = 0; D_{ca}: Canon = 1, other firms = 0; D_{lg}: Fanuc, Kayence = 1 (Non-mobile but high OIS: over 25%), other firms = 0.

Table 8 compares impacts of MP driven innovation on 39 electric machinery firms profit suggesting that: (i) mobile firms *(A,B)* demonstrate higher dependency on R/S for their OIS, (ii) medium firms depend higher spillover effects through learning. (iii) while Canon is non-mobile firms, it utilizes highest spillover effects through intensive learning and coopetition with mobile firms majority of them are PC producers and partner of coopetition.

Thus, Canon has constructed a comprehensive co-evolutionary domestication dynamism as demonstrated in Fig. 25 consists of

(i) Market stimulation by providing attractive innovation,
(ii) Inducement of self-propagating FD in the market,
(iii) Leveraging vendors innovation in response to market demand,
(iv) Domestication by learning and inducement through coopetition, and
(v) Intra-firm technology spillover..

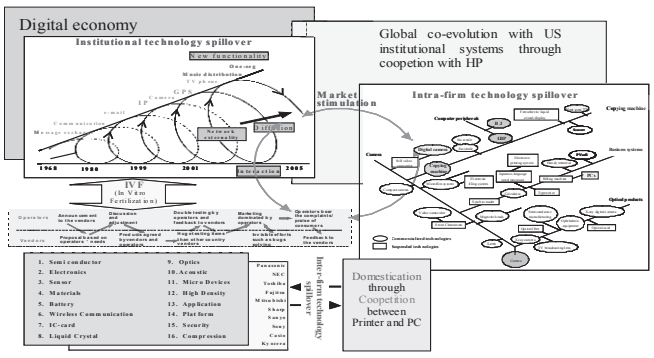


Fig. 25. Scheme of Canon's Co-evolutionary Domestication.

Noteworthy is that this dynamism has been constructed in a stepwise way starting from (i) individual technology, (ii) intra technology spillover, (iii) domestication of rival firms (coopetition), to (iv) domestication of market innovation.

Canon's fusing option can be compared to Google's business model, while Hitachi's model can be compared to that of Microsoft <9, 10>.

7. -FUNCTIONALITY LEADING TO THE "UTMOST FEAR HYPOTHESIS"

7.1 Dynamism Leading to Supra-Functionality

As reviewed in the preceding Section, Japan's global high-technology firms as Canon constructed sophisticated hybrid management system by making effective utilization of external resources and fusing it with indigenous strength. Consequently, these firms demonstrated conspicuously high level of R&D profitability as demonstrated in Fig. 26 <11, 12>.

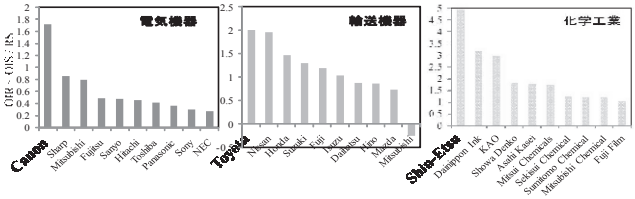


Fig. 26. Operating Income to R&D in 10 Leading Firms in 3 High-technology Sectors in Japan (*2001-2007*).

[a] OIS = OI / S (Operating income to sales); RS = R / S (R&D intensity).

Supported by these global high-technology firms, Japan's economy was succeeded in reactivation in the early 2000s. However, confronting the current global-wide economic stagnation, these firms resulted in decreasing their profits again from the late 2008. This can largely be attributed to diminishing consumption in the hybrid management partners and subsequent stagnation of their innovation.

Important lesson learned from the current global-wide stagnation is the termination of traditional consumption dependent economy that anticipated the recovery of consumption simply by business upturn.

With the understanding that reactivation of Japan's economy is indispensable to sustaining world economy and that maintaining Japan's hybrid management will play a key role for this, institutional way of activation of consumption is examined as this could lead to reactivating innovation of hybrid management partners essential for Japan's hybrid management of technology.

Prompted by habit persistence hypothesis (Modigliani) [47] that people never forget its utmost gratification of consumption ever experienced in its life, and, therefore, people's consump tion behavior is affected by its utmost gratification, supra-FD which may remind people supra-functionality ever experienced was examined. Supra-functionality encompasses social, cult- ural, aspirational, and emotional needs beyond economic value (McDonagh) [42]. Fig. 27 illustrates the dynamics of utmost FD for gratification of consumption leading to supra-functionality <13>.

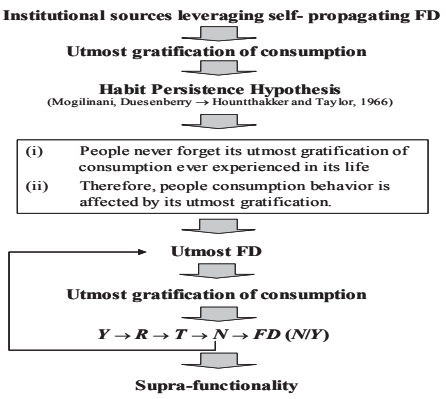


Fig. 27. Utmost FD for Gratification of Consumption Leading to Supra-Functionality.

7.2 Optimal FD Dynamics

Based on the optimal theory, optimal FD trajectory leading to utmost gratification of consumption by satisfying (i) *investment intensity maximizing utility*, (ii) *cost minimum*, and (iii) *FD maximum* conditions was identified as illustrated in Fig. 28 (see ***Appendix G***).

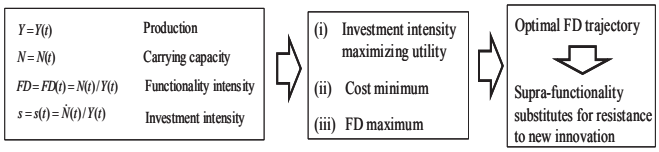


Fig. 28. Analytical Framework for Optimal FD Trajectory.

An empirical analysis taking Japan's MP development over the last decade was attempted as demonstrated in Fig. 29.

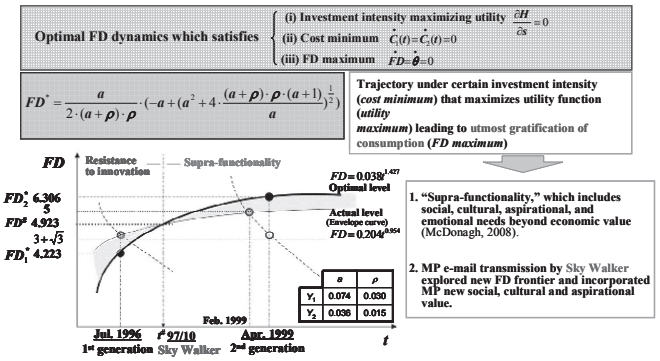


Fig. 29. Comparison of Optimal and Actual Levels of FD in Japan's MP Development Trajectory (*1996-2006*).

The Figure demonstrates that while the optimal trajectory was lower than actual level (Fig. 14), it exceeded this level in 1997/10 corresponding to MP e-mail transmission by Sky Walker (***Appen -dix J***) suggesting supra-functionality substituted for resistance to innovation (Bauer) [6] and also a possibility of follower (optimal level) substitutes for a leader (actual level) in open innovation. By exploring new FD frontier through e-mail transmission which instills customers "exciting story with their own initiative as heroes/ heroines" and thrills them gratification, Sky Walker has incorporated MP new social, cultural and aspirational value.

7.3 Inducement of the "Utmost Fear Hypothesis"

While the dramatic increase in oil prices during mid-2008 has signaled the possibility of a paradigm shift to a post-oil society, utmost fear hypothesis can be induced from the foregoing supra-functionality dynamism as illustrated in Fig. 30.

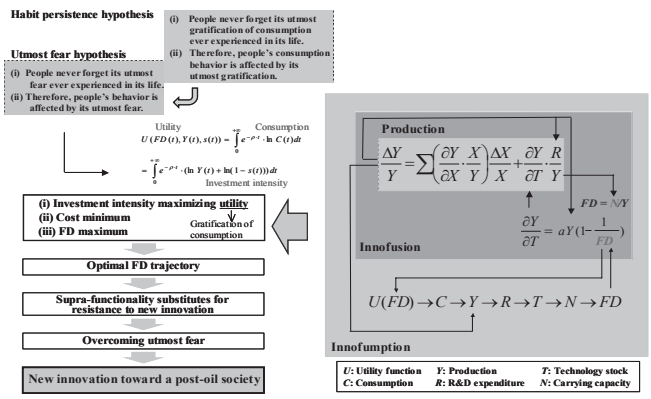


Fig. 30. Leverage of Utmost Fear Ever Experienced in Shifting Resistance to Supra-Functionality.

8. INNOVATION DYNAMISM TOWARD A POST-OIL SOCIETY

8.1 PV Development against Utmost Fear

Supra-functionality dynamism derived from habit persistence hypothesis suggests utmost fear hypothesis. Since Japan's innovation endeavor is very sensitive to such fear as reviewed in Section 2, and given increasing concern on Japan's model for transforming a crisis into a springboard for new innovation particularly in the current environment of simultaneous global economic stagnation, identification of innovation dynamism toward a post-oil society based on this approach is Japan's significant contribution to the global community (see Appendix K).

An empirical analysis taking PV (photo-voltaic solar cell) development as technology driven energy to which Japan maintains institutional advantage was attempted as illustrated in Fig. 31 <14>.

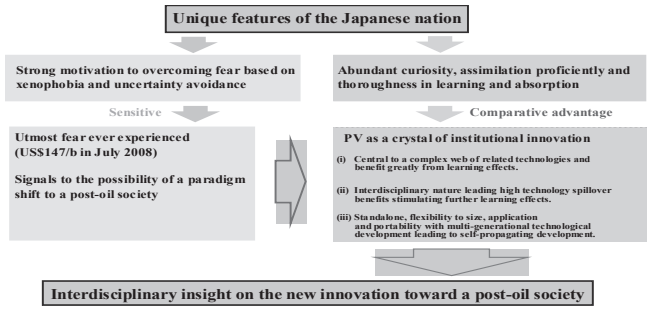


Fig. 31. Utmost Fear Hypothesis in Japan's PV Development.

Similar to the analysis on MP in Section 7, PV development trajectory over the last 3 decades by utilizing bi-logistic growth model was first attempted as illustrated in Fig. 32 and Table 9.

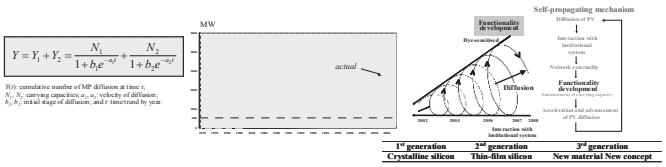


Fig. 32. Japan's PV Development Trajectory by Bi-Logistic Growth Model *(1976-2007).*

Table 9 Estimation of Japan's PV Diffusion by the Bi-logistic Growth Model (*1976-2007*): MW

Parameter	0.2×10^{3}	4.28×10^{-1}	5.0×10^{2}	3.00	1.13×10^{3}	3.08×10^{-1}
	Y_1^1	a^1	b^1	Y_1^2	a^2	b^2

8.2 Optimal FD Trajectory Corresponding to Utmost Fear

Similar to the preceding optimal FD development analysis, optimal FD trajectory was compared with that of actual trajectory based on the foregoing analysis by means of bi-logistic growth model as demonstrated in Fig. 33 <15, 16>.

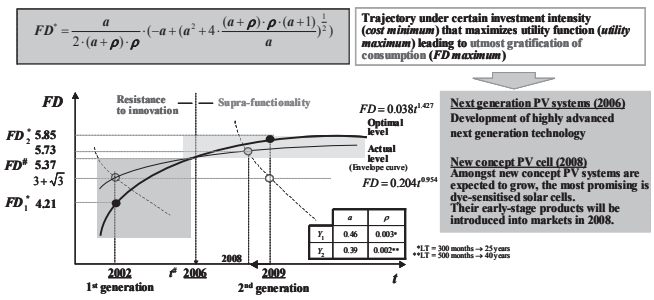
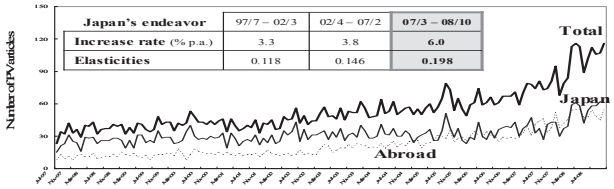


Fig. 33. Comparison of Optimal and Actual Levels of FD in Japan's PV Development Trajectory (*1976-2007*).

[a] FD#: Utmost FD level; $3+\sqrt{3}$: Level of FD at its emergence (Rogers, Mahajan, Moore).

Japan's PV demonstrates supra-functionality substituted for resistance in 2006 and also a possibility of follower (optimal level) substituted for leader (actual level) in open innovation at this timing. Based on preceding innovation, new FD frontier was incorporated in PV in 2006 instilling users "exciting story," similar to Sky-walker in MP. Fig. 34 demonstrates a conspicu-ous increase in PV development endeavor in Japan since then.



Japan's endeavor	97/7 – 02/3	02/4 – 07/2	07/3 – 08/10
Increase rate (% p.a.)	3.3	3.8	6.0
Elasticities	0.118	0.146	0.198

Fig. 34. Trends in Number of PV Endeavors (*Jul. 1997-Oct. 2008*)[a].

[a] Number of projects endeavoring to PV development introduced by PV News.
Source: PV News (PV Energy System Inc., monthly issue).

Table 10 also supports this finding by demonstrating dramatic increase in elasticity of oil prices to PV endeavor as 0.118 *(97/4-02/3)*, 0.146 *(02/4-07/2)* and 0.198 *(07/3-08/10)* in Japan. Furthermore, cumulative PV development increased 5 times higher between 2005 and 2008 (Fig. 32, see ***Appendix K***).

Table 10 Impacts of Oil Prices Increase in Inducing PV Development Endeavors in Japan and Abroad (*Jul. 1997-Oct. 2008*): 3 months moving average

	adj. R^2	*DW*
$\ln N_{Japan} = 2.839 + 0.118D_1 \ln P + 0.146D_2 \ln P + 0.198D_3 \ln P + 0.168D_4$ (39.96) (5.14) (7.81) (12.37) (13.47)	0.881	1.47
$\ln N_{abroad} = 1.010 + 0.467D_1 \ln P + 0.533D_2 \ln P + 0.600D_3 \ln P + 0.183D_4$ (13.36) (19.11) (26.90) (35.32) (13.77)	0.975	1.10
$\ln N_{total} = 2.821 + 0.260D_1 \ln P + 0.302D_2 \ln P + 0.361D_3 \ln P + 0.123D_4$ (62.28) (7.79) (25.49) (33.51) (15.57)	0.977	1.39

where N_{Japan}, N_{abroad} and N_{total}: number of projects endeavoring to PV development in Japan, abroad, and World total, respectively introduced by PV News; P: international oil prices (US$/bbl at current prices) by WTI (West Texas Intermediate); and D_i (i = 1~4): dummy variables with following classifications:

Dummy variables	Aug. 1997-Mar. 2002	Apr. 2002-Feb. 2002	Mar. 2007-Sep. 2009
D_1	1	0	0
D_2	0	1	0
D_3	0	0	1

8.3 Significance of the "Utmost Fear Hypothesis"

However, higher level of elasticity incorporates fragile structure with respect to consistent endeavor regardless the change in oil prices. Thus, utmost fear hypothesis is essential. Table 11 demonstrates this significance by comparing the direct impact of the oil prices and that of utmost fear (highest level of oil prices) on Japan's PV development.

Table 11 Comparison of the Inducing Impacts of Oil Prices Increase on the Advancement of Japan's PV (*1986-2015*)

		adj. R^2	*DW*	*AIC*	*F*
Direct impact	$\ln Y_{23} = -7.712 + 4.911D_1 \ln P + 4.786D_2 \ln P + 5.061D_3 \ln P + 1.881D_4$ (-2.23) (4.30) (5.72) (6.43) (4.14)	0.898	0.75	15.05	64.49
	$\ln Y_{24} = -7.979 + 5.014D_1 \ln P + 4.853D_2 \ln P + 5.222D_3 \ln P + 1.797D_4$ (-2.19) (4.17) (5.51) (6.31) (3.76)	0.895	0.70	18.15	62.74
	$\ln Y_{23} = -8.246 + 5.117D_1 \ln P + 4.921D_2 \ln P + 5.384D_3 \ln P + 1.714D_4$ (-2.15) (4.04) (5.34) (6.18) (3.40)	0.892	0.66	21.23	61.04
Comprehensive impacts with utmost fear	$\ln Y_{23} = 17273 - 3.624D_1 \ln(P_{max1} - P) - 1.495D_2 \ln P - 1.476D_3 \ln(P_{max2} - P) + 2.628D_4$ (14.60) (-9.24) (-5.28) (-3.79) (7.54)	0.952	1.69	-7.70	144.73
	$\ln Y_{24} = 18071 - 3.893D_1 \ln(P_{max1} - P) - 1.683D_2 \ln P - 1.620D_3 \ln(P_{max2} - P) + 2.615D_4$ (14.73) (-9.57) (-5.74) (-4.01) (7.24)	0.952	1.75	-5.53	145.65
	$\ln Y_{23} = 18868 - 4.163D_1 \ln(P_{max1} - P) - 1.872D_2 \ln P - 1.763D_3 \ln(P_{max2} - P) + 2.60D_4$ (14.70) (-9.79) (-6.10) (-4.18) (6.88)	0.952	1.78	-2.82	143.74

*Y_{2i} (i = 1~5): cumulative stock of PV diffusion in phase 2 with extended estimation with annual increase rate of 20% (Y_{21}), 30% (Y_{22}), 50% (Y_{23}), 60% (Y_{24}) and 70% (Y_{25}), respectively;
P: international oil prices (US$/bbl at current prices) by WTI (West Texas Intermediate) with extended estimation of 5US$/b p.a. increase from 2009; and D_i (i = 1~3): dummy variables with following classifications:

Dummy variables	1986-2003*	2004-2008	2009-2015
D_1	1	0	0
D_2	0	1	0
D_3	0	0	1

P_{max1}: 40US$/b (prices in 1980); P_{max2}: 105US$/b (prices in 2008)
D_2: 1994-2003 = 1, 2006-2012 = 1 and other years =0 (comprehensive case).
D_3: 1994-2004 = 1, 2009-2012 = 1 and other years =0 (direct impact case).
*Breakpoint: 2003-2004 and P> 40US$/b from 2008.

Utmost fear demonstrates statistically significance than direct impact and also proves extremely lower elasticity of oil prices to PV development demonstrating explicit ratchet function for consistent PV development independent from oil prices decrease.

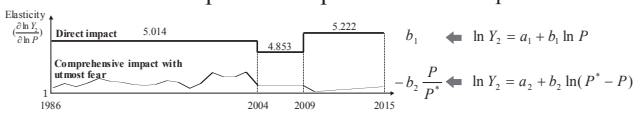


Fig. 35. Elasticity of Oil Prices to PV Development in Comprehensive Impacts with Utmost Fear (*1986-2015*).

This suggests that given Japan's explicit function in trans-forming fear into a springboard to new innovation, institutional mechanism incorporating new concept of utmost fear into the engine of new innovation toward a post-oil society is essential.

9. CONCLUSION

Aiming at elucidating, conceptualizing and operationalizing Japan's explicit co-evolutionary dynamism between innovation and institutional systems, SIMOT has undertaken three approaches: (i) Systems analysis on the interacting mechanism between the market and technology, (ii) Identification of Japan's system of innovation cycle, and (iii) Historical suggestions regarding the institutions co-evolving with innovation.

This paper has shared the first approach and attempted a systems analysis of the co-evolutionary dynamism using an empirical analysis of the rise and fall of the Japanese system of management of technology. Noteworthy findings include:

(i) Japan's notable function in transforming external crises into a springboard for new innovation was enabled by a high level of technology productivity in an industrial society. This can largely be attributed to a co-evolutionary dynamism between the unique features of the nation such a having strong motivation of overcoming fear as well as abundant curiosity, assimilation proficiency, thoroughness in learning, and prioritized innovation.

(ii) However, this sophisticated dynamism moved in the opposite direction in the 1990s due to a systems conflict with an information society where a FD initiated trajectory is essential, resulting in a dramatic decrease in the productivity of technology and a subsequent stagnation of innovation.

(iii) Japan's mobile phone development trajectory demonstrated a self-propagating development through earlier FD emergence in successive innovation based on the effective utilization of learning from preceding innovation, thereby providing a constructive suggestion for sustainable FD.

(iv) Similar self-propagating FD was demonstrated more explicitly by the transitional trajectory from Web 1.0 to Web 2.0, which suggested to firms the significance of follower substitution for a leader in a diffusion process corresponding to an open innovation stream.

(v) This stream suggested the significance of a hybrid management of technology fusing indigenous strength and learning from a digital economy enabled by co-evolutionary domestication, and contributed to reactivating Japan's indigenous co-evolution.

(vi) While reactivated firms have multi-polarized during the current period of global economic stagnation, the utmost gratification of consumption by means of supra -functionality which instills customers with an "exciting story" thrilling them with gratification could maintain co-evolutionary domestication dynamism and prompts an utmost fear hypothesis.

(vii) Since the dramatic increase in oil prices during mid-2008 has signaled the possibility of a paradigm shift to a post-oil society, Japan's notable dynamism based on an utmost fear hypothesis may lead to a new entrepreneurial strategy toward such a society.

[NOTE]

1. Enkawa analyzed that *sophisticated quality management of Japanese companies was based on high uncertainty avoidance and their strengths had been enhanced at every crisis through down-to-the-earth efforts and Japanese corporations had made themselves into crisis-resilient composition*.

2. Senoo and Nomura analyzed that *under the increasing global competitiveness, HQ's isomorphism and local differentiation orientation caused an institutional dilemma while intensive learning changed it into co-evolution*.

3. Muraki pointed out that *contrary to outstandingly high energy efficiency is in the industry sector, it is low in the residential and transport sectors due to an institutional slack*.

4. Iijima analyzed that *Japan's IT investment level was not inferior to that in the US, but IT utilization level was desperately low, attributable to insufficient process-orientation leading to indispensable circumstances in process visualization and changes of company soil through organizational reformation*.

5. Tsao analyzed that *the roots of SCM can be traced back to the integrated system of production, distribution and consumption that met a severe criticism by the US as structural impediments in the late 1980s and SCM has developed from the integrated decision making across different divisions to the one across different organizations. Consequently, in order to raise competitiveness further, micro and macro methods should be combined and firms' capability to evolve according to environmental changes needs to be enhanced*.

6. Higa analyzed by taking a case of successful venture and indicated that *in order for Japan-style e-commerce to be rooted, dynamism of interactions between value and trust need to work well*.

7. Kimoto *analyzed that in order to capture the essence of technological developments, it is insufficient only to account for the mere accumulation of individual improvements. He pointed out that in nstead, the historical trajectory can be understood by studying relationship in technologies and relationship between technologies and social institutions. Post-war technological developments were not necessarily rational, being under the heavy constraint of the social institution*.

8. Tanaka and Saiki analyzed that *lack in cooperation between divisions led to the large amount of dormant patents, indicating a huge loss of intellectual resources. They pointed out that based on the good cooperation between IP division and others, Japanese corporations need to raise a ratio of basic patents to an optimal level according to industrial characteristics*.

9. Chung analyzed the retail internationalization in Taiwan was analyzed through both the micro-aspect and the macro aspect to show the path where business know-how is transferred to China after merger with its domestic strength.

10. Ito identified that *while Japanese patients tend to view doctor's error reporting actions and interactions with patients after a medical accidents relatively more harshly, in the healthcare risk management, where accumulated efforts mitigate such criticism, Japanese institution again draws attention*.

11. Hachiya analyzed that *from the viewpoints of finance and investment, the changes of governance structure of Japanese firms were examined in the comparison of abnormal returns between the companies where monitoring by stockholders works well and the ones where it does not, indicating global corporations maintain institutional complementarity although it may be indirect*.

12. Nagata analyzed that *institutional effects on the relationship between firms' financial activities and the market were also observed based on the earnings management activities at IPO to indicate the characteristics clearly contrasted with the US market*.

13. Umemuro postulated that *in the future product market, affective (being capable to evoke affects in people's mind or being capable to deliberate affects to be invoked in people's mind) technological products and services are decisively important, the key for consumption in the post global recession era. He also suggested that the concept can be expanded to the management, high-quality-orientation and the societal values*.

14. Yamazaki pointed out that *regarding the arguments on the correlations between science-technology and military-economic activities, the history of science policies of the Cold War America and post babble economy Japan were explored and a mathematical model for analyzing economic impact of basic research was introduced*.

15. Miyazaki analyzed that *a hierarchical structure of an institution dictates analyses on a "sector" level. Japanese institution was found to be a bottleneck for diffusion of the wind power, whereas nanotechnology sector suggests the strength that the institution inherently possesses*.

16. Mizuno pointed out that *numerical models connect both, being effective to clarification of the phenomena depending on institutions*.

APPENDIX

A. *Trends in Growth Rate of GDP, TFP and Effect of Learning in Japan*

Table A1 Trends in Growth Rate of GDP, TFP and Effects of Learning in Japan *(1960-2001) % p.a.*

		1960 - 1975	1975 - 1985	1985 - 1990	1990 - 1995	1995 - 2001
	GDP (TFP)	9.7 (6.2)	2.2 (1.4)	3.4 (2.8)	2.0 (-0.3)	1.8 (0.2)
Japan's TFP composition	*Direct effect of R&D investment*	1.0	0.2	0.5	0.2	0.3
	Indirect effect of R&D investment	2.2	0.4	1.0	0.4	0.5
	Learning and spillover effects	3.0	0.8	1.3	-0.9	-0.6

TFP and its components are estimated by the following equation:

$$\frac{\Delta TFP}{TFP} = T\dot{F}P = \underbrace{\kappa^{-1}\eta \cdot \frac{\partial V}{\partial T} \cdot \frac{T}{V} \cdot \dot{T}}_{\text{Direct effect of R\&D investment}} + \underbrace{(1-\kappa^{-1}\eta)\eta^2(\psi-1)\kappa^{-1}\frac{\partial V}{\partial T} \cdot \frac{T}{V} \cdot \dot{T}}_{\text{Indirect effect}}$$

$$+ \underbrace{(1-\kappa^{-1}\eta)\dot{F}_d - (1-\kappa^{-1}\eta)\psi\eta\sum_i s_i \dot{p}_i}_{\text{Learning/spillover effect}}$$

where V: GDP; F_d: final demand; T: technology stock; P: factor's price; s_i: $(PiXi)/(PV)$; X_i: factor i's quantity; η : production elasticity to cost; e: elasticity to production: $\psi = e/(1-e(1-\eta))$: κ : profit ratio ($= PV/C$); and C: total cost.

Source: Watanabe (2005).

B. *Technology Substitution for Constrained Production Factors in Japan's Manufacturing Industry*

By utilizing following translog cost function, technology substitution/complement for/with Energy, Labor and Capital.

(i) Production $Y = F(X_i)$

Xi: L (labor); K (capital); M (material); E (energy): T (technology tock)

(ii) Cost $GC = C(Y, P_i)$

Pi: P_l (lab. price); P_k (cap. price); P_m (mat. price); P_e (energy price);

P_t (technology service price)

$$\ln C = \ln AY + \sum_i \alpha_i \ln P_i + \frac{1}{2}\sum_i\sum_j \beta_{ij} \ln P_i \cdot \ln P_j$$

$$\sum_i \alpha_i = 1, \quad \sum_i \beta_{ij} = \sum_j \beta_{ji} = 0 \qquad \beta_{ij} = \beta_{ji}$$

A: scale factor; α_i, β_{ij} : elasticities $(i, j = L, X, M, E, T)$

$$M_i = \frac{\partial \ln C}{\partial \ln P_i} = \frac{P_i}{C} \cdot \frac{\partial C}{\partial P_i} = \frac{P_i}{C} \cdot X_i = \frac{P_i X_i}{C} = \frac{GX_i C}{C} \quad \text{(cost share)}$$

GX_iC: gross X_i cost

(iii) Elasticity of Substitution between production factors i and j

$$\sigma_{ij} = \frac{C \cdot \left(\frac{\partial^2 C}{\partial P_i \partial P_j}\right)}{\frac{\partial C}{\partial P_i} \cdot \frac{\partial C}{\partial P_j}} = \frac{\beta_{ij} + M_i M_j}{M_i M_j} \quad (i \neq j)$$

$\sigma_{ij} > 0.1$	Substitution
$0.1 \geqq \sigma_{ij} \geqq -0.1$	Neutral
$-0.1 > \sigma_{ij}$	Complement

Table A2 Estimate of Translog Cost Function in Japan's Manufacturing Industry *(1956-1992)*

α_i β_{li} β_{ki} β_{mi} β_{ei}

$$M_l = 0.1608 + 0.0232\ln(P_l/Pt) + 0.0092\ln(Pk/Pt) - 0.0263\ln(Pm/Pt) - 0.0062\ln(Pe/Pt)$$
(91.89) (13.82) (5.40) (−10.60) (−5.80)

$$Mk = 0.1440 + 0.0092\ln(P_l/Pt) + 0.0663\ln(Pk/Pt) - 0.0636\ln(Pm/Pt) - 0.0089\ln(Pe/Pt)$$
(74.13) *(5.40)* *(13.77)* (−12.21) (−3.16)

$$Mm = 0.6350 - 0.0263\ln(P_l/Pt) - 0.0636\ln(Pk/Pt) + 0.1042\ln(Pm/Pt) - 0.0031\ln(Pe/Pt)$$
(265.55) (−10.60) *(-12.21)* (15.58) (−1.01)

$$Me = 0.0386 - 0.0062\ln(P_l/Pt) - 0.0089\ln(Pk/Pt) - 0.0031\ln(Pm/Pt) + 0.0184\ln(Pe/Pt)$$
(32.65) (−5.80) (−3.16) (−1.01) (10.17)

C. *System Conflict in an Information society and Subsequent Functionality Development Decline*

Production function

$$V = F(L, K, T)$$

$$\ln V = A + \alpha \ln L + \beta \ln K + \gamma_1 \ln T + \gamma_2 D_x \ln T$$

where A: scale factor; α, β, γ_1 and γ_2 : elasticities; D_x: coefficient dummy variable representing the trend in shifting from an industrial society to an information society ($D_x = 1/(1+e^{-at-b})$, a, b: coefficients).

Marginal oroductivity of technology

$$MPT = \frac{\partial V}{\partial T} = \frac{\partial \ln V}{\partial \ln T} \cdot \frac{V}{T} = (\gamma_1 + \gamma_2 \cdot D_x) \cdot \frac{V}{T}$$

$$MPT = F(V, T, D_x)$$

$$\ln MPT = B + \alpha_1 \ln V + \alpha_2 \ln T + \alpha_3 \ln D_x$$
$$+ \beta_1 \ln V \cdot \ln T + \beta_2 \ln V \cdot \ln D_x + \beta_3 \ln T \cdot \ln D_x$$

where B: scale factor; α_i and β_i (i = 1~3): elasticities

$$IEL\ (Institutional\ Elasticity) = \frac{\partial \ln MPT}{\partial \ln D_x}$$

$$MPT = aV\left(1 - \frac{1}{FD}\right), \quad FD = \frac{1}{1 - \left(MPT/aV\right)}$$

In case of high-technology firms,

$V = F(L, K, T) = F(L(T), K(T),) \approx F(T), T_t \equiv pt + q$

Epidemic function depicts

$$\frac{dV}{dt} = aV\left(1 - \frac{V}{N}\right) = aV\left(1 - \frac{1}{FD}\right), FD \equiv \frac{N}{V}$$ where N: carrying capacity

$$\frac{dV}{dt} = \frac{dT}{dt} \cdot \frac{dV}{dT} = P\frac{dV}{dT} \approx P\frac{\partial V}{\partial T} = aV\left(1 - \frac{1}{FD}\right)$$

$$\therefore \frac{\partial V}{\partial T} = MPT = \frac{a}{P}V\left(1 - \frac{1}{FD}\right) = a'V\left(1 - \frac{1}{FD}\right)$$ where $a' \equiv \frac{a}{P}$.

D. Necessary Condition for Sustainable FD

Given the average growth rate of T_i and T_s, g_i and g_s, and their ratio w,

$$T_i = T_{i0}e^{g_i t},\quad T_s = T_{s0}e^{g_s t} \text{ and } \frac{g_i}{g_s} = w \tag{A1}$$

where T_{i0} and T_{s0}: initial level of T_i and T_s, respectively, and t: time trend.
z can be developed as follows:

$$z = \frac{1}{1+\frac{\Delta T_s/T_s}{\Delta T_i/T_i}}\cdot\frac{T_i}{T_s} = \frac{1}{1+\frac{g_s}{g_i}}\cdot\frac{T_i}{T_s} = \frac{w}{1+w}\cdot\frac{T_{i0}e^{g_i t}}{T_{s0}e^{g_s t}} = \frac{w}{1+w}\cdot\frac{T_{i0}}{T_{s0}}e^{g_s(w-1)t} \tag{A2}$$

$$\frac{dz}{dT_i} = \frac{dz}{dt}\cdot\frac{dt}{dT_i} \tag{A3}$$

From equation (A2)

$$\frac{dz}{dt} = \frac{w}{1+w}\cdot\frac{T_{i0}}{T_{s0}}g_s(w-1)e^{g_s(w-1)t} = \frac{w(w-1)}{1+w}\cdot g_s\cdot\frac{T_{i0}}{T_{s0}}e^{g_s(w-1)t} \tag{A4}$$

$$\frac{dz}{dt} > 0 \text{ when}$$

$$\frac{w(w-1)}{1+w}\cdot g_s > 0 \tag{A5}$$

Since $\frac{dT_i}{dt} = T_{i0}g_i e^{g_i t}$, $\frac{dt}{dT_i} > 0$ when $g_i > 0$

From equations (A3) and (A4),

$$\frac{dz}{dT_i} > 0 \text{ (necessary condition for sustainable } FD) \tag{A6}$$

when

$$\frac{w(w-1)}{1+w}\cdot g_s > 0 \text{ and } g_i > 0 \tag{A7}$$

Necessary condition for sustainable FD can be identified as inequalities (7) and given that $gi > 0$ and $g_s > 0$ and , it can be identified as follows:

$$\frac{w(w-1)}{1+w} > 0 \tag{A8}$$

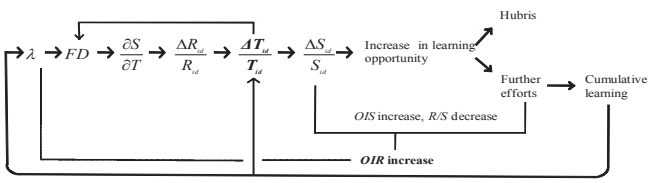
Since

$w = \frac{g_i}{g_s} > 0$, then $w-1 > 0$ therefore, $g_i > g_s$

This implies

$$\frac{\Delta T_i}{T_i} > \frac{\Delta T_s}{T_s} > 0 \tag{A9}$$

E. Learning and Domestication for Sustainable FD



F. Requirement of Sustainable FD for Coopetition

Functionality development (FD) can be depleted as follows → $dFD/dT > 0$ is the question

$$FD \doteq \frac{2}{1-\frac{1}{a}\frac{dP}{dT}\cdot\frac{1}{P}} = \frac{2}{1-\frac{1}{aT}\frac{\Delta P/P}{\Delta T/T}} = \frac{2}{1-\frac{1}{aT}\frac{\partial \ln P}{\partial \ln T}} = \frac{2}{1-\frac{\kappa}{aT}} \tag{A10}$$

where a : diffusion velocity, and κ : elasticity of technology to its relative prices ($= \partial \ln P / \partial \ln T$).

Requirement to Sustainable Functionality Development: A case of Canon's Printers

Requirement to sustainable functionality development (FD) increase ($dFD/dT > 0$) can be obtained:

$$\left(\frac{d}{dT}\left(1-\frac{\kappa}{aT}\right)\right) = -\frac{1}{a}\frac{d\kappa}{dT}\frac{1}{T} = -\frac{1}{a}\left(-\frac{\kappa}{T^2}+\frac{1}{T}\frac{d\kappa}{dT}\right) = -\frac{\kappa}{aT^2}\left(\frac{d\ln\kappa}{d\ln T}-1\right) < 0 \tag{A11}$$

Under the condition when $\kappa\left(=\frac{\partial \ln P}{\partial \ln T}\right) > 0$, this requirement is equivalent to

$$\frac{d\ln\kappa}{d\ln T} > 1 \tag{A12}$$

Since elasticity of technology to its elasticity to price ($\frac{d\ln\kappa}{d\ln T}$) is smaller than 1 equation (A12) can be satisfied by incorporating **the effects of external learning by means of two factors learning** as follows:

$$P = AT^{\kappa_1}PC^{\gamma} = AT'^{\kappa_2}; \tag{A13}$$

where PC : cumulative PC shipment;
T' : gross technology stock that incorporated the effects of external learning;
κ_1, γ and κ_2 : elasticities; and A , A' : scale factors.

In this condition, equation (A12) requirement is equivalent to equation (A14):

$$\frac{d\ln\kappa_2}{d\ln T'} > 1 \tag{A14}$$

Since **printers technology is induced by the dissemination of PC**, it can be depicted by equation (A15):

$$T' = B\cdot PC^{\phi} \tag{A15}$$

where B : scale factor and ϕ : elasticity.

Taking logarithm of equation (A13) and substituting PC in equation (A15) for PC in equation (A10-A13), the following equation is obtained:

$$\ln P = \ln A + \kappa_1 \ln T + \gamma \ln PC = \ln A + \kappa_1 \ln T + \frac{\gamma}{\phi}(\ln T' - \ln B)$$
$$= (\ln A - \frac{\gamma}{\phi}\ln B) + (\kappa_1 + \frac{\gamma}{\phi})\ln T - \ln A' + \kappa_2 \ln T' \tag{A16}$$

From equation (A16), the following identifications can be confirmed:

$$\ln A = (\ln A - \frac{\gamma}{\phi}\ln B) \tag{A17}$$

$$\kappa_2 \ln T' = (\kappa_1 + \frac{\gamma}{\phi})\ln T \tag{A18}$$

Taking logarithm of equation (A18),

$$\ln\kappa_2 + \ln\ln T' = \ln(\kappa_1 + \frac{\gamma}{\phi}) + \ln\ln T \tag{A19}$$

Differentiate equation (A19) with respect to $\ln T'$

$$\frac{d\ln\kappa_2}{d\ln T'} = \frac{1}{\ln T'}\frac{d\ln(\kappa_1+\frac{\gamma}{\phi})}{d\ln T'} + \frac{1}{\ln T}\frac{d\ln T}{d\ln T'} \quad (\frac{d\ln\kappa_2}{d\ln T'} \text{ is small enough with positive value}) \tag{A20}$$

$$\frac{d\ln\kappa_2}{d\ln T'} = \frac{d\ln(\kappa_1+\frac{\gamma}{\phi})}{d\ln T'} + \frac{1}{\ln T}\frac{d\ln T}{d\ln T'} - \frac{1}{\ln T'} > \frac{1}{\ln T}\frac{d\ln T}{d\ln T'} - \frac{1}{\ln T'} > 1 \tag{A21}$$

Thus, equation (A12) requirement can be developed by the following inequality:

$$\frac{d\ln\kappa}{d\ln T} > 1 \quad \frac{1}{\ln T}\frac{d\ln T}{d\ln T'} > 1 + \frac{1}{\ln T'} \quad \frac{1}{Y}\frac{dY}{dX} > 1 + \frac{1}{X} \quad \left(\begin{array}{l} X \equiv \ln T' \\ Y \equiv \ln T \end{array}\right)$$

Provided that initial state of Y as Y_0 and X_0, respectively ($Y_0 = X_0$ given that no external learning at the initial state), the above inequality can be developed as follows:

$$\frac{Y}{X} > e^{X-X_0}$$

From equation (A18),

$$\kappa_2 \ln T' = (\kappa_1 + \frac{\gamma}{\phi})\ln T \quad \kappa_2 X = (\kappa_1 + \frac{\gamma}{\phi})Y$$

Therefore,

$$\kappa_2 = (\kappa_1 + \frac{\gamma}{\phi})\frac{Y}{X} > (\kappa_1 + \frac{\gamma}{\phi})e^{X-X_0} \tag{A22}$$

Inequality (A22) depicts the requirement to sustainable functionality development increase under X ($\ln T'$) development.

X can be identified by the following steps:

From equations (A16) and (A17),

$$\kappa_2 X_0 = \kappa_2 \ln T_0 = \ln P_0 - \ln A' = \ln P_0 - (\ln A - \frac{\gamma}{\phi}\ln B) \tag{A23}$$

$$\kappa_2 = \frac{\ln P_0 - (\ln A - \frac{\gamma}{\phi}\ln B)}{\ln T_0} \tag{A24}$$

From equations (A16), (A22) and (A23,

$$X = \frac{(\kappa_1 + \frac{\gamma}{\phi})Y}{\kappa_2} = \frac{\ln P - (\ln A - \frac{\gamma}{\phi}\ln B)}{\kappa_2} = \frac{\ln P - (\ln A - \frac{\gamma}{\phi}\ln B)}{\ln P_0 - (\ln A - \frac{\gamma}{\phi}\ln B)}\ln T_0 \tag{A25}$$

Therefore, $X - X_0 = \frac{\ln P / P_0}{\kappa_2}$

Substituting this balance for X-X_0 in inequality (A22) (**the requirement to sustainable functionality development increase**) ,

$$\kappa_2 > (\kappa_1 + \frac{\gamma}{\phi})e^{\frac{\ln P/P_0}{\kappa_2}} \tag{A26}$$

G. Optimal FD Satisfying Utmost Gratification of Consumption

(1) Model Construction

$$Y(t) = C(t) + I(t) = (1-s(t))Y(t) + s(t)Y(t) \Rightarrow \begin{array}{l} C(t) = (1-s(t))Y(t) \\ \ln C(t) = \ln Y(t) + \ln(1-s(t)) \end{array}$$

where $C(t)$: consumption, $I(t)$: investment, and $s(t)$: investment intensity ($I(t)/Y(t)$).

(i) Main Variables

				price	cost
$t \in [t_0, +\infty)$	Time on the infinite horizon				
$Y = Y(t)$	Production	*First phase variable*	⇒	ψ_2	$C_2 = \psi_2 \cdot Y$
$N = N(t)$	Carrying capacity				
$FD = FD(t) = \frac{N(t)}{Y(t)}$	Functionality development (FD)				
$\eta = \eta(t) = \frac{Y(t)}{N(t)} = \frac{1}{FD(t)}$	Production to carrying capacity	*Second phase variable* ⇒ $\theta(t) = FD(t) - 1$	⇒	ψ_1	$C_1 = \psi_1 \cdot \theta$
$s = s(t) = \frac{\dot{N}(t)}{Y(t)}$	Investment intensity (II)	*Control variable*			

(ii) System's Dynamics

$$\begin{cases} \dot{Y}(t) = a\cdot Y(t)\cdot(1-\eta(t)) \\ \dot{\eta}(t) = a\cdot\eta(t)\cdot\left[1-\eta(t)-\frac{s(t)}{a}\cdot\eta(t)\right] \end{cases}$$

Stationary level of FD

⇓

Stationary condition $\dot{\eta}(0) = 0$

$$\Rightarrow (1-\eta_0\cdot(1+\frac{s_0}{a})) = 0$$

Constant Levels of Investment Intensity (II)

Constraint $0 < s(t) = s(0) = s_0 \le A < 1$

Gratification of consumption sustaining stationary level of functionality development

It is necessary for accurate application of the Pontryagin maximum principle.

If this constraint is satisfied, one can prove the existence result for the optimal control problem.

$$s_0 = a(\frac{1-\eta_0}{\eta_0}) = a\cdot(\frac{1-Y_0/N_0}{Y_0/N_0}) = a\cdot\frac{(N_0-Y_0)}{Y_0} = a\cdot(FD_0-1)$$

Here, $Y(t)$ represents GDP at time t.

(2) Optimal Control Problem for Functionality Development

$$\begin{cases} \theta(t) = FD(t)-1 \Leftrightarrow FD(t) = \theta(t)+1 \Leftrightarrow \dot{FD}(t) = \dot{\theta}(t) \quad \eta(t) = \frac{1}{FD(t)} = \frac{1}{\theta(t)+1} \\ \dot{\theta}(t) = \dot{FD}(t) = s(t) - a\cdot(FD(t)-1) = s(t) - a\theta(t) \\ \dot{Y}(t) = a\cdot Y(t)\cdot(\frac{\theta(t)}{\theta(t)+1}) \end{cases}$$

(3) Utility Function (Integrated Logarithmic Consumption Index)[2)]

Consumption $C(t) = F(FD(t), Y(t), s(t)) = F(\theta(t), Y(t), s(t))$

$$U(\theta(t), Y(t), s(t)) = \int_0^{+\infty} e^{-\rho t}\cdot\ln C(t)dt = \int_0^{+\infty} e^{-\rho t}\cdot(\ln Y(t) + \ln(1-s(t)))dt$$

The optimality is understood with respect to the utility function U represented by an integral with a discount coefficient ρ.

Application of the Pontryagin Maximum Principle

Hamiltonian function (Hamiltonian problem which measures the current flow of **utility** from all sources)

$$H(\theta, Y, \psi_1, \psi_2, s) = \ln Y + \ln(1-s) + \psi_1\cdot(s - a\cdot\theta) + \psi_2\cdot a\cdot Y\cdot\frac{\theta}{\theta+1}$$

Investment intensity that maximizes Hamiltonian function

$$\frac{\partial H}{\partial s} = -\frac{1}{1-s} + \psi_1 = 0 \Rightarrow s = 1 - \frac{1}{\psi_1} = \frac{\psi_1 - 1}{\psi_1} \quad \text{(Investment intensity that maximizes utility)}$$

2) $Y(t) = C(t) + I(t) = (1-s(t))Y(t) + s(t)Y(t)$ ⇒ $C(t) = (1-s(t))Y(t)$
where $C(t)$: consumption, $I(t)$: investment, and $s(t)$: investment intensity ($I(t)/Y(t)$). ⇒ $\ln C(t) = \ln Y(t) + \ln(1-s(t))$
Logarithmic form of utility function is used in the optimal consumption problems (Krasovskii, 2006).

(4) Hamiltonian System

Hamiltonian system with maximized s

$$H(\theta, Y, \psi_1, \psi_2) = \ln Y - \ln\psi_1 + \psi_1\cdot(1 - \frac{1}{\psi_1} - a\cdot\theta) + \psi_2\cdot a\cdot Y\cdot\frac{\theta}{\theta+1}$$

(i) Price function (adjoint variable)

$$\dot{\psi}_1 = \rho\cdot\psi_1(t) - \frac{\partial H[\theta(t), Y(t), s(t), \psi_1(t), \psi_2(t)]}{\partial\theta} = \rho\cdot\psi_1(t) + a\cdot\psi_1(t) - a\cdot\frac{\psi_2(t)\cdot Y(t)}{(\theta(t)+1)^2}$$

$$\dot{\psi}_2 = \rho\cdot\psi_2(t) - \frac{\partial H[\theta(t), Y(t), s(t), \psi_1(t), \psi_2(t)]}{\partial Y} = \rho\cdot\psi_2(t) - a\cdot\frac{\psi_2(t)\cdot\theta(t)}{(\theta(t)+1)} - \frac{1}{Y(t)}$$

(ii) Cost function

$$\dot{Cost}(t) = \dot{C}_1(t) + \dot{C}_2(t) = \dot{\psi}_1(t)\cdot\theta(t) + \psi_1(t)\cdot\dot{\theta}(t) + \dot{\psi}_2(t)\cdot Y(t) + \psi_2(t)\cdot\dot{Y}(t)$$

$$\dot{C}_1(t) = \dot{\psi}_1(t)\cdot\theta(t) + \psi_1(t)\cdot\dot{\theta}(t)$$

$$\dot{C}_2(t) = \dot{\psi}_2(t)\cdot Y(t) + \psi_2(t)\cdot\dot{Y}(t)$$

(iii) Optimal control [→ (2)] [3)]

$$\dot{\theta}(t) = s(t) - a\cdot\theta(t) = 1 - \frac{1}{\psi_1} - a\cdot\theta(t) = 1 - \frac{\theta}{C_1} - a\cdot\theta$$

$$\dot{Y}(t) = a\cdot Y(t)\cdot\frac{\theta(t)}{\theta(t)+1}$$

(iv) Cost minimum

$$\dot{C}_1(t) = \rho\cdot C_1(t) - \frac{a\cdot\theta(t)\cdot C_2(t)}{(\theta(t)+1)^2} + \frac{C_1(t)}{\theta(t)} - 1$$

$$\dot{C}_2(t) = \rho\cdot C_2(t) - 1$$

⇓

Cost minimum condition

$$\Rightarrow \dot{C}_1(t) = \dot{C}_2(t) = 0 \Rightarrow C_2 = \frac{1}{\rho}$$

Solution of Stationary Equation of the Hamiltonian System $C_1 = \frac{\theta}{(1-a\cdot\theta)}$ ⇒ $\frac{(a+\rho)\cdot\rho}{a}\cdot C_1 = \frac{\theta}{(\theta+1)^2}$ ⇒ $\frac{(a+\rho)\cdot\rho}{a} = \frac{1-a\cdot\theta}{(\theta+1)^2}$

Solution of Stationary Equation for FD $\frac{(a+\rho)\cdot\rho}{a} = \frac{1-a\cdot\theta}{(\theta+1)^2}$ ⇒ $\frac{(a+\rho)\cdot\rho}{a} = \frac{(1-a\cdot(FD-1))}{FD^2}$ ⇒ $\frac{(a+\rho)\rho}{a}\cdot FD^2 + a\cdot FD - (1+a) = 0$

3) **FD maximum** ⇒ $\dot{FD} = \dot{\theta} = 0$ ⇒ $\theta = \frac{C_1}{a\cdot C_1+1}$ ⇒ $\rho\cdot C_1 - \frac{1}{\rho}\cdot\frac{a\cdot\theta}{(\theta+1)^2} + \frac{C_1}{\theta} - 1$ ⇒ $(a+\rho)\cdot\rho\cdot C_1 = \frac{a\cdot C_1}{a\cdot C_1+1}\cdot\frac{(a\cdot C_1+1)^2}{((a+1)\cdot C_1+1)^2}$

Normal form adjoint equation ⇒ $\dot{\psi}_1(t) = \rho\psi_1(t) - \frac{\partial H}{\partial\theta}$, $\dot{\psi}_1(t) = \rho\psi_1(t) - \frac{\partial H}{\partial\theta}$ $(\psi(t) = e^{\sigma}\psi^*(t) \Rightarrow \dot{\psi}(t) = \rho\psi - \frac{\partial H}{\partial X}$, $X = Y, \theta)$

ψ^* : steady state price of X satisfying the above condition.

H. Diffusion Parameters in Major Innovative Goods

		N	p	q	adj. R^2	$x = q/p$	$\varepsilon = \frac{d\ln p}{d\ln x}$	
Printer	LLBP (*1975-1994*)	1581 (19.33)	5.43×10^{-3} (15.13)	5.8×10^{-2} (9.94)	0.999	10.7	0.03	
	LBP/BJ (*1987-2005*)	97205 (166.57)	1.47×10^{-3} (2.27)	2.9×10^{-2} (37.96)	0.999	19.3	-0.35	
MP (*1990-2006*)	MP 1	38216 (149.45)	0.70×10^{-3} (5358.9)	0.5×10^{0} (2616.7)	0.999	5.0	17.6	Sky Walker (*1997/10*)
	MP 2	65741 (170.24)	0.37×10^{-3} (1270.1)	0.15×10^{2} (438.3)	0.999	15.6	-0.10	
LCD (*2000-2008*)	LCD 1	2.4×10^{3} (1654.3)	0.3×10^{-2} (1654.3)	0.2×10^{-1} (1654.3)	0.999	7.3	0.60	
	LCD 2	2.4×10^{3} (656.1)	0.4×10^{-4} (1654.3)	0.8×10^{-1} (1654.3)		1.9×10^{3}	-0.83	
Web (*1993-2006*)	Web 1.0	2.42×10^{6} (145.87)	1.38×10^{-5} (8.35)	1.08×10^{-1} (58.33)	0.999	7.8×10^{3}	-0.87	RSS 2.0 (*2003/7*)
	Web 2.0	2.49×10^{5} (75.66)	0.25×10^{-5} (2.60)	0.55×10^{-1} (22.74)		22.0×10^{3}	-0.89	
PV (*1976-2007*)	PV 1	0.50×10^{6} (8.81)	19.36×10^{-5} (3.87)	2.66×10^{-1} (45.22)	0.999	0.1×10^{4}	-0.83	NGPVs (*2006*)
	PV 2	12.71×10^{5} (8.82)	0.04×10^{-5} (5.72)	4.11×10^{-1} (47.89)		105.4×10^{4}	-0.92	

[a] LLBP: Large-scale Laser Beam Printer; LBP: Laser Beam Printer; BJ: Bubble Jet Printer; LCD: Liquid Crystal Display; MP: Mobile phone; and Web: Internet dependency based on the number of co.jp domains.
Figures in parentheses indicate *t*-value. All demonstrates statically significant at the 5% level.

I. Sustainable FD by Major Innovation

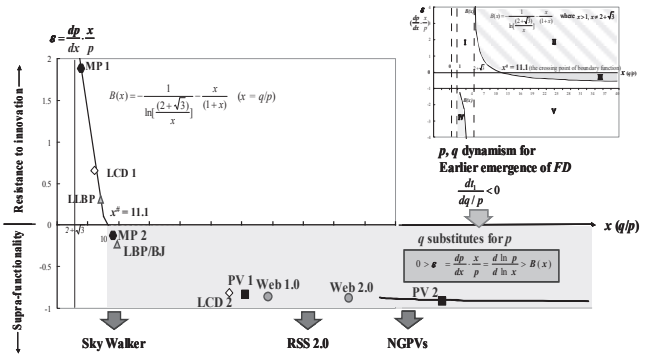
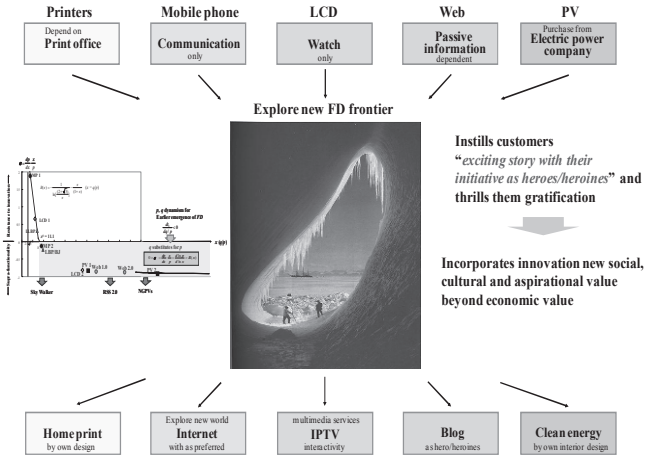


Fig. A1. Sustainable Functionality Development Condition.

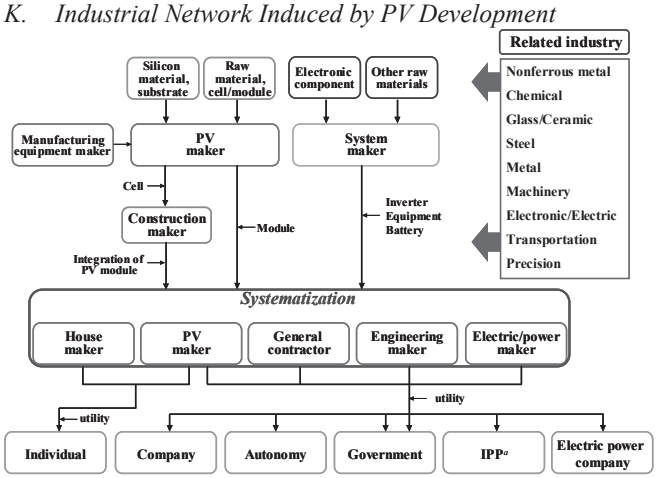
1. While latest high-technology products as LBP/BJ, MP 2, LCD 2, Web 1.0, Web 2.0, PV 1 and PV 2 satisfy conditions for sustainable functionality development, LLBP (1976), MP 1 (1996) and LCD 1 () do not satisfy these conditions resulting in being substituted by LBP, BJ, MP 2 and LCD 2.

2. This can be considered as substitution from 'resistance to innovation' in the early introduction to market, to supra-functionality with customers own initiative.

J. New FD Frontier



K. Industrial Network Induced by PV Development



L. Areas Satisfying Earlier Functionality Development Emergence

$$Y = \frac{N(1-e^{-(p+q)\cdot t})}{1+\frac{q}{p}e^{-(p+q)\cdot t}}$$ where p: innovator; q: imitator; and N: carrying capacity

$$\frac{d^3Y}{dt^3} = 0 \Rightarrow t_1 = -\frac{1}{(p+q)}\ln\left[\frac{1}{(2+\sqrt{3})}\frac{p}{q}\right] = y\ln[\frac{x}{(2+\sqrt{3})}]$$

where $q/p = x$ and $\frac{1}{p+q} = y$.

$$\frac{dt_1}{dq/p} = \frac{dt_1}{dx} = \frac{dy}{dx}\ln[\frac{x}{(2+\sqrt{3})}] + \frac{y}{x}$$

wher $y = \frac{1}{p(1+x)}$, $\frac{y}{x} = \frac{1}{p(1+x)x}$, $\frac{dy}{dx} = \frac{-[(1+x)\frac{dp}{dx}+p]}{[p(1+x)]^2}$

Therefore, $\frac{dt_1}{dq/p}$ can be developed as follows:

$$\frac{dt_1}{dq/p} = \frac{-[(1+x)\frac{dp}{dx}+p]}{[p(1+x)]^2}\ln[\frac{x}{(2+\sqrt{3})}] + \frac{1}{px(1+x)} = \frac{1}{px(1+x)}\left[1+\frac{[(1+x)\frac{dp}{dx}+p]\ln[\frac{(2+\sqrt{3})}{x}]x}{p(1+x)}\right]$$

In case when $W(x) = \frac{[(1+x)\frac{dp}{dx}+p]\ln[\frac{(2+\sqrt{3})}{x}]x}{p(1+x)} < -1$,

$$\frac{dt_1}{dq/p} < 0 \Leftrightarrow \frac{[(1+x)\frac{dp}{dx}+p]\ln[\frac{(2+\sqrt{3})}{x}]x}{p(1+x)} < -1$$

$$\Leftrightarrow \frac{(1+x)\frac{dp}{dx}\ln[\frac{(2+\sqrt{3})}{x}]x}{p(1+x)} + \frac{p\ln[\frac{(2+\sqrt{3})}{x}]x}{p(1+x)} < -1 \quad (\frac{dp}{dx}\cdot\frac{x}{p})$$

$$\Leftrightarrow \frac{\frac{dp}{dx}\ln[\frac{(2+\sqrt{3})}{x}]x}{p} + \frac{\ln[\frac{(2+\sqrt{3})}{x}]x}{(1+x)} < -1$$

If $1 < x < 2+\sqrt{3}$, then , and so

$$\frac{dt_1}{dq/p} < 0 \Leftrightarrow \frac{dp}{dx}\frac{1}{p} < -\frac{1}{\ln[\frac{(2+\sqrt{3})}{x}]x} - \frac{1}{(1+x)}$$

$$\Leftrightarrow \boxed{z \equiv \frac{dp}{dx}\frac{x}{p} < -\frac{1}{\ln[\frac{(2+\sqrt{3})}{x}]} - \frac{x}{(1+x)}}$$ where z: x elasticity to p.

If $x > 2+\sqrt{3}$, then , and we get

$$\frac{dt_1}{dq/p} < 0 \Leftrightarrow \frac{dp}{dx}\frac{1}{p} > -\frac{1}{\ln[\frac{(2+\sqrt{3})}{x}]x} - \frac{1}{(1+x)}$$

$$\Leftrightarrow \boxed{z \equiv \frac{dp}{dx}\frac{x}{p} > -\frac{1}{\ln[\frac{(2+\sqrt{3})}{x}]} - \frac{x}{(1+x)}}$$

REFERENCES

[1] B.K. Ane, A. Tarasyev and C. Watanabe, "Construction of a Nonlinear Stabilizer for Trajectories of Economic Growth," *Journal of Optimization Theory and Applications* 134, No. 3 (2007) 303-320.

[2] B.K. Ane, A. Tarasyev and C. Watanabe, "Impact of Technology Assimilation on Investment Policy: Dynamic Optimization and Econometric Identification," *Journal of Optimization Theory and Applications* 134, No. 3 (2007) 321-338.

[3] M. Aoki, G. Jackson and H. Miyajima, *Corporate Governance in Japan*, Oxford University Press, New York (2007).

[4] J. Baranson, *The Challenge of Underdevelopment*, in C. Kranzberg et al. (eds.), Technology in Western Civilization, Vol. II, Oxford University Press, New York, (1967) 516-531.

[5] F.M. Bass, "A New Product Growth Model for Consumer Durables," Management Science 15, No.5 (1969) 215-227.

[6] M. Bauer, *Risistance to New Technology*, Cambridge University Press, Cambridge (1995).

[7] D. Bell, *The Coming of Post-Industrial Society*, Basic Books, New York (1973).

[8] H. Binswanger and V.W. Ruttan, *Technology, Institutions and Development*, John Hopkins University Press, Baltimore (1978).

[9] A.M. Brandenburger and B.J. Nalebuff, *Co-opetition*, Currency Doubleday, New York (1996).

[10] C. Chen and C. Watanabe, "Diffusion, Substitution and Competition Dynamism Inside the ICT Market: A Case of Japan," *Technological Forecasting and Social Change* 73, No. 6 (2006) 731-759.

[11] C. Chen, C. Watanabe and C. Griffy-Brown, "The Co-evolution Process of Technological Innovation: An Empirical Study of Mobile Phone Vendors and Telecommunication Service Operators in Japan," *Technology in Society* 29, No. 1 (2007) 1-22.

[12] C. Chen and C. Watanabe, "Competitiveness through Co-evolution between Innovation and Institutional Systems: New Dimensions of Competitiveness in a Service-oriented Economy," *Journal of Services Research* 7, No. 2 (2007) 27-55.

[13] H.W. Chesbrough, W. Vanhaverbeke and J. West, *Open Innovation: Researching a New Paradigm*, Oxford University Press, Oxford (2006).

[14] H.W. Chesbrough, *Open Innovation*: *The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Cambridge (2003).

[15] W.M. Cohen and D.A. Levinthal, "Innovation and Learning: The Two Faces of R&D," *The Economic Journal* 99 (1989) 569-596.

[16] W.M. Cohen and D.A. Levinthal, "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly* 35 (1990) 128-152.

[17] Council on Competitiveness, *America's Competitive Crisis: Confronting the New Reality*, Council on Competitiveness, Washington, DC (2004).

[18] Council on Competitiveness, *The New Challenge to America's Prosperity*, Council on Competitiveness, Washington, DC (2004).

[19] B. Emmott, "The Sun Also Rises," *The Economist*, October 6th 2005 (2005).

[20] K. Fukuda and C. Watanabe, "Catalyst Role of Government R&D Inducing Hybrid Management," *IEEE TMC-Japan* (2008) 1-6.

[21] K. Fukuda and C. Watanabe, "Co-evolution and Disengagement of Hybrid Management Leading to a Bipolarization of Technopreneurial Trajectory," *IEEE TMC-Japan* (2008) 78-83.

[22] K. Fukuda and C. Watanabe, "Systems Resilience of Japan's Institutional Systems in Restituting Effective Innovation," *IEEE TMC-Japan* (2008) 100-105.

[23] K. Fukuda and C. Watanabe, "Japanese and U.S. Perspectives on the National Innovation Ecosystem," *Technology in Society* 30, No. 1 (2008) 49-63.

[24] M.V. Geenhuizen and C. Watanabe, *Technological Innovation Across Nations: Co-evolutionary Development*, Springer, New York (2009).

[25] P.A. Geroski, "Models of Technology Diffusion," *Research Policy* 29, Nos. 4-5 (2000) 603-625.

[26] Z. Griliches, *R&D and Productivity: The Econometric Evidence.* University of Chicago Press, Chicago (1998).

[27] A. Gruebler, *Technology and Global Change*, Cambridge University Press, Cambridge (1998).

[28] M. Hobo, C. Watanabe and C. Chen, "Double Spiral Trajectory between Retail, Manufacturing and Customers Leads a Way to Service-oriented Manufacturing," *Technovation* 26, No. 7 (2006) 873-890.

[29] G. Hofstedo, *Cultures and Organizations*, McGraw-Hill International, London (1991).

[30] H. Horio and C. Watanabe, "The Paradox of a Service-oriented Economy for Sustainability: Co-evolution between Innovation and Resources Effectuation by a Global Complement," *Journal of Services Research* 8, No. 1 (2008) 155-175.

[31] International Herald Tribune, "Made in Corporate Japan: New Approach to Business," *International Herald Tribune*, August 31st, 2006 (2006).

[32] A.B. Jaffe, "Technological Opportunity and Spillovers of R&D: Evidence from Firm's Patents, Profits, and Market Value," *The American Economic Review* 76, No. 5 (1986) 984-1001.

[33] R. Kato, C. Watanabe and Y. Tou, "Intra-firm Technology Spillovers Leveraging Co-evolution between Digital Technologies and their Application to Global Warming Mitigation: Towards Eco-friendly Business in a Service-oriented Economy," *Journal of Services Research* 7, No. 1 (2007) 193-213.

[34] R. Katz, *Japan, the System that Soured: the Rise and Fall of the Japanese Economic Miracle*, M.E. Sharpe, Armonk, N.Y. (1998).

[35] A. Koestler, *The Ghost in the Machine*, Hutchinson & Co. Ltd, London (1967).

[36] R. Kondo, C. Watanabe and K. Moriyama, "A Resonant Development Trajectory for IT Development: Lessons from Japan's i-mode," *International Journal of Advances in Management Research* 4, No. 2 (2007) 7-27.

[37] M. Lie and K.H. Sorensen (eds.), *Making Technology Our Own? – Domesticating Technology into Everyday Life*, Scandinavian University Press, Oslo (1996).

[38] V. Mahajan, E. Muller and R.K. Srivastara, "Determination of Adopter Categories by Using Innovation Diffusion Models," *Journal of Marketing Research* 27 (1990), 37-50.

[39] V. Mahajan, E. Muller and F.M. Bass, "New Product Diffusion Models in Marketing: A Review and Directions for Research," *Journal of Marketing* 54 (1990) 1-26.

[40] G. Marten, *Human Ecology: Basic Concepts for Sustainable Development*, Earthscan Publishers Ltd., London (2001).

[41] A.P. McAfee, "Enterprise 2.0: The Dawn of Emergent Collaboration," *MIT Sloan Management Review* 47, No. 3 (2006) 21-28.

[42] D. McDonagh, Satisfying Needs beyond the Functional: The Changing Needs of the Silver Market Consumer, *Proceedings of the International Symposium on the Silver Market Phenomenon - Business Opportunities and Responsibilities in the Aging Society*, Tokyo (2008).

[43] P.S. Meyer, "Bi-Logistic Growth," *Technological Forecasting and Social Change* 47, No. 1 (1994) 89-102.

[44] P.S. Meyer and J.H. Ausbel, "Carrying Capacity: A Model with Logistically Varying Limits," *Technological Forecasting and Social Change* 61, No. 3 (1999) 209-214.

[45] M. Mitsuda and C. Watanabe, "The Role of the Venture Leader Initiative in IPO Accomplishment: The Impact of Leader Characteristics on IPO Performance," *Journal of Services Research* 8, No. 2 (2008) 141-174.

[46] M. Mitsuda and C. Watanabe, "Accelerated Interaction between Firms and Markets at ICT-based Venture Business: The Case of Mobile Phone Business Ventures in Japan," *Journal of Services Research* 8, No. 2 (2008) 101-119.

[47] F. Modigliani, *Life Cycle Hypothesis of Savings, the Demand for Wealth and Supply of Capital*, A Paper Presented to the Rome Congress of Econometic Society (1965).

[48] T. Modis, *Prediction*, Simon & Schnster, New York (1992).

[49] G.A. Moore, *Crossing the Chasm*: *Marketing and Selling Technology Products to Mainstream Customers*, Harper Business Essentials, Harper Collins, New York (1999).

[50] M.A. Nadiri and M.A. Schankerman, The Structure of Production, Technological Change and the Rate of Growth of Total Factor Productivity in the U.S. Bell System, in *Productivity Measurement in Regulated Industries*, Academic Press, Inc., New York (1981) 219-247.

[51] M. Nakagawa, C. Watanabe and C. Griffy-Brown, " Changes in the Technology Spillover Structure due to Economic Paradigm Shifts: A Driver of the Economic Revival in Japan's Material Industry beyond the Year 2000," *Technovation* 29, No.1 (2009) 5-22.

[52] R.R. Nelson and B.N. Sampat, "Making Sense of Institution as a Factor Shaping Economic Performance," *Journal of Economic Behavior & Organization* 44 (2001) 31-54.

[53] D.C. North, *Institutional Change and Economic Performance*, Cambridge University Press, Cambridge (1990).
[54] D.C. North, "Economic Performance through Time," *The American Economic Review* 84 (1994) 359-368.
[55] T.A. Norton and F.M. Bass, "Evolution of Technological Generation: The Law of Capture," *Sloan Management Review* 33, No. 2 (1992) 66-77.
[56] EP. Odum, *Ecology*, Harcourt, New York (1975).
[57] OECD, *The New Economy: Beyond the Hype, Final Report on the OECD Growth Project*, OECD, Paris (2001).
[58] OECD, *Technology and Industrial Performance*, OECD, Paris (1997).
[59] T. O' Reilly, "What is Web 2.0," *Design Pattern and Business Models for the Next Generation of Software* (2005).
[60] E.M. Rogers, *The Diffusion of Innovations,* 3rd ed., The Free Press of Glencoe, New York (1962).
[61] V.W. Ruttan, *Technologies, Growth and Development: An Induced Innovation Perspective*, Oxford University Press, New York (2001).
[62] K.L. Shum and C. Watanabe, "Photovoltaic Deployment Strategy in Japan and the USA – An Institutional Appraisal," *Energy Policy* 35 (2007) 1186-1195.
[63] K.L. Shum and C. Watanabe, "The Effects of Technological Trajectory in Product Centric Firms upon the Transition to Service Provision: The Case of Smart Solar Photovoltaic," *Journal of Services Research* 7, No. 2 (2007) 163-182.
[64] K.L. Shum and C. Watanabe, "Towards a Local Learning (Innovation) Model of Solar Photovoltaic Development," *Energy Policy* 36 (2008) 508-521.
[65] A. Tarasyev and C. Watanabe, "Dynamic Optimality Principles and Sensitivity Analysis in Models of Economic Growth," *Nonlinear Analysis* 47 (2001) 2309-2320.
[66] A. Tarasyev and C. Watanabe, "Optimal Dynamics of Innovation in Models of Economic Growth," *Journal of Optimal Theory and Applications* 108, No. 1 (2001) 175-203.
[67] A. Tarasyev, C. Watanabe and B. Zhu, "Optimal Feedbacks in Techno-economical Dynamics," *International Journal of Technology Management* 23, Nos. 7/8 (2002) 691-717.
[68] Telecommunications Council, Japan, *The Info-communications Vision for the 21st Century*, Telecommunications Council for the Minister of Posts and Telecommunications, Tokyo (2000).
[69] S. Tokumasu and C. Watanabe, "Institutional Structure Leading to the Similarity and Disparity in Innovation Inducement in EU 15 Countries," *Journal of Services Research* 8, No. 1 (2008) 5-42.
[70] US DOC, *Digital Economy 2000*, DOC, Washington, DC (2000).
[71] J.M. Utterback, *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change*, Harvard Business School Press, Boston (1994).
[72] S.K. Vogel, *Japan Remodeled: How Government and Industry are Reforming Japanese Capitalism*, Cornell University Press, New York (2006).
[73] C. Watanabe, "Japanese Industrial Development," *Australian Journal of Public Administration* 49, No. 3 (1990) 288-294.
[74] C. Watanabe and T. Clark, "Inducing Technological Innovation in Japan," *Journal of Science & Industrial Research* 50, No. 10 (1991) 771-785.
[75] C. Watanabe, I. Santoso and T. Widyanti, *The Inducing Power of Japanese Technological Innovation*, Printer Publishers, London (1991).
[76] C. Watanabe, "Trends in the Substitution of Production Factors to Technology," *Research Policy* 21, No. 6 (1992) 481-505.
[77] C. Watanabe and Y. Honda, "Inducing Power of Japanese Technology Innovation," *Japan and the World Economy* 3, No. 4 (1992) 357-390.
[78] C. Watanabe and Y. Honda, "Japanese Industrial Science and Technology Policy in the 1990s," *Japan and the World Economy* 4, No. 1 (1992) 47-67.
[79] C. Watanabe, Choosing Energy Technologies: The Japanese Approach, in *Comparing Energy Technologies*, IEA (ed.), OECD/IEA, Paris (1994) 105-138.
[80] C. Watanabe, "Systems Option for Sustainable Development," *Research Policy* 28, No. 7 (1999) 719-749.
[81] C. Watanabe, K. Wakabayashi and T. Miyazawa, "Industrial Dynamism and the Creation of a Virtuous Cycle between R&D, Market Growth and Price Reduction," *Technovation* 20, No. 6 (2000) 299-312.
[82] C. Watanabe, C. Griffy-Brown, B. Zhu and A. Nagamatsu, *Inter-firm Technology Spillover and the Creatation of a 'Virtuous Cycle' between R&D, Market Growth, and Price Reduction: The Case of Photovoltaic Power Generation Development in Japan*, in A. Gruebler, N. Nakicenovic and W.D. Nordhaus (eds.), Technological Change and the Environment, Resources for the Future (RFF) Press, Washington, DC (2002) 127-159.
[83] C. Watanabe, M. Takayama, A. Nagamatsu, T. Tagami and C. Griffy-Brown "Technology Spillover as a Complement for High-level R&D Intensity in the Pharmaceutical Industry," *Technovation* 22, No. 4 (2002) 245-258.
[84] C. Watanabe, B. Asgari and A. Nagamatsu, "Virtuous Cycle between R&D Functionality Development and Assimilation Capacity for Competitive Strategy in Japan's High-technology Industry," *Technovation* 23, No. 11 (2003) 879-900.
[85] C. Watanabe and B. Asgari, "Impacts of Functionality Development on the Dynamism between Learning and Diffusion of Technology," *Technovation* 24, No. 8 (2004) 651-664.
[86] C. Watanabe, R. Kondo, N. Ouchi, H. Wei and C. Griffy-Brown, "Institutional Elasticity as a Significant Driver of IT Functionality Development," *Technological Forecasting and Social Change* 71, No. 7 (2004) 723-750.
[87] C. Watanabe, J.Y. Hur and K. Matsumoto, "Technological Diversification and Firm's Techno-economic Structure: An Assessment of Canon's Sustainable Growth Trajectory," *Technological Forecasting and Social Change* 72, No. 1 (2005) 11-27.
[88] C. Watanabe, J.Y. Hur and S. Lei, "Converging Trend of Innovation Efforts in High Technology Firms under Paradigm Shift: A Case of Japan's Electrical Machinery," *OMEGA* 34, No. 2 (2006) 178-188.
[89] C. Watanabe, H. Takahashi, Y. Tou and K.L. Shum, "Inter-fields Technology Spillovers Leveraging Co-evolution between Core Technologies and their Application to New Fields: Service-oriented Manufacturing toward a Ubiquitous Society," *Journal of Services Research* 6, No. 2 (2006) 7-24.
[90] C. Watanabe and W. Zhao, *Co-evolutionary Dynamism of Innovation and Institution*, in N. Yoda, R. Pariser and M.C. Chon (eds.), Chemical Business and Economics, Chemical Society of Japan, Tokyo (2006) 106-121.
[91] C. Watanabe and K. Fukuda, "National Innovation Ecosystem: The Similarity and Disparity of Japan-US Technology Policy Systems toward a Service-oriented Economy," *Journal of Services Research* 6, No.1 (2006) 159-186.
[92] C. Watanabe, *Institutional MOT: Co-evolutionary Dynamism of Innovation and Institution*, in M. Horlesberger, M. El-Nawawi and T. Khalil (eds.), Challenges in the Management of New Technologies, World Scientific Publishing, New Jersey (2007) 355-366.
[93] C. Watanabe, J. Shin and J. Heikkinen, "Follower Substitution for a Leader as a Source of New Functionality Development in Open Innovation," *IEEE TMC-Japan* Tokyo (2008) 48-53.
[94] C. Watanabe and S. Lei, "The Role of Techno-countervailing Power in Inducing the Development and Dissemination of New Functionality: An Analysis of Canon Printers and Japan's Personal Computers," *International Journal of Technology Management* 44. Nos. 1/2 (2008) 205-233.
[95] C. Watanabe, S. Lei and N. Ouchi, "Fusing Indigenous Technology Development and Market Learning for Higher Functionality Development: An Empirical Analysis of the Growth Trajectory of Canon Printers," *Technovation* 29, No. 2 (2009).
[96] C. Watanabe, *Managing Innovation in Japan: The Role Institutions Play in Helping or Hindering How Companies Develop Technology*, Springer, New York (2009).
[97] C. Watanabe, K. Moriyama and J. Shin, "Functionality Development Dynamism in a Diffusion Trajectory: A Case of Japan's Mobile Phone Development," *Technological Forecasting and Social Change* (2009) in print.
[98] R. Williams, R. Slack, and J. Stewart, *Social Learning in Multimedia,* Research Center for Social Sciences, The University of Edinburgh, Edinburgh (2000).
[99] G. Yoshikawa and C. Watanabe, "Structural Source Enabling Firm Revitalization Innovation by Sectors – An Empirical Analysis of Japanese 31 Industrial Sectors," *Technovation* 28, No. 1 (2008) 37-51
[100] W. Zhao and C. Watanabe, "A Comparison of Institutional Systems Affecting Software Advancement in China and India – The Role of Outsourcing from Japan and the United States," *Technology in Society* 30, Nos. 3/4 (2008) 429-436.

Sector Innovation Systems in Japan
– Convergence Technologies and Institutional Change

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***Abstract*— Innovation and capabilities to innovate, are the key factors for economic success as well as the well being of nations. Innovation process, which includes the whole innovation chain from basic research, applied research, commercialization is a complicated one and many projects end in failure during these stages. For a successful innovation process, overcoming the 'valley of death' has become a critical issue for policy makers as well as corporate managers. An empirical analysis has been carried out at the micro level, to investigate and analyze a range of factors related to the 'valley of death', from the research phase up to product launch and commercialization.**

Most studies on innovation, have focused on Japan's area of strengths. In this paper, the Sectoral Innovation System approach is used to analyse the diffusion of wind power, which is an area of weakness in Japan. Having first imported a wind turbine from Denmark, technological innovations emerged in the complex product system, first in the mutually dependent subsystems and later on at the product system level. In the third stage innovations at the system level occurred and micro grids emerged. Japanese manufacturers have been able to generate technological innovations to accommodate the Japanese climate and environmental conditions. However, the findings demonstrate that the main reasons for the bottlenecks against the diffusion of wind power in Japan have been related to institutions.

In the final study, an empirical research on Nanotechnology Innovation System is presented to demonstrate a new phenomenon of technological convergence. The analyses elucidated that basic research by scientific disciplines has been changing over time from a separate disciplinary type to a multi-disciplinary type through nanotechnology, which is acting like a bridge interconnecting the scientific disciplines.

***Index Terms*— Sectoral Innovation System, Wind power, Diffusion, Nanotechnology**

1 Introduction

The traditional areas of strengths in Japan, such as consumer electronics, automobiles, robotics are based on underlying strengths in core technologies such as semiconductors, optoelectronics [1], control, machinery, mechanical engineering, nanotechnology as well as competences in manufacturing. On the other hand, it has been argued that Japanese innovation system is characterized by areas of weaknesses, such as software (apart from some types of software such as game software), or pharmaceutical and chemical sector. The main objective of this paper is to demonstrate the hypothetical views by conducting a set of empirical analyses at the micro and meso level.

The Systems of Innovation (SI) approach has attracted the attention of policy makers and academics, by connecting entities through a complex network of relationships and interdependencies [2].

The IS approach can be applied to different levels of the economy, depending on whether one is trying to analyze the national, regional or sectoral level. Sectoral Innovation System is defined as "a network of agents interacting under a particular institutional infrastructure or a set of infrastructures and involved in the generation, diffusion and utilization of technology within a sector".

The main purpose of this paper is to demonstrate the main findings of the analyses carried out on sectoral innovation systems and its relationship with institutions. Analyses have been carried out at both the micro level (projects, firms, technology) as well as sector level. Some comparison has been made between Japan and other countries to draw policy implications.

For a successful innovation process, overcoming the 'valley of death', has become a crucially important issue for policy makers as well as corporate managers. Although the Japanese government has increased funding of basic research in the last decade, its effectiveness has been questionable. Furthermore, once a product is launched, it has to be accepted by the public for diffusion to take place. At the micro level, an analysis has been conducted on the innovation trajectory of nanotechnology, through convergence of scientific and technological disciplines.

The main research questions addressed include the following.

(i) What are the factors that lead to project failure? How can one overcome the valley of death?
(ii) What are the factors which affect diffusion of wind power energy, which is rather low in Japan compared to European countries
(iii) How is the pattern of evolution of nanotechnology, which is a technology of growing importance worldwide? How has nanotechnology affected the science system?
(iv) How is the System of Innovation in Software in Japan compared to other countries in Asia? [3], [4].

Due to limited space in this paper, an analysis on (i), (ii), (iii) will be presented.

2 An Analysis of R&D Project Failures and How to Overcome the Valley of Death

2.1 Background

As a business, a successful R&D project generally requires going through the processes of, 1) success in R&D (technology transfer), 2) success in product launch (placement in the market), 3) success as a new product, and 4) success as a business (black-ink cumulative profit and loss). Many projects end in failure which can also be tracked by cash flow or cumulative profit and loss.

In diversified firms with a broad array of product sectors and types, though systematic research has been conducted at the macro-level [5], [6], there has been little research done on micro-level studies focusing on individual projects. An analysis of why R&D projects end in failure, and tracking the processes through commercialization by examining the cash flow or cumulative profit and loss could provide valuable information for R&D managers.

2.2 Framework

Seventeen large-scale projects that were successful from product launch through technology transfer (R&D) in a diversified Japanese firm were analyzed. Each project started first with research, moved through a chain of processes from the development stage to commercialization. From the perspective of results of R&D we could classify four situations: 1) success in technological transfer; 2) successful market placement in product launch; 3) black ink in a year means success as a new product; and 4) black ink in cumulative years means success as a business. Given these processes, two broad categories of investigations and analyses were conducted [7].

2.3 Investigation and Analysis of the Stages Up to Product Launch

A study was made of the period from R&D to product launch (hereinafter defined as the project duration) and the R&D expenditures accumulated during that time. Since not very many successful product launches are realized out of all the large projects of a single firm, the project duration was distributed broadly from the 1960s to the 2000s. Five market sectors of Information and communications, Electronics, Automobiles, Industrial materials, and Energy, and the three product types of Materials, Parts, and Equipment were analysed. Finally, the obtained results were analyzed with statistical methods.

First, a study was done on the cumulative profit and loss of each project. Normally, after product launch, sales are accounted for and profits are generated from those sales, but profits are not necessarily realized immediately after launch. Increased research investments may be required to further improve performance, reduce costs and stabilize quality. It is also assumed that there are projects that do not achieve black ink in a year or black ink in cumulative years. Therefore, cumulative profit and loss curves are expected to differ from project to project and were categorized by pattern. Furthermore, the reasons for failure of each project were studied through interviews and other means and analyzed.

2.4 Main Findings (1) Analysis of Processes from Product Launch to Commercialization

From start of research to product launch, the shortest and longest project durations were 3 years and 20 years respectively, and the overall mean was 9.5 years. Most project durations were between 8 to 12 years, with periods of less than 12 years comprising approximately 80% of the total. It seems that if projects currently underway, or future projects cannot launch products after 12 years have passed from the start of research, then changes in the external environment, progress of technological development, and other factors must be rigorously checked.

From start of research to product launch, the maximum standardized cumulative R&D expenditure was 7.6, and the overall mean was 3.1. Projects with a standardized cumulative R&D expenditure of less than 4 comprised approximately 80% of the total.

After tracking and investigating the cumulative expenditures from project launch of each project, it was learned that projects can typically be categorized into four patterns, as shown in Fig. 1 [7].

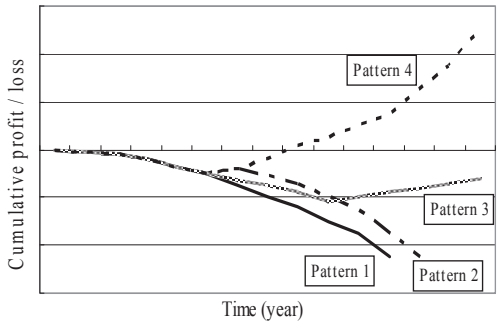

Fig. 1. Time-cumulative profit / loss curve

(i) Pattern 1: Cancelled after being unable to achieve black ink in a year.

These projects were clearly failures from a commercialization perspective. In this pattern, a product was launched, but deficits continued and cumulative losses grew. Namely, this pattern indicates that the product sold to some degree, but for reasons explained below, profits were not realized. Furthermore, these projects were cancelled when they were judged to have no potential to move into the black in the future. In this study, six projects fell into this category.

(ii) Pattern 2: Cancelled after achieving black ink in a year but going into the red in successive years.

These projects were also failures from a commercialization perspective. After projects included in this pattern launched, they seemed to head smoothly towards commercialization, but for reasons explained below, fell into the red again, could not recover, and cumulative deficits grew resulting in cancellation of the project. In this study, two projects fell into this category.

(iii) Pattern 3: Black ink in a year was achieved for 1 or more

years, but cumulative losses were not recovered.

Projects in this pattern are currently still underway and are heading toward elimination of cumulative losses over time, but this has not been achieved as of the present, and it is unclear whether the cumulative losses can be recovered. Therefore it cannot be determined whether the project is a success or a failure. Normally it would have already been commercialized, but errors in making estimates were made mainly due to unexpected advances or other phenomena in existing technology, and the market did not expand exactly as predicted. In this study, two projects fell into this category.

(iv) Pattern 4: Black ink in cumulative years was achieved, and the project was a success as a business.

Projects in this pattern were able to cross the so-called "valley of death." In this pattern, the target market started up well, project management functioned well, competitive technology could be developed, access to markets was gained, and after commercialization there was a good balance between cost and price, and market share and profit steadily expanded. In this study, seven projects fell into this category.

From these projects it was learned that there is a time lag between the product launch period and the period of maximum cumulative loss. In the case of pattern 1 or 2, the maximum cumulative loss is at the time of cancellation, but up to that point even more time and money has been invested. The periods from product launch to cancellation were 10 years maximum and 2 years minimum for pattern 1, and 7 and 9 years max/min for pattern 2. For more about this, see the section below on failure analysis.

Furthermore, in pattern 3 or 4, in cases where the cumulative loss had a long period of remaining flat, or in cases where the cumulative loss grew large, it goes without saying that these products were under pressure to be cancelled.

2.5 Main Findings(2) Analysis of Failures

First, a major reason for failure of five pattern 1 projects was a technical problem, and the reason for the remaining projects was, vaguely, a market-related problem. On the other hand, with pattern 2, both projects failed due to market-related problems.

The two specific technical problems were as follows:

(i) Technical breakthroughs to reach higher levels of performance could not be made

Two projects in this study fell into this category. In both cases, different technology in other companies met performance demands, other companies entered the market successfully, there was a certainty that a large market would be available if technical breakthroughs were made and the success rate was high.

(ii) Difficult to lower costs

This applied to three projects in this study. In each case, other companies realized success as a business. When selecting a technology to achieve performance targets, there may have been problems in evaluating low-cost manufacturing processes and other items, or insufficient assessment of risks, which led to failure to achieve cost targets.

On the other hand, the specific reasons for the failure of one of the pattern 1 projects and two of the 2 projects were all the same, namely the company was not able to keep up with the explosive amount of development in the market expansion period. This represents a misreading of the market in which the management failed to believe that the market would directly expand to the extent that it did. It is due to a certain type of project management problem in which many resources could not be invested in a short time period, and furthermore the inability in the first place to invest resources in excess of an allowed risk level determined by the size or other aspects of the company.

With the relationship between the period from product launch to cancellation and the reasons for failure, there was considerable difference between technical and market-related problems. This is because compared to projects with technical problem, in projects with market problems the products were more highly complete, and sales level was high. As a result, the project was expected to move into the black, and the period of continuation of the project was longer.

With this information, the following adjustments can be made in Table 1.

(i) Sales generally do not reach 100 million yen per year
Performance targets cannot be cleared (two projects)

(ii) Sales are generally up to about 1 billion yen per year
Fail to lower costs (three projects)

(iii) Sales are generally from 1 billion to 3 billion yen per year

Table 1 Analysis of Failed Projects

Project No.	Pattern	Major reasons for failure	Specific reasons for failure	From product launch to stop (year)	Sales per year
7	1	Technical problems	Performance targets cannot be cleared	2	Not reach 100 million yen
16	1			3	
11	1		Fail to lower costs	2	Generally up to about 1 billion yen
8	1			4	
17	1			6	
3	1	Market -related problems	Cannot keep up with amount of development during period of market expansion	7	Generally from 1 billion to 3 billion yen
4	2			9	
10	2			10	

Cannot keep up with amount of development during period of market expansion (three projects)

2.6 Implications for Innovation Management

The insights thus far obtained were incorporated into a summary chart that may be useful as a source of reference for project managers, as shown in Fig. 2.

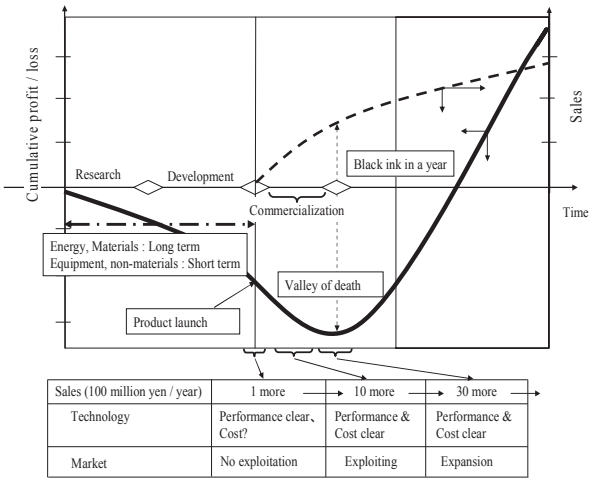

Fig. 2. Relationship between Cumulative Profit/loss, Technology Market Factors

Certain R&D projects pull themselves through the research and development stages to product launch. A variety of characteristics of the project duration and cumulative profit and loss up to that point can be appraised.

Management up to and following product launch is summarized as follows.

It may be that guidelines can be set for the project duration depending on the project's market sector, product type, and presence/absence of research on materials. In contrast to a long period of ten to twenty years being required for research on materials or the Energy sector, non-materials–related or Equipment projects have short periods of three to five years. Cumulative profit and loss up until product launch cannot be analyzed only by market sector or product type, but in general there are many projects for which the standardized cumulative R&D expenditure is 4 or less. Caution is required if research is expected to continue longer than that. .

The issues that management must focus on are different depending on sales, so organizations, systems, and personnel must be handled accordingly.

Of the reasons for failure, misreading of the market though it may be, it is probably necessary to investigate in advance whether entrance must be made into sectors in which there is a possibility of that happening, or how one should handle such a scenario if it were to occur after entering that sector.

In the next section, an analysis of wind power diffusion is presented.

3 Diffusion of Wind Power Energy in Japan

3.1 Presentation of the Issues

In recent years, environmental pollution, global warming and similar phenomena have surfaced as issues, causing individuals and corporations to change their awareness, resulting in considerable focus on environmental business. However, many of the renewable energy, supposedly effective in protecting against global warming, have low energy densities. Wind power in Japan accounts for less than 0.3% [8] of the total generation capacity. On the other hand, in Europe it accounts for a larger percentage of the total generation capacity at 13% in Germany and 24% in Denmark [9], representing a growing business.

Japan basically shares the same type of system for wind power generation with Europe, and there is no major difference in technological performance between the two countries. It is therefore hard to consider that wind power generation will not diffuse in Japan due to technological efficiency.

3.2 Framework of Analysis

Wind power systems are type of CoPS (Complex Product System) [10], [11] which are high-cost, engineering-intensive systems and never mass produced for the final customers. They are designed and produced on a project basis as one-offs for professional business. Unlike the final customer, intermediate customers are intimately involved in the innovation process through out the life cycle of the project. Technological accumulation is generated by the design, building and operation of the complex product system.

Wind power system also has multiple aspects such as technological system [10], which receives the influence of non-physical artifact such as institutions.

We propose a dynamic diffusion model in which supply and demand of innovations progress by coexisting with the existing energy system as shown in Fig. 3. To promote the diffusion of wind power, economic factor is essentially important. For example, investment costs should be collected by electricity, obtained by wind power. There are several problems in economic efficiency under the present circumstances.

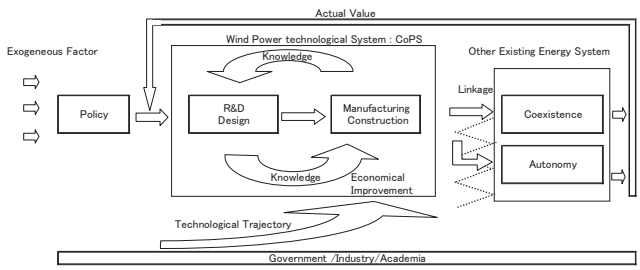

Fig. 3. Diffusion Model for Wind Power Generation System

Even if a wind power system is not able to link directly with the existing energy system economically, the alternative systemic measures that avoid some critical points are taken into consideration in this institution, from the stand point of a battle against global warming or energy security.

3.3 Technological System of Wind Power Generation

Modern wind turbines featuring a three-bladed monopole arrangement became the dominant design in the 1980s. The top nine positions in the global ranking of leading large wind turbine manufacturers all go to European manufacturers such as Vestas, NEG Micon, and Bonus based in Denmark, Enercon, Nordex in Germany, and Gamesa and Ecotecnia in Spain respectively [12]. In Japan Mitsubishi Heavy Industries [13], Ltd. builds large systems but ranks only 10th in the world in

terms of the shipment volume.

The power obtained from wind energy cannot be supplied to consumers on an as-is basis. Power distribution of wind power generation requires existing power network (one calls it a grid). Wind power is usually connected to a commercial power grid to supply power to an electric company, which then supplies the electricity to consumers. Wind energy does not have the same stability performance as existing power grids. Consequently, the higher percentage of unstable power supplies tends to have an adverse effect on the operation of existing power lines, which limits the connection of new wind power.

3.3.1 Efficiency

This case study tried to analyze the technological relationship between the operating performances of the focusing device with

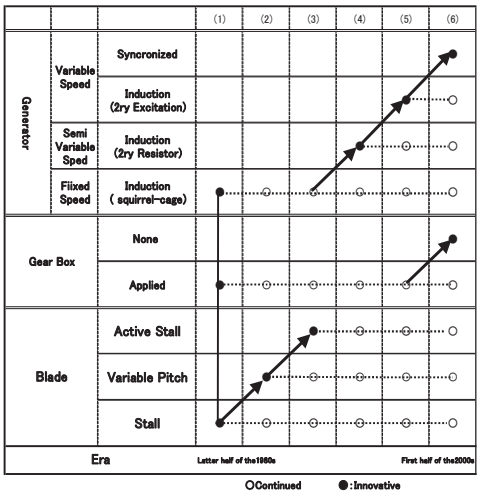

Fig. 4. Technological Trajectory of Wind Turbine [15]

the mix of mutually dependent parts of a product with reference to documentations of EWEA [1], catalogues available from leading wind turbine manufactures and a database of wind turbine [14]. As a result, with the vector of technological change and emergence order of the focusing device we may draw a technological trajectory shown in Fig. 4.

(1) Original design

The wind turbines as originally designed by the Danish manufacturer [16] operate at a fixed speed (20 rpm or so). Their speed has been raised to about 1800 rpm by the use of a gear box and electric power is retrieved from a rigidly constructed squirrel-cage motor for supply to a grid system. Turbine operation responds in a passive manner as irregular fluctuating velocity of wind under stall control.

(2) Pitch control implementation

Under stall control, the output would fall in a wind velocity region higher than the rated speed. As a solution, pitch control has been implemented to regulate the blade angle for adjusting the volume of wind received.

(3) Active stall implementation

Only the low-wind-velocity region is accommodated by stall control, rather than pitch control.

[1] EWEA: The European Wind Energy Association

(4) Semi-variable speed control implementation

The secondary resistance of the induction generator is controlled to vary the rotor speed by about 10% according to the wind velocity, thereby absorbing the wind energy fluctuation to be directed to the generator as much as possible under natural conditions.

(5) Variable speed control implementation

The rotating speed that maximizes the wind turbine efficiency should depend on the wind velocity. This implementation was applied to offer maximum rotating speed efficiency matched to wind velocity.

(6) Gear less variable speed control implementation

The gearbox entails a mechanical energy loss by itself. This innovation has enabled wind turbines to operate at low speed without the gearbox so that higher efficiency was achieved.

As can be seen from the implementation of pitch control, in the case study reviewed above, any state of technological disequilibrium among interdependent parts that makes up a product system was resolved by implementing technological innovations, allowing the wind energy to be converted to power in both a stable and efficient manner. Technology has always maintained an ever-increasing trajectory of stability and efficiency and has never stepped back.

In the first stage, innovations occurred in the subsystems of a product system. Pitch control was adopted in Denmark's original design, which became the dominant design. It enabled the equipment to approach the performance of a generator with an increased conversion efficiency of the turbine blades complementing one another. In other words, in a complex product system consisting of mutually dependent subsystems, it is necessary to increase the integrated performance with parts having such mutually dependent relationships with the system, when an innovation emerges in a product system. This case study indicates not only that technological disequilibrium increases the performance of focusing equipment, but also creates further technological opportunities to realize larger wind turbine designs.

In the second stage, innovation occurred at the modular unit level of a product system by the adoption of a speed change function. When a product system has nonlinear characteristics with regard to the external environment, each part inside the modular unit is unable to sufficiently improve the technological disequilibria against the nonlinear characteristics. For that reason, the researchers turned interferences from the external environment into non-interferences, which cannot be realized in isolation, but only by cooperating within the product system with which there was a mutual relationship. In the third stage, innovation occurred at the system level and micro grids emerged.

3.3.2 Economic performance

Regression formula concerning installation capacity, scale of wind turbines and installation costs in reference with CO2 emission in Japan are shown in Table 2. It can be can be recognized that exponentially increasing installed capacity and

logarithmic scaling up of wind turbines are progressing and costs are showing a logarithmic decline under increasing CO2 emission.

As a result, we found that through these technological

Table 2 Installation Capacity, Scale and Cost of Wind Power in Japan

	Explanation	Regression Formula	Y	X	R^2	Note
-	CO2 Emission vs. Installed Capacity	y = 3E-21e0.0416x	Installed Capacity (MW)	CO2 Emission (M-ton)	0.84	*1. *2
Single Installation	Scale of WT vs. Installed Capacity	y = 337.9Ln(x) – 664.35	Av. Scale of Installed WT (KJPY/kW)	Installed Capacity (MW)	0.90	*2
	Cost of Installed WT vs. Installed Capacity	y = -33.828 Ln(x) + 427.11	Av. Cost of Installed WT (KJPY/kW)	Installed Capacity (MW)	0.53	*2
Multiple Installation	Scale of WT vs. Installed Capacity	y = 291.49 Ln(x) – 569.57	Av. Scale of Installed WT (KJPY/kW)	Installed Capacity (MW)	0.73	*2
	Cost of Installed WT vs. Installed Capacity	y = -13.655 Ln(x) + 328.85	Av. Cost of Installed WT (KJPY/kW)	Installed Capacity (MW)	0.26	*2

*1: Source Data; Ministry of the Environment, Japan, 2007 during 1996-2005

*2: Source Data; NEDO 2007 during 1996-2005 [17]

innovations it was possible to enlarge the system and to meet the region of high wind velocities, so that wind turbine has become more efficient and the collected wind plant has achieved scale economies when installed.

3.4 Evolutions of Energy Policy

3.4.1 Japan

The related policy trend of wind power generation in Japan is shown below in Table 3.

The business model has evolved further and the electric

Table 3 Transition of wind energy policy in Japan

1997.11	Long-term purchase menus for renewable power by electronic company started.
1997.12	Adopted Kyoto Protocol. Reduction target was determined by 6% from the actual 1990 level during the five years from 2008 to 2012.
1998.6	Revised the 2010 target for implementing wind energy upwards from 150 MW to 300MW.
1999.6	Ceiling of accepting wind power to 150 MW and shifted to a bidding program by a leading Electronic Company.
2000.3	Numerous electronic power companies announced their intention to shift from long-term purchase menus to a bidding program.
2000.1	Voluntary “green power fund” was established.
2000.11	Voluntary “Green Power Certification System” was established by Natural Energy Company.
2002.5	RPS Law was established. Implementation target of wind power was changed to 3000MW.

power companies began to buy electric power from large-scale wind farms in 1997. A subsidy system also started by the governments called for terms of acceleration in the introduction of local renewable energy. Under the encouragement of COP3 in 1997, both a buy back and a subsidy system were activated. As a result, due to government subsidy, which incurred half of the construction costs for the local government and one third of the construction costs for the private company, many of the wind proprietors installed high efficient wind turbines mostly imported from the EU. A long term guaranteed buy back system such as this one, which has been in use for 17 years, combined with a low cost wind power generation program, has proven profitable. Nowadays, many wind power proprietors have contributed to the diffusion of wind power generation. However, because the source of economic profits is supported by the voluntary work of the electric power companies, they were forced to introduce a bid system for undertaking wind power generation due to their financial issues. Adversely, diffusion has been limited. As a countermeasure the Japanese government introduced "the RPS (Renewable portfolio standard) law" from 2003 for attaining the target value of renewable energy. A lower target value was introduced unfortunately, and the validity of RPS proved insufficient. In what follows, we clarify the problems by comparison with EU countries in terms of electric power buy-back program in connection with stakeholders

3.4.2 EU countries

Denmark has alleviated barriers to the participation of wind power proprietors for the three reasons mentioned below, so that wind power has diffused. (1) A subsidy program for construction funds has allowed windmills to be built. (2) Wind power proprietors were given incentives, which ensured that all surplus power produced by wind energy is purchased by electric company supported by the government at rates of 85% of the power charges paid by customers. (3) The concept of priority connection was introduced, where electric power companies reimbursed 35% of the costs for linking the wind power generators with the electric power network [34]. Germany gave more incentives to wind power proprietors than Denmark, by taking five measures. This has alleviated the barriers to participation in the power industry, resulting in the rapid diffusion of wind power.

3.5 Implications for Technology Policy.

Wind power has advantages over the existing high efficiency power generation systems used today. Wind power’s major advantage lies in the fact that power can be generated from natural resources, which are already readily available and abundant. However the electric power obtained by wind power is influenced by a natural condition, which can disrupt the stability and reliability. Without getting away from this root problem further development cannot be expected.

The Japanese institution has potential power for further diffusion of wind power under the countermeasure against global warming, although there is no equilibrium between incentives and contributions among wind power business proprietors and electric power companies. In this context, it is important to consider the demand-pull measures for wind power so that our institution can have a “time slot” for “learning by doing” to catch up and accelerate diffusion of wind power, including institutional reform of RPS law. In the next section, the case of nanotechnology innovation system to demonstrate a new phenomenon of technological convergence will be discussed.

4 NANOTECHNOLOGY INNOVATION SYSTEM

4.1 Background of Nanotechnology and Nanotechnology Innovation System

Nanotechnology has become a very active and vital area of research, which is rapidly developing and spreading to almost every field of technology domain and science & engineering disciplines. Nanotechnology provides new possibilities of manufacturing and control for individual objects on nano-scale that could lead to breakthrough-level innovations. An analysis has been made of the performance of nanotech research systems focusing on industry and academia research activities using bibliometric indicators (volumes of scientific publications) as a measure of the output of the research system [18].

Systems of innovation related to nanotech (NanoSI) can be thought of as a complex system of different science & engineering disciplines and technology domains at nano-scale; comprised by a set of actors engaged in the development, fusion and diffusion, and utilization of the technology; linkages among actors (inevitable due to its multi-disciplinary nature) which particularly focus on a nanotech domain. In addition, NanoSI is a dynamic process, which changes pattern over time, involving multiple interacting and co-operating actors [19].

Nanotechnology is currently positioned just prior to or at the beginning of commercialization stage or hardly commercialized. In this study we effectively utilize the TEN framework [20] to analyze and explore nanotechnology fusion strategy, specially focusing on the Science pole, where academic publications and citations related to nanotech are regarded as viable scientific output indicators

4.2 Technology Fusion related to Nanotech

Relevant works on innovation system include Lastres [21] focusing Japanese system of innovation on advanced materials, and Kumaresan and Miyazaki [22] on robotics innovation system.

The analysis is based through a combination of quantitative (bibliometric exploration) and qualitative (primary data analysis: face-to-face interview) methods. The research findings start with a general analysis of categorization of all nano-scientific articles into scientific disciplines based on keyword search. We then move towards the analyses of specific fields' fusion into nanotech as well as the relative importance of nanotechnology for researchers in scientific disciplines worldwide. Fig. 5 presents the total volume of identified nanotech-related articles and compares their relative share distribution within each disciplinary field over the period 2000-2004. The findings clearly indicate that nanotech-related research plays a significant role in fusing with every analyzed discipline, accounting for above 40% of all nanotech academic articles in physics, around 40% in chemistry, 30% in material science, 15% in engineering disciplines and 10% in biological science.

4.2.1 Chemistry Discipline

We investigated first nanotech fusion trend in the case of chemistry discipline. Fig. 6 demonstrates the overall shares of

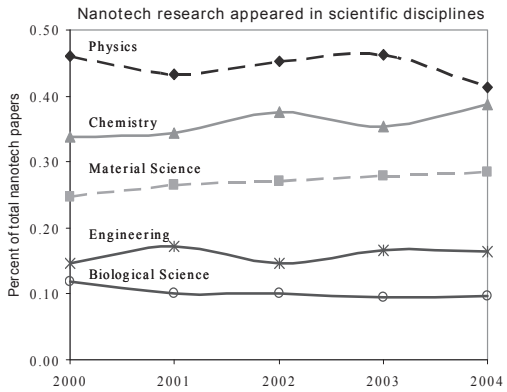

Fig. 5. Share of nanotech research output in scientific disciplines

nanotech articles in the chemistry discipline. When compared with other chemistry journals, the volumes of nanotech-related articles appear to be substantial in ten journals out of 25, as demonstrated in Fig. 6. Nanotech publications volumes have been increasing rapidly in different areas of chemistry research.

4.2.2 Physics Disciplines

The annual shares of nanotech articles in the physics are demonstrated in Fig. 6. The volumes of nanotech-related articles appear to be substantial in nine journals out of 25, when compared with other physics journals. Nanotech publications volumes have been also rapidly increasing in different areas of physics research. This growth corresponds to the extent of nanotechnology research fusion and its growing importance for basic research in physics.

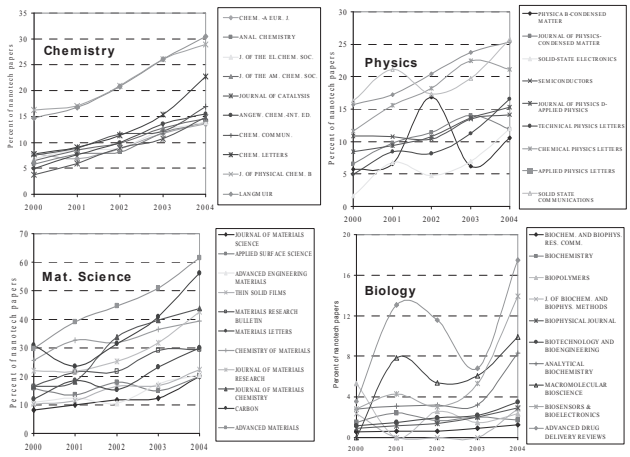

Fig. 6. Nanotechnology Research activity in Multi-disciplinary Boundaries [19]

4.2.3 Materials Science, Biology Disciplines

The volumes of nanotech-related articles appear to be substantial in eleven journals out of 25, when compared with other journals. Nanotech publications volumes have been increasing rapidly in different areas of material science research (such as thin films, surfaces, carbon material etc) rather than other disciplines. This growth corresponds to the extent of nanotechnology research fusion and its growing importance for basic research in material science.

In the case of biology, the volumes of nanotech-related articles appear to be substantial in a few journals much less compared with other disciplinary journals. Nanotech publications volumes have been increasing slowly in different areas of biology research (such as drug delivery, biosensors, biotechnology etc). This slow growth corresponds to the low extent of nanotech research fusion and yet it is growing importance for biological basic research and is indicative that biological science is still an emerging field for nanotech research.

4.3 Technology Fusion Pattern

We selected a set of nanotech papers from each discipline and analyzed the reference linkages by different disciplines to establish the pattern of fusion. As demonstrated in Table 4, for materials domain, it indicates that each discipline's citing references were strongly linked with the respective disciplines 10 years ago (1995) instead of fusing with other disciplines, whereas this trend has changed recently (2005), by sharing nanotech knowledge with different disciplines (i.e., focusing multi-disciplines' linkages) [23]. In the case of chemistry journals, the share of cited references from chemistry related areas was 64.47% in 1995, but dropped the share to 40.65% in 2005. In the case of physics, material science and biology, it dropped from 74.39% to 53.71%, 39.02% to 29.15% and 54.12% to 36.02% respectively. On the other hand, the share of cited references from other disciplines has grown over the last 10 years period and balanced the gap. It seems that in the earlier period, every discipline had less need to share nanotech knowledge or link with other disciplinary knowledge, but rather this trend has changed recently in the materials domain. With the evolution of nanotech, the trend of basic research by disciplines has been changing over time from a more separate disciplinary base to a more multi-disciplinary type.

Table 4 Scientific disciplines' fusion into nanotech in the materials domain

Domain	Search string	Search period	A set of papers from science disciplines' journals	Share of cited references appearing from scientific disciplines						Trend of nanotech fusion
				Chem	Phy	Mat Sci	Biol	Multidis	Nano Sci	
Nano-materials	nanocrys*, nanotub*, fullerene*, nanostruc*, nanocompos*, nanomat*, nanocat*, nanofib*, thin film*, dendrim*, nano* and polymer*	1995	Chem	**64.47**	10.42	7.33	4.63	11.96	1.15	Less fusion with multi-disciplines
			Phy	11.11	**74.39**	4.34	0	8.21	1.93	
			Mat Sci	26.08	19.92	**39.02**	0.4	12.65	1.89	
			Biol	23.19	7.21	0	**54.12**	12.88	2.57	
		2000	Chem	**56.76**	12.05	15.05	5.04	10.25	0.81	
			Phy	9.06	**51.1**	5.13	0	33.36	1.32	
			Mat Sci	24.99	13.07	**35.76**	0	25.77	0.4	
			Biol	26.38	4.18	7.34	**50.79**	9.62	1.67	
		2005	Chem	**40.65**	13.26	19.93	8.86	11.04	6.23	Relatively high fusion with multi-disciplines
			Phy	16.05	**53.71**	8.07	1.13	12.9	8.11	
			Mat Sci	22.29	18.87	**29.15**	1.15	16.95	11.47	
			Biol	35.57	10.03	5.21	**36.02**	8.6	4.54	

Basis of Analysis-Selected top rated and most common 25 journals of each disciplines classified by ISI

Search method-Specific keywords, derived from the Nano Science and Technology Institute publications

In the electronics domain, the same trend appears but shows relatively more strong fusion with diversified disciplines at present. Nanotech evolution derives from taking advantages of scientific opportunity that could allow researchers to undertake or share multi-disciplinary research by utilizing nano-tools on 'nano' theme. In the earlier period, researchers linked with their respective disciplines' research network due to lack of nano instruments, but now the trend has changed by having much scope of utilizing techniques to explore unfocused areas. Researchers are more interested or have to interact with researchers from other disciplines to share their expertise or knowledge to uptake more efficient outcome through nanotech. In addition, this only happens as a multi-disciplinary approach, trying to break down the boundaries of all scientific disciplines.

4.4 Exploring the Factors of Nanotechnology Fusion

Having analyzed in some detail the extent to which nanotechnology research is fused with multi-disciplines, we conducted a series of interviews with nanotech scientists or researchers in universities and public research institutes in European countries (such as UK, France, Germany, Switzerland and Italy) as well as in leading nanotechnology research institutes in Japan.

4.4.1 The Case of Europe

Most European scientists interviewed believe that nanotechnology enables people to move from a system of specific areas into something that is a bridge of multi-fields in nano-scale. In this sense, one expert from one field may connect with another expert and develop some cross-linkages, help move very separate disciplinary system into a more homogeneous system. The trend of nanotech fusion highlights convergence of all scientific disciplines since it is an interface of all disciplinary fields at nano-scale. Some experts believe that the starting point for such fusion is scientific opportunity that could begin to address a new system. Another extremely important factor appears to have been the re-labeling research topic, because it is quite fashionable nowadays to pull funding for research through a domain name such as nanotech, by traditional disciplines in this competitive age. The most basic research agenda would be new nano-materials discovery with novel properties and function as well as new applications, and the development of techniques to observe, manipulate and fabricate the nanostructures.

4.4.2. The Case of Japan

Japanese scientists mostly believe that nanotech has an ability to drive research in multiple disciplines, as no boundary exists between physics, chemistry, material science, engineering and biology in nano-scale. Nano dimension requires these different scientific fields by its own characteristics to understand each other and exploit with new and much improved or efficient applications. In this way, some networks or linkages between disciplines and expertise may develop, helping to lead to an efficient outcome in science. The basic strategy for nanotech fusion in Japan has been driven by researchers' keen intension to take advantages of nano-tools or techniques in every disciplinary research. So the main factors of nanotech research spreading is curiosity drive to explore new domains with new applications; scope of sharing or using techniques to observe nanostructures; to grasp funding since much funding is available

in this area; and collaboration and exchange among nanotech practitioners.

4.5 Implications

In this paper, we tried to explore how nanotech basic research fused with science fields such as chemistry, physics, material science and biology. The analyses elucidated that chemistry, material science and physics have played an important role in the rapid fusion of nanotech research, accounting for a relatively higher share and significant growth in comparison with biological sciences.

5 CONCLUSION

The following points of this study may be of future use in innovation project management.

First, regarding the study on 'valley of death', the performance of large projects from R&D to product launch, by obtaining quantitative analysis results by project duration, cumulative R&D expenditures, and other factors, these findings may be able to be used as standard guidelines for continuing or cancelling large scale projects. In particular, with diversified firms, there are a variety of market sectors, product types, and other factors, and it is hoped that these results can be beneficial when it is difficult to judge whether to continue or cancel a project.

Second, information obtained from failures after a product launch can be used by management. In particular, since losses incurred as a result of failure after product launch are large compared to failure before launch, there is convincing evidence that information on the causes of failure corresponding to sales can be beneficial to management for increasing the success rate of future projects, and preventing failure in advance.

The case of wind power has demonstrated that in sectors with strong environmental and social characteristics, even if wind power has no economic advantage over existing energy systems, if sufficient benefits or alternative values are provided, it would create opportunities for technological innovation and innovations are induced. Internal technological innovations have resolved the technological disequilibrium between subsystems constituting a system, thus enhancing the performances of wind turbines. Although the initial wind turbines were imported from Europe, the Japanese manufacturers have been able to continue generating technological innovations, to develop wind turbines to suit the Japanese climate and environment. However, for the business system in Japan, there is no equilibrium between incentives and contributions among wind power proprietors, electric power companies, and customers. The case highlighted the need for institutional reforms to bear the cost of diffusion of wind power.

The study on Nanotechnology Innovation system elucidated that the basic research trend by disciplines has been changing over time from a highly separate disciplinary type to more multi-disciplinary type. In the earlier phase, researchers linked with their respective disciplines' research, but now they are interested to share their expertise or knowledge to uptake more efficient outcome through nanotechnology. This happens as a multi-disciplinary approach, trying to break down the boundaries of all scientific disciplines. The discovery of new nano-materials and the intention of its full utilization in variety of applications, and the development of techniques (e.g., nano-tools) to control and manipulate materials structure in the nano-scale have driven the technology fusion rapidly. Finally the multi-layer model represents a real-time analysis on the exploration of nanotechnological trajectories, and seeks to capture the attributes related to the co-evolutionary nature.

REFERENCES

[1] K. Miyazaki, *Building Competences in the Firm, lessons from Japanese and European Optoelectronics*, Macmillan , (1995).

[2] B. Lundvall, *National Systems of Innovation, Towards a Theory of Innovation and Interactive Learning*, Pinter, (1992).

[3] Q. Wu, K. Miyazaki, "Sectoral Systems of Innovation in China: the Case of Software Sector," *International Journal of Knowledge and Systems Sciences* 3, No. 1 (2006) 52-60.

[4] Q. Wu, K. Klincewicz, K. Miyazaki, "An Analysis of Open Source Software," *Asian Journal of Technology Innovation* 14, No. 2 (2006) 117-142.

[5] Y. Osawa, K. Miyazaki, "An Analysis of R&D Project Performance from Research to Commercialization," Proceedings of the First World Congress of *the International Federation for Systems Research*, S1-5-3, Nov. (2005) 14-17.

[6] R. Rothwell, *Factors for Success in Industrial Innovation, Project Sappho- A Comparative Study of Success and Failure in Industrial Innovation*, SPRU Report , (1972).

[7] Y. Osawa, K. Miyazaki, "An Empirical Analysis of the Valley of Death: Large Scale R&D Project Performance in a Japanese Diversified company," *Asian Journal of Technology Innovation* 14, No. 2 (2006) 93-116.

[8] Harrison, L.(ed), Wind Power Monthly 4, 2004.

[9] IEA, OECD Electricity Statistics, 2005.

[10] A. Davies, M. Hobday, *The Business of Projects*, Cambridge University Press, (2005).

[11] M. Hobday, "Product complexity, innovation and industrial organization," *Research policy* 26, (1998) 689-710.

[12] EWEA, *Wind Energy The Fact*, The European Wind Energy Association, (2004).

[13] Y. Ueda, H. Idaka, A. Inoue, "Mitsubishi New Wind Turbines, MWT-1000A & MWT-S2000," *MHI Technical Report* 40, No. 4 (2003) 238-241.

[14] M. Meis, Wind Energy 2004, BWE-service.

[15] Y. Inoue, K. Miyazaki, "Technological Innovation and Diffusion of Wind Power in Japan," *Technological Forecasting and Social Change* 75, (2008) 1303-1323.

[16] R. Gasch, J. Twele, Wind Power Plants, Solarpraxis, 2002.

[17] NEDO, Accessed on the Web at http://www.nedo.go.jp/english/index.htmlon March 29, 2007.

[18] K. Miyazaki, and N. Islam, "Nanotechnology Systems of Innovation - An Analysis of Industry and Academia Research Activities," *Technovation* 27, (2007) 661-675.

[19] N. Islam, K. Miyazaki, "Nanotechnology Research and Development Policy An Analysis of R&D Strategy and Some Policy Implications for Promoting Nanotechnology R&D in Japan," *Journal of Science and Technology Studies* 6, (2008) (kagakugijutushakairon kenkyuu) 23-37.

[20] G. Bell, and M. Callon, "Techno-Economic Networks and Science and Technology Policy," *STI Review*, OECD 14, (1994) 59-118.

[21] H. Lastres, *The Advanced Materials and the Japanese System of Innovation*, McMillan, London, (1994).

[22] N. Kumaresan, and K. Miyazaki, "An Integrated Network Approach to Systems of Innovation-the Case of Robotics in Japan," *Research Policy* 28, (1999) 563-585.

[23] N. Islam, K. Miyazaki, "Innovation in Nanotechnology – Trend of Nanotech Fusion with Scientific Disciplines and Nanotech Roadmapping," *Tehnologicy Intelligence and Planning* 2 (2008).

Institutions and Optimization Models

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Abstract — **When we construct a mathematical model of a real life decision problem, optimization models and mathematical programming problems are very useful. Based on each institution underling the real problem, we should choose an appropriate optimization problem so that it can be solved by using computers and methods. For efficient modeling, it is important to understand well standard models and methods for mathematical programming problems. In this paper, we summarize optimization models, methods for them, and some results of research.**

Index Terms — **Algorithms, Institutions, Linear Programming, Optimization**

1 Introduction

Optimization models and mathematical programming problems are used to formulate a real life decision problem. When we make an optimization model, the model will be influenced by institutions underling the real life problem.

It is important to construct a mathematical model so that it expresses a real life problem correctly and it could be solvable by using computers and methods. In this paper, we examine optimization problems, and we summarize methods for solving them. We also show some results of research on institutions and optimization models.

2 Optimization Problems

When we construct an optimization model or a mathematical programming problem for a real life decision problem, we should determine the following three factors:

(1) Variables,
(2) An object function,
(3) Constraints.

Choice of variables is very important in modeling. Usually there are several ways to choose the variables for a real life problem. The models may be quite different depending on the choice of variables. Each variable takes a value of a real number or an integer. The problem is usually difficult to solve when some of the variables are integers.

A decision problem may have several objectives. In that case, we should choose an important objective from them, and the other objectives are considered in the constraints. Sometimes we construct a single objective by combining several objectives. The objective is expressed by a function, and constraints are expressed by equalities and inequalities of functions.

The most fundamental optimization problem is called a linear programming problem, in which the variables take real numbers, the objective function is linear, and all the constraints are expressed by using linear equalities and inequalities. The standard form of a linear programming problem is expressed as

$$\begin{aligned} &\text{Minimize} && \langle c, x\rangle \\ &\text{Subject to} && A\,x = b, \\ & && x \geqq 0, \end{aligned}$$

where x is an n-dimensional variable vector, b is an m-dimensional vector, c is an n-dimensional vector, and A is an m*n matrix. The formula <c,x> represents the inner product of vectors c and x. The problem is to find a vector x which minimize the function <c,x> under the conditions that x satisfies all the constraints

When the objective function or some of the functions in the constraints are not linear, the mathematical programming problem is called a nonlinear programming problem. Mathematical programming includes quadratic programming, nonlinear programming, integer programming, network programming, semidefinite programming, and second order cone programming.

Some typical real life optimization problems are production planning problems, transportation problems, scheduling problems, and optimal portfolio selection problems. We can formulate those optimization problems as one of mathematical programming problems shown above. For example, an optimal portfolio selection problem can be modeled as a quadratic programming problem, when the object function represents a variance of a return rate of a portfolio.

3 Methods

There are three important methods for solving a linear programming problem. A simplex method, which is a first algorithm for solving a linear programming problem, is proposed by Dantzig [1] in 1947. The algorithm solves efficiently most of linear programming problems. But it is known that there exists a linear programming problem which can't efficiently be solved by a simplex method, or theoretically the simplex algorithm is not known as a polynomial time method. A first polynomial time algorithm for linear programming is proposed by Khachian [6]. But the algorithm is not as efficient as a simplex method for practical problems.

Karmarkar [5] propose an interior-point algorithm for linear programming in 1984. The algorithm is polynomial time and it solves practical problems as efficiently as the simplex method. Especially interior-pint algorithm is more efficient for a large size problem than the simplex method. Moreover interior-point algorithms can solve not only linear programming problems but also various models of mathematical programming problems. Some new optimization problems including semidefinite programming problems could be solved by development of interior-point algorithms.

4 INTERIOR-POINT ALGORITHMS

Since Karmarkar [5] proposes a practically efficient and theoretically polynomial time interior-point algorithm for linear programming, various researches related it has been done. A prototype of interior-point algorithms is discussed by Fiacco and McCormick [3]. Dikin [2] presents a first interior-point algorithm called an affine-scaling algorithm in 1967.

An interior-point algorithm which solves a primal and dual pair of optimization problems is proposed by Kojima, Mizuno, and Yoshise [9]. This algorithm is currently most popular and used in practical software for solving various optimization problems. Mizuno, Todd, and Ye [11] construct a predictor-corrector interior-point algorithm, which has nice properties of both local and global convergence.

5 CONCLUDING REMARKS

In this paper, we explain modeling of real life decision problems and summarize algorithms for solving the models.

We get the following results on institutions and optimization models. Inaba, Mizuno, and Nakata [4] show that a robust tracking error optimization problem is modeled as a second-order cone programming problem. We propose a minimax method for multiple classification problems in Kitahara, Mizuno, and Nakata [7] by extending the result of Lanckriet et al. [10], and show that the problem is formulated as a parametric second order cone programming. Kitahara, Mizuno, and Nakata [8] extend a linear minimax method by Lanckriet et al. to quadratic and convex minimax methods. We show that the former problem is transformed as a semidefinite programming problem and we analyze the relations of those problems theoretically.

REFERENCES

[1] G. Dantzig, *Linear Programming and Extensions,* Princeton University Press, New Jersey (1962).

[2] I. I. Dikin, "Iterative Solution of Problems of Linear and Quadratic Programming", *Soviet Mathematics Doklady 8*, (1967) 674-675.

[3] A. V. Fiacco and G. P. McCormick, *Nonlinear Programming: Sequential Unconstrained Minimization Techniques*, John Wiley & Sons, New York (1968).

[4] H. Inaba, S. Mizuno, and K. Nakata, "Robust Tracking Error Optimization Problems by Second-Order Cone Programming", *Transactions of the Operations Research Society of Japan 48*, (2005) 12-25.

[5] N. Karmarkar, "A New Polynomial-Time Algorithm for Linear Programming", *Combinatorica 4*, (1984) 373-395.

[6] L. G. Khachian, "A Polynomial Algorithm in Linear Programming," *Dokklady Akademiia Nauk SSSR 244*, (1979) 1093-1096.

[7] T. Kitahara, S. Mizuno, and K. Nakata, "An Extension of a Minimax Approach to Multiple Classification", *Journal of the Operations Research Society of Japan 50*, (2007) 123-136.

[8] T. Kitahara, S. Mizuno, and K. Nakata, "Quadratic and Convex Minimax Classification Problems", *Journal of the Operations Research Society of Japan 51*, (2008) 191-201.

[9] M. Kojima, S. Mizuno, and A. Yoshise, *A Primal-Dual Interior Point Algorithm for Linear Programming*, in N. Megiddo (ed.) Progress in Mathematical Programming, Interior Point and Related Methods, Springer, New York (1989) 29-47.

[10] G. R. G. Lanckriet, L. El Ghaoui, C. Bhattacharyya, and M. I. Jordan: A Robust Minimax Approach to Classification. *Journal of Machine Learning Research 3*, (2002) 555-582.

[11] S. Mizuno, M. J. Todd and Y. Ye, "On Adaptive-Step Primal-Dual Interior-Point Algorithms for Linear Programming", *Mathematics of Operations research 18*, (1993) 964-981.

Japanese Culture and Quality
Source and Mechanism of Strength and Weakness

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Abstract– **In this article, our weakness is first considered based on current IMD competitive ranking after confirming our strength on quality philosophy and various innovation concepts, as represented by Kaizen, born in our country. Then through the international cultural comparison by Hofsted, it is claimed that these strength and weakness come from our inherent culture, high uncertainty avoidance for objects and time, quite different from not only Western countries but also Asia countries.**
And the above hypothesis is verified by citing various our laboratory's researches such as international CS, cross national comparison of SCM performance using our LSC and so on. Through these considerations, some interpretation is provided about the phenomena, considered side effect of high quality, e.g. Galapagos and quality homeostasis happening in current Japanese context. Finally taking advantage of relativistic culture indifferent to ideology and religion fixate society, it is proposed how we overcome the problem and create new quality concepts.
The content of this article is abstracted from the author's reading book [1] published soon introducing our laboratory's research activities on SIMOT.

***Index Terms*—high uncertainty avoidance culture, customer satisfaction, supply chain management, competitiveness**

1. BACKGROUD

1.1 Quality Philosophy and Innovation Concepts Born in Our Country

The basis of the operation (work and business) that efficiently secures the quality is to make a best standard to accomplish it, and to work according to it. However, when increase of product varieties and shortened product life have progressed, it became not possible to follow to the change only on operation just according to the standard. Then, organizational Kaizen efforts on the basis of standard, as shown in Figure 1, were invented in manufacturing of our country[1][2][3]. It is called incremental improvement or continuous improvement as an English translation. TQM, TPM and JIT (or TPS) are organizational Kaizen efforts aiming at enhancement of QCD respectively, and have now been well known and adopted all in the world.

At the same time, many new innovative concepts and new maxims changing way of traditional thinking were created. Representative ones as to quality for example are as follows.

- Customer oriented
- If the quality is improved, the cost falls, too.
- Source management (Do it right at the source)

In addition, Japanese manufacturing created many innovative concepts like visibility and Just-in-Time, ect. in the three factors of QCD, considered global standards on operations management. They became competitive edge in our country, and the name of high quality and high reliability was made to roar all over the world in the latter half of 1980.

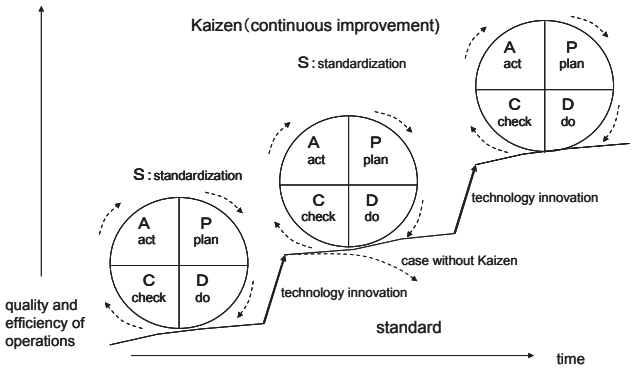

Fig.1 Standard and Kaizen

1.2 Current Problems in Our Competitiveness

However, the situation has changed completely since the collapse of the bubble and under low growth economy lasting for long time[4]. Figure 2 shows Japanese transition of IMD ranking[5]. Its ranking had been dropped, and lowered up to the 27th place in 2002 although top rank had continued from the started year, 1989 until 1993. From the bottom of 2002, the rank was raised gradually, but dropped again in the 24th in 2007.

The latest rank in 2008 is 22th place. Instead of depressed Japan, the United States has continued to occupy the top rank during the periods.

What happened in the recent sluggish situation compared to the top ranked period around 1990? It may be attributed to a depression of the business efficiency to struggle with low

competitiveness besides the government efficiency. Another reason comes from the big change of present ranking criterion of the IMD in contrast with ones around 1990.

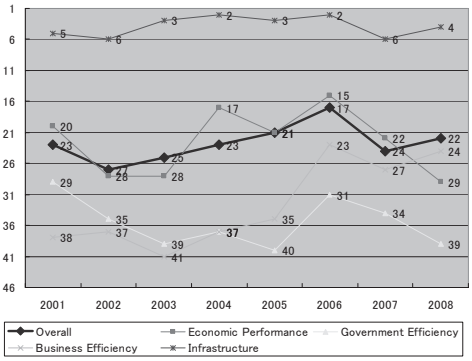

Fig.2 Transition of our IMD competitive Ranking

Table 1 is a list of strength and weakness items of the business efficiency, in 2003 when it was ranked the 41-th place, and in 2008 that raises the order to the 24th place. Apparently it is understood that similar items compose the strength and the weakness in the both years.

Tab. 1 Strengh and weakness in business efficiency

2003	
strength	weakness
priority of employee educatio	entrepreneurship
labor relations	shareholder value
customer satisfaction emphas	remuneration in service secto
stock market capitalization	banking regulation
banking sector asset	openess of national culture
2008	
strength	weakness
customer satisfaction emphas	entrepreneurship
priority of employee educatio	variation of stock market inde
stock market capitalization	remuneration in service secto
labor relations	openess of national culture
availabilty of skilled labor	international experience of senior managers

As opposed that "CS Management " and "Priority of the employee training" are strong points, "Manager's entrepreneurial spirit", "The manager's international experience" and "Efficiency of top management" in other years are weak, that is , placed close to the lowest rank. It can be summarized that it is poor at management under admitting the existence of the risk, and top management is weak in relation to it.

When the decrease of the IMD rank came not to put the brakes, it has come to be pointed that the profitability of Japanese enterprise is quite low compared to the other countries irrespective of top raking of the number of patents and R&D expense, and that this is due to weakness of its entrepreneurship. Straight development management based on a single target until then might have caused a discrepancy with global environmental change. It is absent of the strategic management so that development efforts connect to financial outcomes by observing an environmental change. From the next chapter, our strength and weakness are explored from the viewpoint of culture inherent in Japanese.

2. SOURCE OF KAIZEN EFFORTS: HIGH UAI CULTURE

2.1 High uncertainty avoidance culture for objects

How can country culture be measured ? There have been many researches on international cultural differences, and their basis lies on the four dimensions by Dutch researcher G. Hofsted[6]. In his famous book, Culture and Organization, he mentions quite interesting insights about country culture as follows;.

(1) No matter how the globalization progresses, and a new technology like the Internet. appears, the culture in the country does not easily converge.
(2) A lot of theories and techniques concerning management are only effective under the culture where they were invented.
(3) Therefore, the road to a super-excellent company is never one.

There has been a trend for management theory and technique born in the United States to be often considered global standard. If the above mentioned opinion of Hofsted is true, that is a criticism or warning against Pan-Americanism. Including verification of this aspect, let's consider what a feature of Japanese culture is. The four dimensions of Hosted consist of the followings.

i Power difference (PDI): dependency of subordinates on bosses. PDI is higher as dependency is stronger.
ii Individualism (IDV): degree of connection among each individuals. IDV is higher as the connection is looser, and the opposite pole is collectivism.
iii Masculinity (MAS): distinction of roles between men and women. MAS is stronger as the distinction is clearer, and its opposite pole is femininity.
iv Uncertain avoidance (UAI): tolerance to ambiguous or unknown situations. UAI is higher as it is intolerant to ambiguity and uncertainty. the opposite.

This result is based on the questionnaire survey conducted in the 1970s and intended for the employee of IBM in more than the country 50 in the world. Afterwards many researchers conducted confirmatory surveys intended for other various occupations, and the validity of the four dimensions and the scores provided to the countries has been examined and confirmed[7][8].

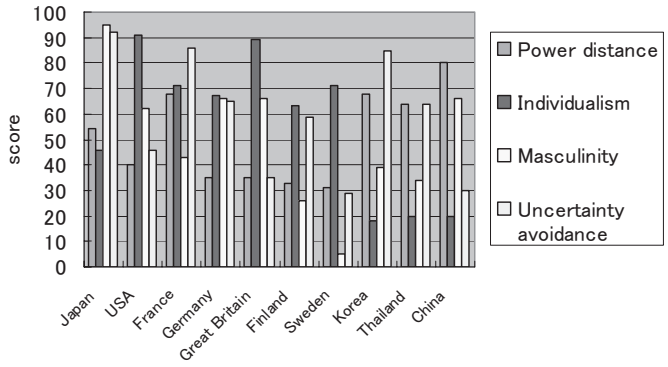

Fig.3 Comparison of Hofsted cultural scores

How is our country's culture characterized ? Figures 3 shows comparisons of the four dimensions' scores in ten countries including our country. Japanese characteristics can

be summarized by middle scores of PDI and IDV, and quite high scores of MAS and UAI. At the same time it is apparently observed that Japan is not only different from Anglo-Saxon's United States, Britain and Scandinavian countries like Sweden and Finland, but also quite different from East Asian vicinity countries like South Korea, Thailand and especially China. If cluster analysis is conducted, it resulted in that France has the nearest country to Japan.

What should be paid attention as for our cultural characteristic is high UAI tendency terms of management in particular. Typical featsures of high UAI are as follows. “The uncertainty inherent in life is felt as a continuous threat that must be fought”, "Higher stress and high anxiety”, “What is different is dangerous”, “Students are comfortable in structured learning situations and concerned with the right answers.”, “Teachers are supposed to have all the answers.”, “Laws are necessary, even if they cannot be respected.”, “Time is money, “There is an emotional need to be busy and an inner urge to work hard”, ”Precision and punctuality come naturally”, “Innovations resisted but, if accepted, applied consistently.” and so on.

It should be noted that Japanese high UAI makes sense for object, thing, and time, but that it never works for concepts or something like ideology and religion. We have relativistic culture, that is ,the Japanese ares quite tolerant or indifferent to ideology and religion fixate society. Then there is another features like “ we can go ahead even in vague situation” and “ yuzu-muge (flexible)” This claim is supported by .Ryotaro Shiba's writings[9], and in one of his books, the term “relativistic and technology oriented Japanese culture” appears frequently, where technology oriented culture corresponds to high UAI for object.

2.2 Source of Kaizen efforts: strength and weakness

The above mentioned high UAI of our culture especially for object, like dislike of uncertainty and inner urge to decrease it, might be considered a source of Kaizen efforts for other countries not to imitate easily. And once this kind of innovation on operations management is accepted, it is applied consistently by strong appeal of technological oriented solutions. As a result, accuracy or precision and punctuality come naturally. Due to this culture, TQC or kaizen aiming at defective 0 and breakdown 0 and Just-In-Time and visibility as its means aiming at 0 inventory were born in Japan.

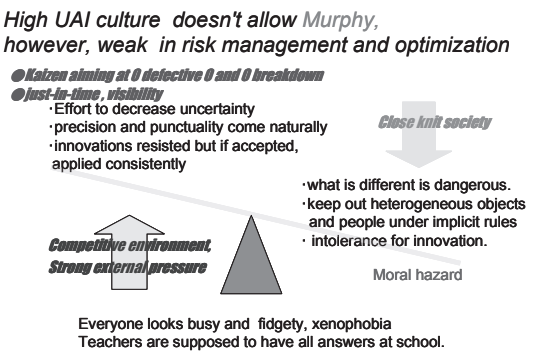

Fig.4 Source of Kaizen and double-edged sword

In other words, so call *Murphy*, where *Murphy* means something like troubles such defective and breakdown, is not allowed from the first time, continuous improvement is triggered naturally to decrease them aiming at Defect 0 and breakdown 0, and JIT.

However, as shown in Figure 4, high uncertainty avoidance easily falls in organizational behavior something like what is different is dangerous and innovators feel constrained by rules. This brings about intolerance of diversity and closed society or behavior pattern to keep out heterogeneous objects and people under tight and implicit rules within a group. In such a society, an implicit rule works so that the nail that sticks out gets hammered down or “*yoko-narabi*”. What is a moderator, that is, a turning point leading to mutually opposite directions? It might be existence and awareness of competitive environment.

On the other hand, E. Goldratt famous for TOC (Theory of Constraints)[10], tell us our weakness as well as strength. TOC can be considered the philosophy of the system improvement which was born to overtake Japanese kaizen approach. Goldratt criticizes Japanese approach in the two points, as described in the balloon part in Figure 5 which expresses the five focusing steps of system improvement, while admitting enough ascendancy over Western approach. It should be noted Japanese approach is considered short-cut approach from step 1 to step 4.

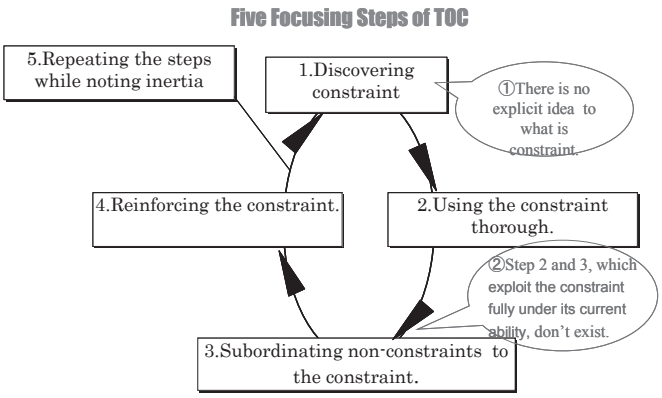

Fig.5 Five focusing steps and criticism agaist Japanese model

The first one is that there is no explicit idea to what is constraint. In other words, the bottleneck in Japanese approach is not constraint determining system goal or throughput, and often only statistical variation such as failure or breakdown occurs unexpectedly but inevitably in manufacturing. He provided this with the terminology “*Murphy*”. Then he identified Japanese Kaizen is never an activity intended for constraint directly, but one intended for the edge of throughput such as inventory reduction and quality improvement. I agree, This is a question of management to connect improvement effort with company goal.

The second one is Step 2 and 3, which exploit the constraint fully under its current ability under the concept that one hour of the constraint is equal to one hour of the whole plant, don’t exist. This means lack of *status quo* concept or risk management. In addition, it is unrealistic to conduct Kaizen from first to last aiming at failure 0, inventory 0 while denying the existence of Murphy, as described in the left of the figure.

It is considered that the above criticism is quite rational. However conversely speaking Kaizen effort aiming at defective 0, failure 0, delivery delay 0 and inventory 0, itself is our inherent strength while it never functions well nor is possible to imitate in other counties different from our culture. As an evidence, management tools such the benchmarking and ABC (The activity standard cost: Activity Based Costing) were developed and necessitated as the means in order to generate organizational Kaizen efforts[11].

3. STRICT CUSTOMES FORGED QULITY

3.1 Influence if Economic Situation on CS

On the other hand, how did our cultural characteristic work in customers and consumer? This chapter explores this through the cross country comparison of CS. As the determinant mechanism of CS, the most established one is considered expectancy disconfirmation theory that CS is determined by the arithmetic or subjective difference between an individual perception perceived quality and his or her comparison standard (various expectations).

The comparison standard (prior expectation) that gives CS a negative effect is influenced quite by outside environments other than the product and service. What are outside environments? They are information such as advertisement, word of mouse and so on, and change of own capability to buy the product and service. And at their back the economical situation lurks influencing a lot on the consumer behaviors. We had periodically measured the CS of the three durables goods of .refrigerator, television and .washing machine for about 30 years from 1977 to 2007.

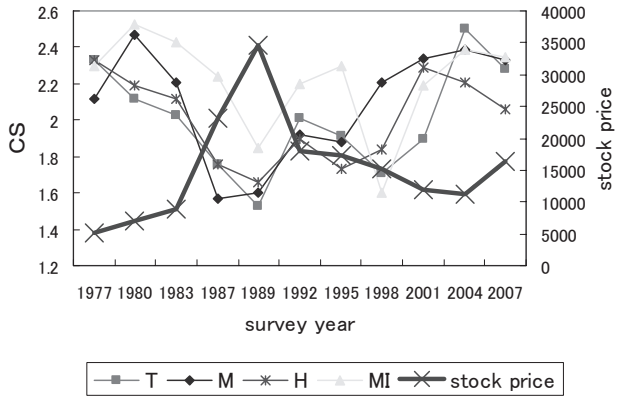

Fig.6 Transions of CSs of the four companies' rerigeratos and NIKKEIstock price

Figure 6 shows the transition of CS values of the four companies with larger market shares over time. Corresponding Nikkei average stock value is drawn by the heavy line, which represent the economic variation, in particular, supposed to be related to the business condition, and observed having the negative correlation with CS values. If the coefficient of correlation with the average CS value of the four companies is calculated, it shows quite highly significant value of -0.907. This tendency is not only common to the television and the washing machine, but also is observed similarly in the hospital CS data and a national level like ACSI described later [12][13][14][15][16][17] .

This result implies meaningful management insight that it is necessary to remove the bias caused by the economic fluctuation when own company's CS measurement is continuously conducted to judge the company's performance. It seems most preferable to correct the original measured CS value into the value to reflect the managerial effort by using simply the stock value although there are a lot of indices representing economic situation[18].

For example, let's take up the case of McDonald, the fast food chain in the United States, and consider correlation of sales and the operating profit and the CS value available from the ACSI database of 12 years from 1994 to 2003 2005 2006. In Table 2, the original CS value means the correlations between the measured CS value as it is and the managerial outcomes (sales and profit) of the corresponding year, one year delay and the two year delay. In contrast, the corrected CS, which is the residual obtained by regressing the original CS by Dow-Jones stock price, stands for the correlation between the corrected CS value and the three kinds of managerial outcomes considering the time delays. Obviously high significant correlations are with the sales and profit resulted from company efforts in the case of the corrected model by the stock price.

Tab. 2 Effect of removing economic bias

	time lag	original CS value r	original CS value p	model 1 r	model 1 p	model 2 r	model 2 p	N
sales	0 yr	0.325	(0.302)	0.022	(0.946)	0.867***	(0.000)	12
	1 yr	0.229	(0.498)	−0.065	(0.850)	0.792**	(0.002)	11
	2 yr	0.228	(0.526)	0.159	(0.662)	0.789**	(0.004)	10
profit	0 yr	0.330	(0.294)	0.055	(0.864)	0.866***	(0.000)	12
	1 yr	0.233	(0.490)	0.037	(0.914)	0.852***	(0.000)	11
	2 yr	0.165	(0.650)	0.181	(0.616)	0.836**	(0.002)	10

**$p < 0.01$; ***$p < 0.001$

3.2 Influence of country culture on CS

As opposed to our high quality reputation known in the World in the 1980's., many countries ended up taking various incentive countermeasures to improve quality. One of them was the national level CS measurement to measure CS of own country's companies continuously and publish their values. Represented by ACSI(American Customer Satisfaction Index) of the United States, EPSI(Europe Performance Satisfaction Index) in EU, and GCM (German Customer Monitor) of Germany, CS measurements are practiced in Hong Kong Korea and so on in about ten countries in the World at present.

Figure 7 shows the ten counties' cross country comparison of the average CSs from 2003 to 2005 converted into 100 point full marks. The ANOVA of country average taking account of variation of CS within each country resulted in significant difference of F=69.99(p=0.000), that is, CS value differs in countries. The United States is the highest, and Scandinavian countries, Finland and Denmark, follow putting Hong Kong between them. And Germany, Japan, and South Korea belong to the lowest group, and there is a difference of ten points or more with the highest United States.

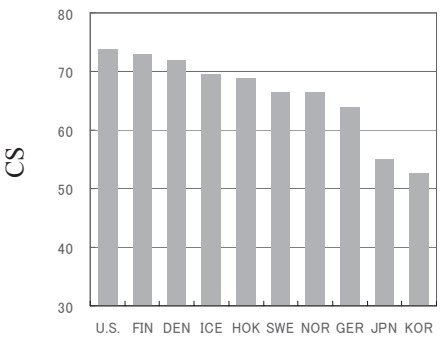

Fig. 7 International comparison of CS（2003-2005）

Low CS value of our country never means low quality of products and services in our country. It rather indicates our customers and consumers are severe with the quality. And in terms of the expectancy-disconfirmation theory, it means that Japanese customers and consumers have unexpectedly high expectation about products and services. This phenomenon can be explained by the country culture[19].

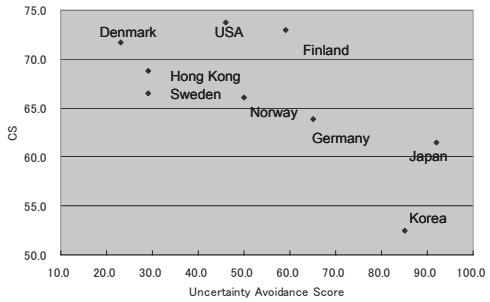

Fig. 8 Corelation of CS and UAI score

As for the 9 countries excluding Iceland., investigating the correlation between each country's CS value and Hofsted's four dimensional cultural score, UAI shows the highest coefficient of correlation (r=-0.712 (p=0.000). As illustrated in Figure 6, negative correlation is observed. The higher UAI is, the lower its country's CS is

Since the cultural dimensions highly correlated each other, the multiple regression analysis with decreasing variable method was applied by the five independent variable, the four dimensions and GDP/capita, and the following model is obtained.

$$CS = -0.487 \times UAI + 0.486 \times IDV + cons \tan t$$

$$t: -3.578(p = 0.002) \qquad 3.575(p = 0.002)$$

$$R^2 = 0.650 \qquad Ad.R^2 = 0.618$$

The two variables remain, UAI has highly significant negative coefficient while IDV has positive one. The CS of a country becomes higher as UAI score is lower and IDV score is higher, and their contribution ratio is more than 60%. This means that 60% of CS variation among countries is determined by country cultural factor, in particular UAI score. This is because almost the same result is obtained even if the regression is conducted using GDP/capita in stead of IDV.

It is considered one of crucial factors to enhance national competitiveness that there exist highly demanding and sophisticated customers in a country. Then it is said that severe consumes and customers, which source comes from Japanese inherent culture, have forged our quality. In addition, the fact that CS value itself is a lot influenced by the country culture implies we should be careful to do international comparison of CS for the same product and service in a global company.

3.3 Cultural influence on Happiness and IMD ranking

Negative impact of UAI on CS is also observed in a personal level CS measurement[20]. Furthermore besides CS, the same negative impact is observed even in other various satisfaction measures like life satisfaction (happiness) as well[21][22][23]. Figure 9 is a scatter diagram of UAI and LS (life satisfaction) as for the 24 advanced countries where cultural scores are available.

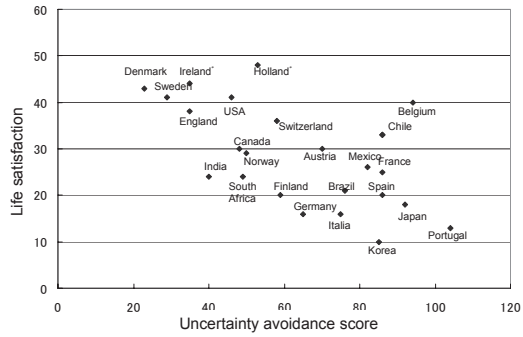

Fig.9 Corelation of LS and UAI score

Negative impact of UAI on CS is also observed in a personal level CS measurement. Furthermore besides CS, the same negative impact is observed even in other various satisfaction measures like life satisfaction (happiness) as well. Figure 9 is a scatter diagram of UAI and LS (life satisfaction) as for the 24 advanced countries where cultural scores are available.

$$LS = -0.675 \times UAI + cons \tan t$$

$$t: -4.197(p = 0.000)$$

$$R^2 = 0.456 \qquad Ad.R^2 = 0.430$$

The model that LS is lower as UAI is stronger was derived.

However, there is the difference between CS and LS in something like influential mechanism. In the case of LS, cultural impact is through the aspiration level that an individual has internally and genetically while CS cultural impact is through the expectation for specific product, service and company. Therefore LS might be little influenced by economic variation[24].

Fig.10 Time transition of CS and LS

Figure 10 shows a time transition of Japanese LS and CS converting the same 100 full scale. LS is almost constant even though our life has become more than ten times affluent since 1958 in terms of GDP. In contrast CS average of the three durable goods fluctuates a lot so as to make turning over point at the collapse of babble economy.

Interesting thing is that the above mentioned cultural influence is observed in the IMD competitive ranking. The result is almost the same even though the recent ranking of any year is used, the same analysis is conducted for the IMD ranking score intended for the 39 counties ranking scores in 2006, the following result is obtained.

$$IMD\_SCORE = 72.7 + 0.227 \times IDV - 0.675 \times UAI$$

$$t: 2.521(p = 0.000) \quad -3.210(p = 0.004)$$

$$R^2 = 0.456 \quad Ad.R^2 = 0.430$$

Figure 11 is a scatter chart where the horizontal axis is the estimated value by the above model and the vertical one is actual IMD ranking score. And the straight line stands for one for the estimated and actual values to be equal.

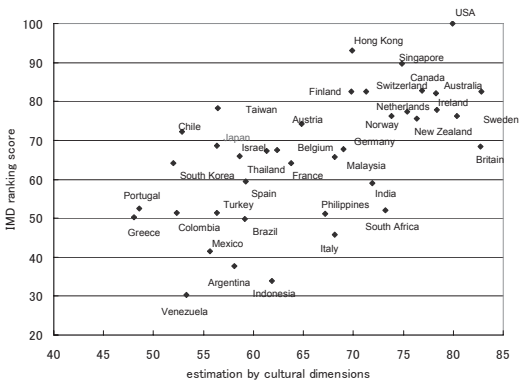

Fig.11 Estimated value model and actual IMD ranking score

Current criteria or norm of IMD competitive ranking may work as the background why about 40% or less of the overall IMD ranking score is determined by country cultural score. Roughly speaking current IMD criteria are considered *individual risk taking culture* and *globality.* The typical country most fits the criteria is Anglo-Saxon's the United State with high IDV and low UAI.

Although the government and politicians often refer to our sluggish IMD ranking, it is the author's opinion that we should not aim simplistically at raising IMD ranking under the current IMD criteria. Should we drive for countries like Hong Kong and Singapore which occupy 2nd and 3rd positions of IMD ranking ? It falls into misplaced results if destroying our culture as a source of organization Kaizen efforts by imitating their institutions superficially to raise the rank[25][26][27].

4. SCM PERFORMANCE, ITS OUTCOMES AND CULTURE

4.1 How does SCM performance bring financial outcomes?

Following the topic of CS, let's explore the cross country comparison and the influence by the culture by taking up SCM (supply chain management) performance as a representative of operations management. The SCM logistics score card (LSC), a kind of simplified benchmaking tool, was developed to measure company's SCM performance. There are the three kinds of LSCs intended for manufacturer, 3PL and distributor. In addition to Japanese original version, there are 5 other language versions of English, Chinese, Thai, Koreans, and Finnish[28].

LSC consists of 22 items: five items concerning the strategy and the organization, five items to the plan execution power, seven items concerning the logistics performance, and five items concerning how to use ICT. In Japanese version, the data base of about 700 companies is constructed, and diagnosis system based on the data base is built to provide the company with various bench mark information such as ranking within own industry and t visualized strength and weakness map by the three dimensions, which are SCM organizational ability, responsiveness and IT utilization ability extracted by the factor analysis shown in Figure 12.[29][30][31]

	Factors		
	1	2	3
1-(1)Corporate strategy regarding logistics and its importance	0.572	0.222	0.231
1-(2) Definition of supplier contract terms & degree of information sharing	0.635	0.276	0.210
1-(3) Definition of customer contract terms & degree of information sharing	0.651	0.242	0.158
1-(4) System for measurement and improvement of customer satisfaction	0.511	0.332	0.230
1-(5) System for employee training and evaluation	0.548	0.231	0.179
2-(1) Strategies for optimizing logistics system resources based on DFL	0.462	0.346	0.323
2-(2) Understanding of market trends & accuracy of demand forecasting	0.391	0.403	0.268
2-(3) Accuracy and adaptability of SCM planning	0.374	0.499	0.190
2-(4) Control and tracking of inventory (product/parts/WIP).	0.311	0.499	0.242
2-(5) Process standardization and visibility	0.434	0.464	0.299
3--(1) Just-In-Time	0.309	0.574	0.349
3-(2) Inventory turnover & cash-to-cash cycle time	0.328	0.541	0.222
3-(3) Customer lead time (from order placement to receipt) and load efficiency	0.215	0.604	0.205
3-(4) Delivery performance and quality	0.251	0.516	0.301
3-(5) Supply chain inventory visibility & opportunity costs	0.347	0.405	0.352
4-(1) Electronic Data Interchange (EDI) coverage	0.100	0.243	0.658
4-(2) Usage of Bar Coding / Automatic Identification and Data Capture (AIDC)	0.160	0.262	0.590
4-(3) Effective usage of computers in operations and decision-making	0.201	0.257	0.512
4-(4) Open standards and unique identification codes	0.304	0.129	0.575
4-(5) Decision-making systems and support to supply chain partners	0.302	0.232	0.608

SCM Organizational Ability

Responsiveness

IT Utilization Ability

Fig.12 Three factors andtheir loading matrix

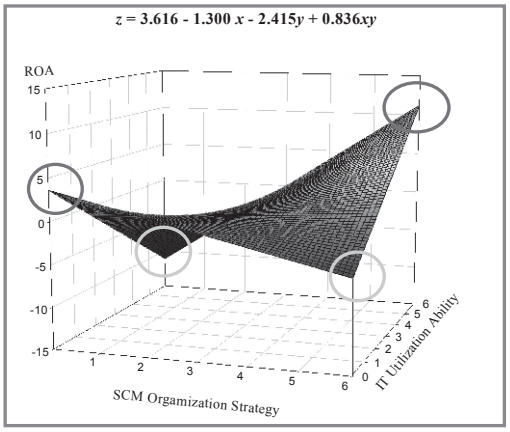

Fig.13 Mechanism of IT paradox

What happens if conducting the regression analysis of company profitability indices like ROA and cash flow by SCM performance expressed by the scores of the three factors ? Concerning ROA, it results that the interaction effect of (SCM organizational ability)×(IT utilization ability)

is most significantly positive influential and (IT utilization ability) itself has a negative coefficient surprisingly. Figure 13 shows the obtained response surface on (SCM organizational ability)×(IT utilization ability). It is implied that high IT implementation yield better only when high SCM organizational ability is accompanied. This may provide controversy of "IT paradox" with one concrete evidence. [32]

4.2 International comparison and culture

Next is the international comparison measured by LSC. The number of samples N is 694, 53,206,100,181 respectively in Japan, Finland, Thailand, South Korea, and China respectively. [33][34][35]

Simply comparing the overall scores of LSC, the rank became order of China, South Korea, Thailand, Finland, and Japan unexpectedly. Especially, Japan is the lowest rank in the items of "corporate strategy and inter-organizational alliance", and this causes the lowest Japanese overall score. It might mean the weak point on our top management. Moreover, calculating the correlations with country UAI score, it shows significant negative coefficient r= -0.103(p=0.000), that is, SCM performance is lower as UAI is higher.

4.3 Reverse effect of strong "Genba"

Recently there are many requests from companies to apply for gap analysis. This is one of the functions of our diagnosis system, and visualize gap of awareness for own company based on responses by more than one member belongs to the same organization. Then the interesting thing is that quite the same tendency is observed in common, that is, the higher member's hierarchy is the higher or the easier his or her score is, in other words, the score is lower or severe as a member becomes closer to the front line. Figure 14 shows its example.[36]

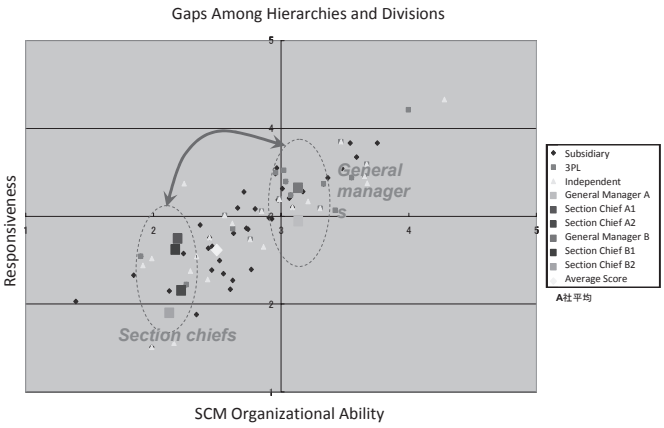

Fig.14 Example of LSC gap analysis in our country

On the other hand, it is quite opposite for foreign countries. The example hangs to Figure 15. This is an example of an Europe and America foreign capital enterprise in Thailand. This is caused by the fact the fields (*Genba*) never work well unless higher class management identify well and control them. Conversely it is said *Genba* is very strong, and it works well without strong management. As well as LSL, this tendency is observed even NPDSC (New Product Development Score Card), which was developed intended for NPD corresponding to the LSC purpose.[37][38][39][40][41]

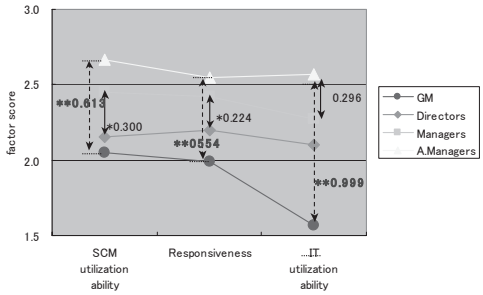

Fig.15 Overseas example of LSC gap analysis

Furthermore, this kind of awareness gap influences organizational maturity that learning of overall organization leads to larger increase of value. Figure 15 is an example of relationship between awareness gap and degree of organizational maturity in hospital.[42]

5. COCLUSIVE REMARKS

Japanese high uncertain avoidance culture for object and time was a source of not only high quality and high reliability, but also Kaizen and strong Genba. However, we are facing the phenomena considered happening only in Japan. They are excessive response against safety of food, unexpected accidents considered side effect of high quality and high reliability, and high cost institution of service industries. For example Japanese citizen tend to seek for unrealistic absolute safety. And so called *Galapagos phenomenon* [43] by competing for high within our country is occurring, and another one should be provided the naming of *quality homeostasis* that consumers get accustomed no failure products face unexpected accident by continuing the product for 30 years or more without maintenance.

It is said that the age has changed from cost to quality, and will change to design. Now considering this trend, it is necessary to refine new Japanese in addition to enhancement of management in order to draw out our cultural strength to strengthening the management power in such an age. It may be a creation of new quality concept based on culture of f respect to all kinds of objects[44], and redefinition of what quality should be in accordance with diversified global markets on the other hand. Finally it is also crucial to advocate definitely be "environment founded country" in addition to "quality founded country".[45][46]

REFERENCES

[1] Enkawa, T.: Japanese Culture and Quality, Its Source and Future Perspevtie, JSA Press, in print,(2009)

[2] Deming, W. E.: The New Economics for Industry, Government, Education(2nd Edition), NTT Publisher(1996)

[3] Florida, R, The Flight of the Creative Class, HarperCollins Publishers(2005)

[4] Porter, M.E. and Takeuchi, H., Can Japan Compete?, Diamondo

Publisher(2000)
[5] IMD World Competitiveness Year Book(2003-2008)
[6] Hofstead, G :Multi-dimensional Soviety, Yuuhikaku(1995)
[7] Hofstead, G.: Cultures and Organizations: Software of the mind, Revised and Expanded 2nd Edition, McGraw-Hill(2004)
[8] House, R.J. et.al. : Culture, Leadership, and Organizations: The GLOBE Study of 62 Societies, Thousand Oaks, Sage Publications(2004)
[9] Shiba R. : History and Cultural Climate, Bunsyun Bunnko（1998）
[10] Goldratt, E. The Goal, The North River Press(1992)
[11] Enkawa, T.: ”TOC（Theory of Constraints）and Japanese Culture, *Defense Facility & Technology*, October, No.58, 4-17 (2005)
[12] Ikeshoji, M. and Enkawa, T. : “A Study on Relationship between Customer Satisfaction and Economic Condition”, *Quality,* 34, No.4, 90-99(2004)
[13] Ogikubo, M., Schvaneveldt, S. J., and Enkawa, T. : “An Empirical Study on Antecedents of Aggregate Customer Satisfaction: Cross-country Findings,” *Total Quality Management and Business Excellence*, 20, No.1, 23-37(2009))
[14] Frank, B and Enkawa, T.: “How economic growth affects customer satisfaction”, *Asian Pacific Management Review*, 13, No.2.512-526(2008).
[15] Frank, B. and Enkawa, T.: “Economic Influences on Perceived Value, Quality Expectations, and Customer Satisfaction,” *International Journal of Consumer Studies*, accepted for publication (2009)
[16] Frank, B., Sudo, S., and Enkawa, T.: “Interpreting Time Series of Patient Satisfaction: Macro vs. Micro Components,” *International Journal of Hospital Marketing and Public Relations*, 19, (1), 1-25(2009)
[17] Frank, B. and Enkawa, T.: “Economic Influences on Customer Satisfaction: An International Comparison,” *International Journal of Business Environment*, accepted for publication, .2, No.3 (2009).
[18] Frank, B., Sudo, S., and Enkawa, T. : “Influence of Economic Situation Bias on Customer Satisfaction and Correction Method Reflecting Company’s Effort”, *Quality*, 39, No.1(2009)
[19] Ogikubo M. and Enkawa T.: “Cross National Analysis of Customer Satisfaction, Economic Institutions and Cultural Factors, *Journal of Japan Industrial Management*, 58, No.3, 167-172(2007)
[20] Ogikubo M., Zheng, H. and Enkawa T. ; “Influence of Personal Cultural Factors on Customer Satisfaction and Repurchase Intension”, *Quality*, 38, No.2 , 63-72(2008)
[21] Frank, B., and Enkawa, T.: “Does Economic Growth Enhance Life Satisfaction? The Case of Germany,” *International Journal of Sociology and Social Policy*, 1, No.2, 113-131 (2009)
[22] Frank, B., and Enkawa, T.: “Does Aggregate Income Influence Satisfaction with the Standard of Living?” *International Journal of Society Systems Science*, accepted for publication (2008).
[23] Frank, B. and Enkawa, T.: “Economic Drivers of Dwelling Satisfaction: Evidence from Germany,” *International Journal of Hosing Markets and Analysis,* accepted for publication,2, No.1(2009).
[24] Frey, B.S and Stutzer, A, Happiness and Economics, Princeton University Press(2002)
[25] Enkawa, T. : “Production Management to Realize Sustainable Competitive Edge by Facilitating Japanese Cultural Strength”, *Quality*, 36, No.3, 6-13(2006)
[26] Enkawa, T. : “Management of Technology and Formation of New Japanese Institution”, PHASE, No.135, 14-15(2005)
[27] Enkawa, T. : “Severe Customers and Kaizen Efforts, and Monozukuri and Quality From Now On”, *Quality Management*, 59, No.1, 34-37(2008)
[28] Enkawa, T. and Suzuki, S. : “SCM Logistics Score Card (LSC), *Physical Distribution & Information*, 7, No.6, 55-59(2005)
[29] Hamazaki, A., Arashida, T. and Enkawa,T. : “Relationship of logistics and Financial Outcomes and Consideration on Role of Departments Using SCM Logistics Score Card”, *Japan Physical Distribution Society Journal*、No.12, 89-94(2004)
[30] Arashida, K., Enkawa, T, Hamazaki, A. and Suzuki, S. : “Development of SCM Logistics Score Card and Analysis of Relationship with Managerial Effects, *Journal of Japan Industrial Management,* 55, No.2, 95-103(2004)
[31] Suzuki, S., Zao, T. and Enkawa, T. : “Comparison between Japanese and Chinese Companies by SCM Logistics Score Card”,*Japan Physical Distribution Society Journal*、No.13, 67-74(2005)
[32] Yaibuathet, K., Enkawa, T. and Yoshika, T.: “Impact of Information Technology and SCM Organizational Strategy on Corporate Financial Performance and Its Cross National Comparison”, *International Journal of Information Systems for Logistics and Management*, l.3, No.1, 13-24(2007)
[33] Yaibuathet, K., Enkawa, T.and Suzuki, S. : “Supply Chain Operational Performance and Its Influential Factors: Cross National Analysis”, *Journal of Japan Industrial Management*, 57, No.6, 473-481(2007)
[34] Yaibuathet, K., Enkawa, T.and Suzuki, S. : "Effect of Industrial Type and Ownership Status on Supply Chain Operational Performance in a Developing Country", *International Journal of Integrated Supply Management,* 4, No.3/4, .322-354（2008）.
[35] Yaibuathet, K., Enkawa, T.and Suzuki, S. : "Influences of Institutional Environment Toward the Development of Supply Chain Management", *International Journal of Production Economics*, 115,No.2, 262-271（2008）
[36] Suzuki, T., Ohono, A. and Enkawa, T. : “ A Study on Intra-Organizational Awareness Gap Retarding SCM Efficiency”, *Journal of Japan Logistics Society*, 7, No.2, 11-19(2007)
[37] Irikura, N., Ishikawa, S. and Enkawa, T. : “Exploration of Core Problem for NPD by Making CRT Practical Procedure”, *Quality*, 34, No.1, 97-106(2004)
[38] Irikura, N.and S. and Enkawa, T. : “Proposal on Development of Score Card for NPD and Its Application”, *Quality*, 35, No.4, 73-84(2005)
[39] Enkawa, T. : “A Solution to Overcome Organizational Hurdle Retarding NPD; “Score Card” and “CRT””, *Standardization and Quality Control*, 60, No.3、40-47(2007)
[40] Enkawa, T., Irikura, N.and Washitani, K. : New Product Development Story, JSA Press (2007)
[41] Anantana, T., Enkawa, T. and Suzuki S. : "Empirical Research on The Influential Factors for successful New Product Development and Their Differences among Industries", *Journal of Japan Industrial Management Association*, 59, No.6（to appear）(2009)
[42] Sudo, S., Enkawa, T and Mochizuki, T. : “Structural Analysis on CS and ES in Medical Organizations”, *Journal of Japan Medical Management*, 46, No.1(2009)
[43] Miyazaki, T. : Galapagos Phenomenon Progressing in Japanese Manufacturing, Toyokeizai Shinnpou Press(2008)
[44] Taki S. :Homo Contribuens The Need to Give and the Search for Fulfilment, Renaissance Book (2008)
[45] Enkawa, T. : “Innovation of Monozukuri Necessitates Defeat of Social and Organizational Constraints”, Economist Weekly, February 17 issue, 50-53(2004)
[46] Enkawa, T. : Institutional Management of Technology Eliciting Strength of Our Country, in 58 Arguments for Japanese Monozukuri, 6-61、JIPM Solution Press(2005)

The Response of Japan toward Global Warming

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***Abstract*— It has been commonly recognized that global warming caused by greenhouse gas (GHG) emissions from fossil fuel combustion would have serious influence globally, and the developed economies are committed to reduce GHG emissions under the Kyoto Protocol. The Voluntary Action Plan and the Law of Saving Energy for industrial sectors in Japan, in which numerical targets are assigned to the individual stakeholders, work well, but total of Japanese GHG emissions in fiscal 2005 is an increase of more than 6 percent compared to emissions in the base year (1990), because of large increase of emissions in residential and transport sectors. It is predicted that industrial sectors are required to get the large amount of credits through the Kyoto Mechanisms to achieve the reduction target. In order to achieve the goals of reducing at least 50% of GHG emissions by 2050 (long-term) and of peaking out GHG concentration in the next 10 to 20 years (mid-term), Japan also sets the long-term goal of reducing 60 to 80 percent of its current level of emissions by 2050 with the aim of building a Low-carbon Society. The European Union has already been committed to reduce its total emissions by at least 20% of 1990 levels by 2020, but Japan could cut emissions by 7.4% of 1990 levels by 2020, which largely differ from the long-term target. In the Kyoto Protocol, the reduction targets were determined through the top level negotiations, then Japan proposes Sectoral Approaches (SA) to estimate reduction targets by compiling data of the sector levels this time. The negotiations about allocating the costs in reducing GHG are not fruitful now, and then we discuss about mid- and long-term targets from the view-point of advantages of the Low-carbon Society in order to solve global warming.**

***Index Terms*—Emission trading, GHG, Global warming, Kyoto Protocol, Sectoral Approach**

1 Global Warming

The CO2 concentration, which was about 280ppm at pre-industrial times, became now about 370ppm with GHG emissions from fossil fuel combustion, and its further increase could be predicted with the economic growth and population increase. Continued GHG emissions at above current rates would cause further warming and induce many serious problems such as the global climate change, sea level rise, eco-systems [1].

In 1992, the UNFCCC (United Nations Framework Convention on Climate Change) was adopted in order to keep the GHG concentration under the safe level, and in 1997 the Kyoto Protocol was adopted with the principle of common but differential responsibilities. Ensuring 5.2 percent reduction of the total GHG emissions compared to the base year (1990), the numerical targets were set mainly to the developed economies, and Japan also promised 6 percent reduction as the average GHG emissions for the commitment period (2008 to 2012). Japan planed to achieve the reduction target by the countermeasures and policies by using the Keidanren's Voluntary Action Plan [2], unfortunately the GHG emissions in fiscal 2005 was an increase of 6% compared to emissions in 1990 [3]. Ensuring 6% reduction as the average emissions of the commitment period, the countermeasures and policies effective for commercial and other, residential, and transport sectors, in which the current CO2 emissions are larger than the emissions of the base year, are added to reduce the energy-originated CO2 emissions since 2005.

According to that USA of largest GHG emissions didn't ratify the Protocol, and that China and India didn't participate the Protocol, the total emissions of countries assigned to reduce is about 30% of the whole emissions in the world, and less than 2% of the whole emissions would be reduced when all of the countries ratifying the Protocol would achieve their reduction targets [4]. Although it would be difficult to determine the safe GHG concentration level (450ppm, 550ppm, and others), IPCC (Intergovernmental Panel on Climate Change) reported that halving total global GHG emissions by 2050 and peaking out the GHG concentration in the next 10 to 20 years are requisite [1]. The contributions from not only major economies including China and India but also all of the developing countries are requisite in the post-2012 (post-Kyoto Protocol) framework, but most of the developing countries have misgivings to set numerical reduction targets. It is planned at COP15 (Conference of the parties) held at the end of 2009 that a framework based on the principle of common but differential responsibilities is adopted, and already some of developed economies declared their mid- (2020) and long-term (2050) reduction targets as shown in Table 1. More than 20% reductions compared to emissions of 1990 as mid-term targets, and 60 to 80% reductions compared to the current emissions as long-term targets are dominant, but Japanese perspective of mid-term reduction target is less than others. In these conferences, Japan, especially industrial sectors, proposed SA as tools to estimate national emission targets [6]. In SA, the targets could be set based on a bottom-up approach by compiling based on CO2 intensities and/or marginal abatement costs in sectors and tallying up the reduction volumes.

Table 1
Mid-term and long-term targets [5]

	2020	2050
Japan	14%（2005）*(perspective)	60～80% (2005 basis)
EU	20%(1990)	-
UK	26%（1990）(at least)	80%（1990）
France	20%（1990）	75%（2000）
German	40%（1990）	-
Canada	20%（2006）	60～70%（2006）
Austraria	-	60%（2000）
USA	0%(1990)	80%(1990)

*( ):base year

2 Response toward the Kyoto Protocol

In the Kyoto Protocol adopted in 1997, the major developed economies were assigned to reduce the GHG emissions as the average of emissions for the five years commitment period (2008-2012) compared to emissions of the base year (1990), including accounting removals by forests and emission trading through so called Kyoto Mechanisms:

- Joint Implementation (JI);
- Clean Development Mechanism (CDM);
- Emission Trading (ET),

Table 2 shows the target reduction ratios and necessary reduction ratios to achieve targets based on emissions of 2005. USA didn't ratify, and Canada gave up the target reduction at 2008. For the case of Japan, 13.8% reduction of emissions of 2005 is necessary to achieve the target.

Table 2
Target reduction ratios and necessary ratios [4]

	Target ratios（%）	Necessary ratios（%）
EU	-8	+6
France	0	-1.9
UK	-12.5	-3.2
German	-21	+2.3
Japan	-6	+13.8
USA	-7	+23.3
Canada	-6	+31.3
Rossia	0	-28.7

Table 3
Reduction targets and rates in the base year (1990) [7]

	Emission (million t-CO2)	rates (%)
CO2 generated from energy use	1059	84
Industrial sector	482	38
Commercial and othersector	164	13
Residential sector	127	10
Transport sector	217	17
Energy industries sector	68	5
Non-energy-originated CO2	85	7
Methane, Nitrous oxide	66	10
Three Fluorinated gases	51	4
Total	1261	100

GHG emissions in the base year (1990) is 1261 milion t-CO2, and its composition is shown in Table 3. CO2 generated energy use is more than 80 percent, and industrial sector (including energy industries sector) is 43% of its emissions. 6% reduction is 1185 milion t-CO2, then the Global Warming Prevention Headquaters made the Outline for Promotion of Efforts to Prevent Global Warming in 1998 after the Kyoto Protocol adoption. Evaluating emissions status of fiscal 1999, they revised the Outlines in 2002. After the Kyoto Protocol effectuation, they made the Kyoto Protocol Target Achievment Plan as its asuccessor in 2005 throught investigation of the emissions of fiscal 2002. Furthermore, they revised the Plan in 2008 again through evaluating the progress of policies, countermeasures, and emission status in fiscal 2005 [3].

Figure 1 shows trends in CO2 emissions in each sector (industrial, commercial and other, residential and transport sectors) from fiscal 2002 to 2007, and 1990. Emissions in the industrial sector is almost stable, but in the transport sector increases about 20%, in the commercial and other and the residential sectors are increasing.

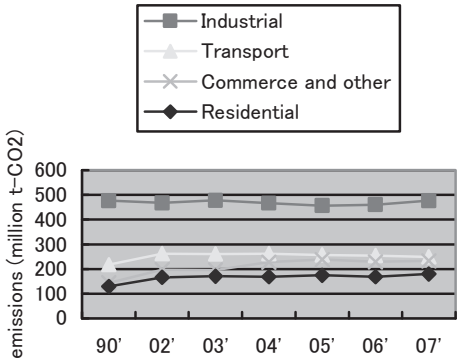

Figure 1 Trends in CO2 emissions in each sector [8]

From the Outline for Promotion of Efforts to Prevent Global Warming in 1998 to the Kyoto Protocol Target Achievment Plan in 2008, the changes of the reduction targets in each sector are shown in Table 4.

Table 4
The changes of the reduction targets in each sector [3],[9]

	1990*	1998	2002	2005	2008
Industrial and energy industrial	550	-2.5%	-2.0%	-4.3%	-4.7～-4.4%
Commercial and other	164			+1.7%	+3.4～+3.6%
Residential	127			+0.6%	+0.9～+1.1%
Transport	217			+2.6%	+1.8～+2.0%
Non-energy-CO2, Methane, N2O	151		-0.5%	-1.2%	-1.5%
Three Fluorinated gases	51	+2.0%	+2.0%	+0.1%	-1.6%
Forests		-3.7%	-3.9%	-3.9%	-3.8%
Kyoto Mechnism		-1.8%	-1.6%	-1.6%	-1.6%

* mllion t-CO2

At the beginning of planning under the Kyoto Protpcol in 1998, it became clear that Japan allocated 3.7 to 3.9% removal to forests, 1.6 to 1.8% emissions to the Kyoto Mechanisms, and 0.5 to 0.4% emissions reduction to the other sectors. Necessary reduction ratios and reduction valumes to achieve the target of 6% reduction of the base year emissions, which are estimated based on the emission status in fiscal 2006, are shown in Table 5.

From Tables 4 and 5, firstly an large increase of emissions of the three fluorinated gases was predicted in the Outline, but oppositly their emissions largely decreased as shown the status of fiscal 2006. 1.6% reduction of their emissions was added in the next Outlines and Plans. As shown in Figure 1 and Table 5, according to the large increases of emissions in the commerce and other, the residential and the transport sectors, the revised Plan in 2008 contained additional countermeasures and policies necessary for reducing largely the emissions in those sectors.

Table 5
Necessary reduction ratios and values in each sector[7]

	Fiscal 2006* (ratios to 1990)	Fiscal 2010* (reduction ratios based on fiscal 2006)	Reduction values from fiscal 2006*
Industrial and energy industries	537 (-2.4%)	490～494 (-8.0～-8.8%)	-43～ -47
Commerce and other	229 (+39.5%)	208～210 (-8.3～-9.2%)	-19～ -21
Residential	166 (+30.0%)	138～141 (-14.7～-16.5%)	-25～ -28
Transport	254 (+16.7%)	240～243 (-4.1～-5.5%)	-11～ -14
Non-energy-originated-CO2,methane, N2O	137 (-9.4%)	133 (-2.9%)	-4
Three Fluorinated gases	17 (-66.2%)	31 (+79.2%)	+14

＊ million t-CO2

From the Outline for Promotion of Efforts to Prevent Global Warming in 1998 to the revised version of the Kyoto Protpcol Target Achievment Plan in 2008, various countermeasures and policies were added for achieving the target 6 percent reduction commitment under the Kyoto Protocol, and comparing to the emission status of fiscal 2006 we can say followings;

- Emissions in the industrial and energy industries sector level off or decrease slightly,
- Emissions in the transport sector increased and recently decrease slightly, but larger than those of 1990,
- Emissions in the commerce and other sector increased continueously, and much larger than those of 1990.
- Emissions in the residential sector increased continueously, and much larger than those of 1990.

In the Plan shown in Table 4, Japan allocates 3.8% removal to forests, 1.6% reduction through the Kyoto Mechanisms, and 3.1% reduction to non-energy-originated CO2, methane, nitrous oxide, and the three fluorinated gases. It becomes clear that 98 to 110 million t-CO2 reduction from CO2 generated from energy use is necessary for Japan in achieving the target of 6% reduction according to the calculation based on the data of Table 5. Extracting the countermeasures and policies, which are effective for reducing largely CO2 emissions, from the Progress Report of the Kyoto Protpcol Target Achievment Plan [7], and their actual results in fiscal 2006 and reduction targets in fiscal 2010 are shown in Table 6.

Keidanren's Voluntary Action Plan and the Law of Saving Energy were main countermeasures and policies at the beginning of the Kyoto Protocol. In the former, each sector sets a reduction target voluntarily, but Ministry of Economy, Trade, and Industry (+ Ministry of the Environment) evaluates its actual emission data and urges to achieve the target and/or revise the target. In the latter, industries consuming energies more than certain volume have the duty to improve more than yearly 1 % of energy efficiency. The target is determined voluntarily, but the sector is forced to achieve it by getting the credits through the Kyoto Mechanisms. It is possible to consider the voluntary target as the top-down one determined by the government under the certain law. The Federation of Electric Power Companies and The Japan Iron and Steel Federation are respectively planning and/or partially implementing to get 190 million t-CO2 and 59 million t-CO2 for five years commitment period (2008 to 2012). Comparing between credit valumes planning in 2007 [10] and in 2008 [2], it is observed that these federations are in difficult situations to achieve the target reduction because of a large increase of credit volumes.

Tbale 6
Reduction targets in fiscal 2010 and countermeasures [7]

Sector, measure	**Fiscal 2006**	**Targets of fiscal 2010**
Industrial and enrgy industries sector		
Voluntary action plan	-	65.3
Introducing equipment with high efficiency	2.7	3.4～4.9
Energyb management	-	8.2～9.8
Atomic energy	-	14.0～15.0
New energy	32.4	38.0～47.3
Co-generation, fuelbattery	11.2	14.0～14.3
Commerce and other sector		
Improving energy efficiency in buildings	10.2	28.7
Energy management	2.9	5.2～7.3
Introducing equipment with high efficiency	11.1	26.0～30.0
Residential sector		
Improving energy efficiency in housing	0.8	9.3
Transport sector		
Top-runner	13.0	24.7～25.5
Voluntary action plan	-	13.1
Impoving truck transportation	13.1	15.6

As shown in Figure 1 and Table 5, it is clear that there exists large differnce between planed and actual reduction amounts , and we enumerate followings:

- CO2 intensities are used as the voluntary numerical targets in certain industries, and energy efficiencies are used in the Law of Saving Energy. There exists possibilities to increse CO2 emissions even when the targets of intensities and/or efficiencies are achieved.
- Without of the Voluntary Action Plan and the Law of Saving Energy, there is no numerical reduction target in the commerce and other, the residential and the transport sectors. Incentives, especially economical ones have large effects on the emission reduction. The incentives in the current countermeasures and policies are not so effective to reduce the emissions largely.
- In the Kyoto Protocol, the top down approach was adopted to determine the reduction target of Japan, but the reduction targets allolcated to individual sectors were not clear, especially the commerce and other and the residential sectors. A step-by-step approach that implements any additional requsite measures and policies was adopted in Japan, then it became difficult for stakeholders to make decision of investments.

In the Plan (2008), 3.8% removal (47.9 million t-CO2) was allocated to forests, but in the current status it was about 3.0% reduction. Activities of reforestration for 2.0 x10^5 ha /year would be necessary for six years since fiscal 2007 to achieve the target removal. It would be necessary to get credits of JI and/or CDM of the Kyoto Mechanisms, and there exists the possibility to pay large amount of money when we cannot achieve the reduction target.

The European Union has developed the EU Emission Trading System (EU ETS), and the EU ETS is the company-level cap-and- trade system under the Kyoto Protocol. Phase 1, from 2005 to 2007, was implemented as a three-year pilot, and their reduction level was 2% compared to emissions of 1990. Phase 2 is now running from 2008 to 2012, and they cut the volume of emission allowance permitted to 6.5% below the 2005 level for ensuring the commitment of the Kyoto Protocol (8% reduction). [11]

2.Rresponse toward the post Kyoto Protocol

As mentioned before, only about 2% reduction compared to the emissions of 1990 is possible under the Kyoto Protocol. Halving the total global GHG emissions by 2050 and peaking out the GHG concentration in the next 10 to 20 years are requisite to stabilize the GHG concentration under the safe level. For achieving these two goals, it is necessary to establish a framework participating not only developed economies but also developing economies based on the principl of common but differential responsibilities. Unfortunately, developing countries have misgivings that setting the emissions reduction targets would disturb their economic growth, and even China and India elude to set the reduction targets, in spite of their rapid increases of emissions. It is necessary to set the mid-term targets in order to peak out the GHG concentration in the next 10 to 20 years, and also necessary the long-term targets in order to halve the GHG emissions by 2050.

Japan recently propose SA in COPs as tools to set national emission targets. [6] In spite of having high energy efficincy and energy saving technologies, Japanese companies are required a large amount of money to reduce GHG emissions, and to get the credits of CDM and/or JI, for achieving the reduction targets, which determined through the top level negotiations under the Kyoto Protocol. Japanese companies, consuming a large amount of energy (such as power generation, steel, paper and pulp and so on), have excellent technologies in energy intensities and saving energy, and Japanese marginal abatement costs are higher than those of the other developed economies. [2],[13] If we use SA based on CO2 intensities and the marginal abatement costs, the reduction volume (ratio) commited to Japan would be lower than the other developed economies targets. Of course, sharing precise and fair data about CO2 intensities and the marginal abatement costs for each sector in each countory, and the measures and policies for technology transfer and financial supports are requisite. Abatement cost, abatement cost per GDP, CO2 emission per GDP, CO2 emission per capita, and so on are enumerated, but it is difficult for all the countries to accept as basis of common but differential responsibilities.

As mentioned before, the European Union also declared to reduce 20% of emissions of 1990 by 2020 as the mid-term target. To achieve the mid-term target, they use EU ETU phase 3 from 2013 to 2020 to revising phase 2, which is used to achieve 8% reduction under the Kyoto Protpcol. In Phase 3, they adopt a linear 1.74% reduction in the cap on allowances each year. As the result, it is possible to achieve the mid-term target. They also use auctioning of most of the allowances. They determine the reduction targets based on top-down approches, and use the market mechanisms coherently. They may reduce 30% of emissions if other developed countries commit to comparable reduction.[11]

We commonly recognize that halving the total GHG emissions by 2050 is requisite, and main developed economies declared as the long-term targets that they will reduce 60 to 80 percent of emissions of 2005 as shown in Table 1. Reduction volumes and ratios commited targets of the Kyoto Protpcol (2008 to 2012), mid-term (2020), and long-term (2050) are shown in Table 7. 14% reduction of emissions of fiscal 2005 corresponds to 7.4% reduction of those of 1990.

Table 7
Reduction volumes and ratios in targets

Year	Base year 1990	Kyoto Protocol 2010	Mid-term 2020	Long-term 2050	
				60%	80%
Emission*	1261	1185	1168	543	272
Reduction ratio**	0.0	6.0	7.4	56.9	78.5

* million t-CO2, **reduction ratioto the base year

The European Union will plan to reduce emissions by 1.74% yearly from 2012 after achieving the target of 8% reduction. If they continue to reduce emissions by 1.74% yearly, they will be able to reduce about 53% of emissions of 1990 by 2050. The yearly reduction ratios may be about 1.93 to 3.61% under the condition that Japan can reduce 60 to 80 % emissions by 2050 if we also continue to reduce emissions by the same yearly ratio from 2010. We can get about 23 to 35% reduction of emissions of 1990 if we will also use continueouly these reduction ratios from 2010 to 2020. These values are largely different from 7.4% of the mid-term reduction target. It is necessary to keep GHG concentration under the safe level that developed economies will reduce 60 to 80% of the current emissions by 2050, and it is necessary to determine the mid-term target under the consideration of the consistency between these targets.

It is difficult to build a framework with the principle of common but differential responsibilities for all of the countries, especially developing countries, because they would consider about disadvantages of committing reduction targets. A Low-carbon society will be requisite to reduce 60 to 80% of current emissions, and developing innovative technologies such as fast breeder reactor cycle technology, carbon capture and strage technology and disseminating existing advanced technologies such as solar power generation, fuel cell viecles are requisite to establish the Low-carbon society.[12] It is necessary to consider about this framework based on advantages such as producing new business opportunities by realizing these technologies.

4. Conclusion

Japan committed to reduce 6% of emissions of 1990 under the Kyoto Protocol, but Japanese GHG emissions in fiscal 2006 is larger than 6% of those of the base year (1990) because of increases of emissions in the sectors which have not any numerical targets. Incentives, especially economic ones have large effects on the emission reduction. CO2 intensities are used as numerical targets in certain industries. There exists possibilities to increse CO2 emissions even when the targets of intensities are achieved.

In the Kyoto Protocol, the top down approach was adopted to determine the reduction target, and Japanese companies are required a large amount of money to reduce GHG emissions in spite of having high energy efficincy and energy saving technologies. For the post Kyoto Protocol, Japan proposes SA in which the targets could be set by tallying up the reduction volumes based on a bottom-up approach.

We can get about 23 to 35% reduction of emissions of 1990 if we will also use continueouly the reduction ratios from 2010 to 2020. These values are largely different from 7.4% of the mid-term reduction target.

REFERENCES

[1] IPCC, *The Physical Science Basis*, IPCC Fourth Assessment Report: Working Group 1 Report, (2007).

[2] Keidanren, *Environmental Voluntary Action Plan "Global Warming"*, Follow- up Report, (2008).

[3] Global Warming Prevention Headquarters, *Kyoto Protocol Target Achievement Plan*, (2005),(2008).

[4] Agency for Natural Resources and Energy, *Section Measures to Cope with Global Warming Issues*, FY2007 Annual Energy Report.

[5] Steering Committee of Mid-Term Target 1, http://www.kantei,go,jp/jp/singi/tikyuu/kaisai/dai01tyuuki/01gijisidai.html

[6] Sawa, A and F. Fukushima, *Sectoral Approach as a Framework of the Post-Kyoto Protocol*, The 21st Century Public Policy Institute, (2008).

[7] Global Warming Prevention Headquarters, *Progress of Kyoto Protocol Target Achievement Plan*, (2008).

[8] Ministry of Environment, *GHG Inventory*. Available: http://www.env.go.jp/earth/ondanka/ghg/gaiyou.html

[9] Global Warming Prevention Headquarters, *Outline for Promotion of Efforts to Prevent Global Warming*, (1998), (2002).

[10] Keidanren, *Environmental Voluntary Action Plan "Global Warming"*, Follow- up Report, (2007).

[11] The European Commission, [*EU Action against climate change*], The EU Emission Trading System, (2008 edition).

[12] Global Warming Prevention Headquarters, *Action Plan for Achieving a Low-carbon Society*, (2008).

A Survey towards Patient-Centred Approach to Healthcare Risk Management

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***Abstract*— Toward the first step for establishing a patient centred approach to healthcare risk management, the present paper reports results of a survey about patients' views about adverse events, focusing on the disclosing actions and apologies by healthcare staff involved in a medical accident. The results show that many patients indicated negative expectations to a doctor's error reporting actions and interactions with patients after a medical accident. When asked in the mild-outcome case, 30% of respondents expected that doctors hold back on providing information to patients about a medical accident and its future risk. With regard to submission of a report to the hospital's incident reporting system, 36% revealed negative views of the staff action. In addition, one third of respondents expected no apology from the doctor who involved in the event. Compared with results of a similar survey which was made five years before the present survey, however, patient views about the doctor's actions shifted significantly more positive. Regarding healthcare staff actions after the adverse event, a sincere apology which includes admittance of hospital responsibility to the event and a promise to take actions for avoiding from iterative occurrence of the same and similar events is the most effective in terms of patient forgiveness. In contrast, exemption of expenses for additional treatment and admission by the accident was almost as helpless as only informing about the event and future risk unless the action includes expression of apology.**

***Index Terms*— Patient safety, Patient-centred approach, Disclosure of accident information, Patient questionnaire.**

1 INTRODUCTION

THERE has been a massive increase in attention to patient safety in Japan during the last decade as in most western countries [1]~[3]. One of the signs of the attention has been the extensive coverage in the Japanese press of often tragic and sometimes spectacular instances of "medical errors". During the entire year of 2001, for instance, the major Japanese newspapers brought stories of 412 medical accidents [4]. At the same time, the Japanese public has been receiving from the press an impression that hospitals often deal defensively when patients are injured due to medical errors, and sometimes slow and reluctant to reveal facts and apologise to the injured patients and their families. The picture seems to be similar to that of some other countries

Hospitals and hospital staff do not have an evidence-based approach to dealing with reactions to patients after adverse events. Consequently, when Japanese hospitals make plans for dealing with adverse events, efforts tend directed towards litigation defences and not preparing staff to deal openly and directly with patients and their families. Although a number of studies have been made of patients about their "wants" and requirements following an adverse event, little is known about their priorities. Moreover, several studies show that differences in national culture make it questionable to transfer results across cultural borders.

With the above-mentioned background, in former studies [5], [6], we made a series of surveys to investigate patients' views about disclosure and reactions of staff after a medical accident. Our surveys sought to uncover patients' trust or mistrust in the candidness of healthcare staff, including their wishes and expectations with regard to staff reactions after adverse events. In one of the surveys [5], we collected approximately 900 responses from both inpatients and outpatients in a teaching hospital in Tokyo. The results of the survey were also compared with doctors' reports about likelihood of taking the same actions [7]. Comparative analysis was made between patient views and doctor's self-reported actions, and we yielded several noteworthy remarks regarding patient views of patient safety issues: Japanese patients were highly suspicious about healthcare staff attitudes to disclosure of accident information; and experience of being met with little degree of openness, the stream of uniformly negative media reports and actual staff reluctance against openness based on fear of sanctions and punishment might be potential sources of Japanese patients' mistrust in staff actions [5]. We believe such views about healthcare accidents are shared by most of Japanese population. However, the generalizability of the results from the previous survey may be still questioned due to a biased sample of patient responses which were collected only from a single, large university hospital. A new survey was therefore planned, which might also reveal to what extent patient views have been changed in Japan as a result of recent frequent press reports of patient safety issues and management efforts of healthcare organisations.

In the present paper we report results of a questionnaire based

survey of patient views of adverse event in which a reasonably large volume of responses were collected from a number of hospitals. The study aims at identifying basic characteristics about patient expectation of staff actions about disclosure and interactions with patients, including differences in age classes, gender, outpatients/inpatients and experience of suffering medical error. We also seek to find effects of different types of staff apologies on patient attitudes of forgiveness to the adverse event. Changes of the patient views in the last four year interval are also discussed.

2 QUESTIONNAIRE

A questionnaire comprises six sections asking patients of their views of various aspects of adverse events and the way they are dealt with. An additional demographic section asks respondents to fill in their consultation department, gender, age group, and experience of hospitalisation and whether they had suffered medical errors during the last two year hospitalisation. Majority of sections in the questionnaire was originally developed in Danish (used in a Danish patient survey accompanying focus group interviews with patients who had suffered medical injury), and was subsequently translated into Japanese [8]. In the first two sections, on which this paper focuses, respondents' views were elicited as responses to two fictitious adverse events (see event descriptions of the two cases in [5]) – one in which the patient suffers a relatively mild outcome and the other a relatively severe outcome.

In Section 1 of the questionnaire, each of the cases was followed by questions asking respondents to what extent they would expect the doctor to carry out each of the following potential actions:

- Keep it to himself/herself that he/she has made a mistake;
- Talk with a close colleague about the incident;
- Write in patient's case-record about the event;
- Inform the patient about the event and the future risk;
- Explain the patient that the event was caused by his/her mistake; and
- Express his/her apology about the event to the patient.

Responses were made for these actions in terms of ratings on a five point Likert-type scale ranging from 'definitely yes' to 'definitely not'.

In the next section – which was not included in the original Danish questionnaire –, respondents were asked about their acceptance to each type of doctor's apology, assuming they became victims of each of the same two adverse event cases. Japan takes a 'free access' policy to healthcare organisations, and therefore one can receive healthcare services at any hospital or organisation as he or she wants to do. Thus, it can be assumed that if one does not forgive the hospital where he/she suffered the adverse event, he or she will go to another hospital next time. Accordingly, instead of asking respondents whether they would forgive the hospital or not, we would investigate the degree of patient acceptance of a specific type of apology by a five-point scale response to the following statement: you would or want "to come to this hospital again if the doctor …", followed by six different reactions by the doctor:

- Informs you about the adverse event and explain you the risk in the future (but no apology and no sympathy);
- Expresses sympathy to you about the event (but no apology and no responsibility to be taken);
- Expresses sympathy, and apologise to you, admitting that the hospital must take responsibility to this event;
- Offers exemption of expenses for additional treatment and admission by this event, but no apology to you;
- Expresses apology about the event to you, and then offer exemption of expenses for additional treatment and admission by this event; and
- Expresses apology about the event to you, and then promise you that the hospital will take actions for avoiding from recursive occurrence of the same or similar incidents.

The survey was made between September 2007 and March 2008, collecting responses from outpatients, inpatients and their family members and relatives in 14 hospitals in Japan. An ownership type of five hospitals was public and each of these belonged to a local municipality. The others were public hospitals all of which were owned by the same incorporated medical institution. The questionnaire was distributed in every ward to inpatients who were able to fill it out by themselves and to outpatients or patients' families at a reception desk in each hospital. After the questionnaire was completed at home (outpatients and families) or in a ward (outpatients), responses were directly sent to the author by post mail. The number of questionnaires distributed and responses collected and response rate are shown in Table 1.

Table I
Number of questionnaires distributed and collected responses

Ownership types	Distributed	Collected					Response rate
		Inpatients	Relatives	Outpatients	NA	Total	
Private hospitals	2,000	35	108	414	142	699	35%
Public hospitals	1,775	357	196	355	149	1,045	59%
Total	3,775	392	304	769	291	1,744	46%

3 PATIENT VIEWS ABOUT DISCLOSURE

3.1 Overall Expectations to Disclosure

Patient expectations about the doctor's actions after an adverse event are summarised based on the severity cases in Table 2. The percentage figures represent both respondents who expect and those who do *not* expect the doctor to carry out each of the specified actions: keep the event him/herself; write the event in the patient's case record; inform the patient about the adverse event and the future risk; explain the patient that the event was caused by his/her mistake; and express his/her apology about the event to the patient. As can be seen from this table, patients' expectations were significantly more positive t for the severe case than for the mild case with respect to the following three actions: keep the event him/herself ($p<0.05$); admitting the event caused by own error ($p<0.05$); expressing his/her apology to the patient ($p<0.001$). About half of respondents expected the doctor not to keep the event and error in his/her mind even for the severe case. Similarly, it is less than half of respondents who expected the doctor to apologise to the patient for both cases.

For the rest of the doctor's actions such as writing the event in the patient's case record and informing the patient about the event and future risk, no significant differences were observed between different severity cases for. Like for apology to the patient, about a half of respondents had negative views about doctor's disclosure of accident information and the future health risk caused by the event.

Table II
Patient expectation about doctor's actions: Percentage of respondents who *expect* and those who do *not expect* doctors to perform the action described

Doctor's actions	Mild		Severe		*p*
	Expect	Not exp.	Expect	Not exp.	
Keep it him/herself	27%	46%	27%	51%	*
Write in patient record	39%	36%	38%	34%	
Inform event and risk	48%	30%	47%	28%	
Admit own error	39%	38%	43%	33%	*
Express apology	43%	33%	48%	27%	***

Expect: Respondents who expect doctors to perform each action
Not exp.: Respondents who do not expect doctors to perform each action
*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$.

3.2 Patient Attribute Differences in Patient Expectations

The Kruskal-Wallis test was applied to examine differences between 14 hospitals where respondents were hospitalised or consulted. The results of the statistical test revealed that there were significant differences between these hospitals for all actions except for informing the patient about the event and the future risk. Ranges of percentage expectations by 14 hospital based respondents were rather large for each of doctor's actions. Variations by hospitals became larger with severity of event, i.e., 23%~29% in the mild outcome case and higher than 30% (except one, 23%) in the severe case. Classifying the 14 hospitals into two groups in terms of ownership, i.e., private and public hospitals, significant differences were also observed between the two groups for most of the doctor's actions in each severity case. As an overall trend, respondents hospitalised or consulted in the public hospitals had more positive views of doctors' disclosure and interactions with patients than those from the private hospitals.

In the questionnaire we asked respondents to rate the degrees of their expectation to actions taken by a general or ordinary doctor, not those by the doctor who consulted them or who was in charge of them in a specific hospital. Therefore, percentage figures calculated by data from respondents in a specific hospital did not express proportions of patients who actually expected the doctors in *the* hospital to take or not to take these actions. Rather, the results should be interpreted that hospital and ownership differences might be affected by patients' health status – patients hospitalised in a big hospital may be more severely ill on average – clinic specialties and a local area though it might be plausible for some – but not many – patients to provide their expectation ratings while recalling their doctors in charge.

In the same manner of Table 2, a summary of response data is provided in Table 3 across group classifications comprising inpatients vs. outpatients, age groups, gender, and having vs. not having experienced medical error. As can be seen from this table, outpatients' mistrust in the doctor's disclosure and apology was significantly stronger than those of inpatients for all actions offered except for informing the patient about the event and the future risk in the mild case. This may be in part influenced by frequency of staff interactions with patients – inpatients have in general more frequent staff interactions in a hospital ward than outpatients. Fewer frequency of interactions may result in the lack of mutual understanding, which in turn seems to contribute to the patient's negative views of healthcare staff reactions.

Dividing respondents into two groups by their ages (under and over 60 years old – this is a formal retiring age in most of Japanese companies at present), the younger group exhibited slightly more negative expectations to the doctor's actions than the older as a general trend, although we observed significant differences for a few 'apology'-related items, i.e., admitting own error and expressing apology to the patient only in the mild case. The relatively more critical views of younger respondents correspond to the findings from surveying different age group about their views about the quality of care in healthcare [9]. Regarding gender, we observed significant differences for most items in the two types of severity. As a whole, male patients' mistrust in doctors' willingness to disclose was greater than that of female in both of the two severity cases. The trend of age and gender differences are shared with the results obtained in the previous survey [5].

According to respondents' self-reported statement, 14% of patients who had been hospitalised within the last two years –

Table III
Patient expectation about doctor's action based on respondent attributes

Doctor's potential actions		(a) Outpatients/Inpatients					(b) Age class				
		Outpatients		Inpatients			Under 60		Over 60's		
		Expect	Not exp.	Expect	Not exp.	*p*	Expect	Not exp.	Expect	Not exp.	*p*
Keep it him/herself	Mild	29%	45%	23%	51%	*	26%	47%	28%	45%	
	Severe	29%	50%	22%	58%	*	24%	51%	29%	51%	
Write in patient record	Mild	38%	38%	47%	30%	**	38%	35%	42%	38%	
	Severe	37%	36%	48%	28%	**	38%	32%	39%	38%	
Inform event and risk	Mild	47%	32%	53%	27%		47%	32%	50%	28%	
	Severe	46%	31%	57%	20%	***	46%	27%	49%	28%	
Admit own error	Mild	38%	41%	45%	30%	**	35%	39%	45%	35%	**
	Severe	40%	37%	53%	22%	***	41%	33%	46%	33%	
Express apology	Mild	42%	37%	49%	27%	**	40%	34%	48%	33%	*
	Severe	46%	29%	58%	19%	***	47%	26%	51%	28%	

Doctor's potential actions		(c) Gender					(d) Error suffering experience				
		Male		Female			Error experience		No experience		
		Expect	Not exp.	Expect	Not exp.	*p*	Expect	Not exp.	Expect	Not exp.	*p*
Keep it him/herself	Mild	31%	44%	24%	48%	**	32%	37%	24%	50%	*
	Severe	30%	48%	24%	54%	**	33%	43%	26%	53%	**
Write in patient record	Mild	37%	39%	42%	34%	*	39%	39%	40%	34%	
	Severe	37%	39%	40%	30%	*	29%	40%	40%	32%	**
Inform event and risk	Mild	45%	34%	51%	28%	**	43%	38%	52%	27%	*
	Severe	45%	31%	50%	25%	*	42%	33%	49%	27%	*
Admit own error	Mild	36%	39%	42%	36%		34%	46%	41%	36%	
	Severe	42%	36%	44%	31%		38%	39%	45%	31%	
Express apology	Mild	38%	36%	46%	32%	**	36%	46%	44%	32%	*
	Severe	46%	31%	51%	24%	**	37%	33%	51%	25%	*

Expect: Respondents who expect doctors to perform each action Not exp.: Respondents who do not expect doctors to perform each action
*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$.

including outpatient respondents – had experienced minor (9%) or major (5%) medical errors. As an overall trend, respondents who had experienced an error were more sceptical of doctors' openness than those having had no such experience. Fusing major and minor error experience groups into one, there were significant differences between the error experience and the non-experience groups for most of items in both cases, as can be seen in Table 3. Although significant differences were identified between the two types of error experience groups, i.e., minor and major error experience, only for two items in the mild case, 'writing in patient's case record' and 'expressing apology to the patient' – presumably because of the sample size, i.e., the small number of patients having experienced a medical error, respondents who had experienced *minor* errors were sceptical of doctors' disclosure willingness than those having had experience of a major error. This trend is different and opposite from that of the former survey [5], where patients having experienced major errors exhibited more negative views of the doctor's disclosing actions than those having minor errors. A greater influence of minor errors than major errors on patient mistrust might be explained by a doctor's actual actions (or no action) when a patient suffered a medical incident. In a former study on staff attitudes of incident reporting [7], it was found that healthcare staff was more willing to take disclosing actions and interactions with patient for a severer event. Accordingly, it can be speculated that a greater percentage of respondents who

Table IV
Changes in patient expectation about doctor's actions in four year interval

		2007		2003		
		Expect	Not exp.	Expect	Not exp.	*p*
Keep it him/ herself	Mild	27%	46%	32%	43%	*
	Severe	27%	51%	27%	47%	
Write in patient record	Mild	39%	36%	33%	42%	**
	Severe	38%	34%	34%	37%	
Inform event and risk	Mild	48%	30%	44%	37%	**
	Severe	47%	28%	44%	31%	
Admit own error	Mild	39%	38%	32%	45%	***
	Severe	43%	33%	36%	36%	
Express apology	Mild	43%	33%	34%	43%	***
	Severe	48%	27%	41%	29%	*

Expect: Respondents who expect doctors to perform each action
Not exp.: Respondents who do not expect doctors to perform each action
*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$.

had experienced a major error were informed about the event and received apology from the staff than those having had a minor error. It may be natural to suppose that patients have responded to the question items based on such error experiences.

3.3 Changes in Four Year Interval

To ascertain possible changes of patient views in the last half decade we compared two samples of patient responses collected at different periods, using the one obtained in 2003. In the former survey [5], we collected a total of 920 responses, (64% of total response rate) including 691 and 229 responses from outpatients and inpatients, respectively. Comparative results between 2003 and 2007 are shown based on the two severity cases in Table 4 in terms of percentage of respondents who had positive and negative expectations to the doctor's actions as well as levels of significance between the two survey periods.

The table indicates that patient views of the doctor's actions were significantly changed from 2003 to 2007 for all the items offered in the questionnaire. Compared with responses collected five years before the present survey, patient views of healthcare staff behaviour shifted more positive for the mild adverse event case in 2007: a larger proportion of respondents expected the doctor not to keep the event him or herself, to write the event in the patient's case record, to inform the event and future risk to the patient, to admit his or her own error and to express apology to the patient. In contrast, there were no significant differences between the two periods in the severe outcome case for any action except for 'apology to the patient', for which respondents also changed to make their views more positive.

4 PATIENT REACTIONS TO DOCTOR'S APOLOGY

4.1 Overall Trend of Acceptance to Apology

With respect to patient forgiveness to the hospital or the doctor, Table 5 shows acceptance and refusal rate – i.e., percentage of respondents who would come and those who would not come to the same hospital when they need to be consulted next time – for different types of apology based on the severity cases. As a matter of course, there were significant differences in patient acceptance to apology between the two levels of outcome severity and the rate of coming back to the same hospital was lower in the severe case than the mild outcome case for each of apology actions.

Relative ranks of acceptance for all types of apology actions were identical between the two severity cases. Despite the severity of events, *full* apology – including admittance of hospital's responsibility to the event – plus promising the patient to take a countermeasure for avoiding from recursive occurrence of the same or similar accident was the most effective of six apology actions offered in the questionnaire in terms of patient acceptance. Greater than a half of respondents would come back to the hospital next time if the doctor makes this apology action for the mild case, and approximately 40% would do so for the severe case. In contrast, the worst action was merely to express sympathy to the patient without admittance of hospital responsibility. This *partial* apology was even worse than no apology but simply informing the event and the future risk to the patient. An offer of exemption of additional expenses caused by the event was almost as ineffective as the worst action, i.e., partial apology. If the exemption is attached with full apology, the acceptance rate became much higher: 49% for the mild and 38% for the severe case. These results may suggest that compensation for expenses with no apology does not contribute

Table V
Patient acceptance to doctor's apology actions: Percentage of respondents who *would* and those who *would not* come to the hospital next time

Types of apologies	Mild		Severe		
	Would come	Would not	Would come	Would not	*p*
Inform event and risk	36%	31%	23%	51%	***
Express sympathy (no apology)	18%	40%	13%	58%	***
Apologise (admitting responsibility)	40%	26%	26%	45%	***
Offer exemption of expenses	21%	45%	18%	57%	***
Apologise and offer exemption	49%	20%	34%	36%	***
Apologise and promise taking actions	55%	17%	38%	35%	***

Would come: Respondents who would come to the hospital next time if the doctor takes each action
Would not: Respondents who would not come to the hospital next time if the doctor takes each action
*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$.

to patient's positive attitudes to the hospital and hospital staff who involved in the adverse event.

4.2 Patient Attribute Differences in Apology Acceptance

Like the results of patient expectation of the doctor's actions after the adverse event, the degrees of forgiveness differed significantly between hospitals for most types of apology actions. In case of full apology with promising the patient to take a countermeasure – which might be the most effective apology –, 64% and 42% of respondents selected from one of 14 hospitals participating in the present survey would come back to this hospital next time in the mild and severe outcome case, while the lowest rates of acceptance to this apology type were 38% and 23%, respectively.

With regard to differences by other respondent attributes such as inpatients vs. outpatients, age groups, gender and having vs. not having experience of suffering medical error, comparative results were shown in Table 6. As an overall trend, variations of patient acceptance to staff apology by respondent attributes might be similar to those of patient expectation of doctor's disclosing actions, which were mentioned in Section 3.2. Respondents who had suffered medical errors had significantly more negative attitudes to forgiveness of the adverse event – i.e., they were less likely to accept the doctor's apology – than those who had no such experience for most of apology actions.

There were not significant differences between outpatients and inpatients for most of apology actions. For several types of minor or no apology – e.g., compensation for additional expenses, expressing regret and informing about the event and future risk – inpatient respondents were more willing to forgive medical errors that they suffered. The older age group of respondents, over 60 years old, were more likely to become willing to accept apology actions than the younger group particularly in the server outcome case. It is only a gender difference that we obtained a different trend of attribute effects from patient expectations to staff disclosure. Female patients were significantly more reluctant to forgive the adverse event than male regardless any type of apology taken by the doctor while the former group exhibited more positive views of staff actions which were taken to report his/her error after the event.

5 Conclusion

In the present paper, we aimed at uncovering patients' expectations of disclosing actions taken by doctors and their attitudes to hospital or staff apology when suffering medical errors to introduce a patient-centred approach to healthcare risk management. For this purpose, we conducted a questionnaire based survey concerning patients' views of adverse events and safety-related issues. In order to identify changes in the patient views of staff actions, we compared the results with those of the former survey which was made using a similar questionnaire sharing the same parts.

Firstly, it has been found that Japanese patients are still highly suspicious about healthcare staff attitudes to disclosure of accident information although their views have shifted significantly more positive in the last five year interval. We obtained the same or similar characteristics about patient expectations about staff actions to those of the former study in terms of variations made across some attribute groups such as age classes, gender, inpatients/outpatients and groups with or without experience of suffering medical error. Therefore, we believe that generalizability of the results obtained in the former study has been ensured.

Secondly, degrees of patient attitudes to forgiveness to an adverse event vary depending upon types of apology actions as well as upon severity levels of adverse events. The most effective action was suggested to be a full apology (including admitting the hospital responsibility to the adverse event) with a promise to take actions for which recursive occurrence can be avoided. The acceptance rate of this apology action was slightly but significantly higher than that of full apology with offering exemption of additional expenses by the event. It is also found that a partial apology (expressing regret to the patient) and only

Table VI
Patient acceptance to doctors' apology actions based on respondent attributes

Types of apologies		(a) Outpatients/Inpatients					(b) Age class				
		Outpatients		Inpatients			Under 60		Over 60's		
		Would come	Would not	Would come	Would not	*p*	Would come	Would not	Would come	Would not	*p*
Inform event and risk	Mild	35%	35%	41%	26%	**	35%	29%	38%	34%	
	Severe	23%	52%	24%	49%		19%	56%	29%	44%	***
Express sympathy (no apology)	Mild	17%	42%	19%	34%	*	17%	42%	19%	35%	**
	Severe	11%	61%	15%	54%		10%	64%	18%	50%	***
Apologise (admitting responsibility)	Mild	41%	28%	40%	24%		41%	27%	39%	26%	
	Severe	26%	46%	27%	42%		21%	51%	33%	37%	***
Offer exemption of expenses	Mild	20%	47%	24%	40%	*	19%	48%	24%	41%	**
	Severe	16%	59%	22%	50%	*	14%	64%	23%	46%	***
Apologise and offer Exemption of expense	Mild	50%	23%	49%	18%		50%	20%	48%	22%	
	Severe	35%	36%	37%	30%		30%	41%	40%	29%	***
Apologise and promise taking actions	Mild	54%	19%	57%	14%		56%	17%	54%	16%	
	Severe	37%	36%	42%	31%		32%	40%	46%	30%	***

Types of apologies		(c) Gender					(d) Error suffering experience				
		Male		Female			Error experience		No experience		
		Would come	Would not	Would come	Would not	*p*	Would come	Would not	Would come	Would not	*p*
Inform event and risk	Mild	40%	31%	33%	31%		31%	36%	40%	27%	*
	Severe	25%	49%	20%	54%	*	17%	55%	24%	50%	
Express sympathy (no apology)	Mild	19%	38%	16%	41%		15%	52%	18%	36%	**
	Severe	15%	57%	11%	61%	**	6%	63%	14%	58%	*
Apologise (admitting responsibility)	Mild	43%	23%	37%	29%	**	36%	38%	43%	23%	*
	Severe	30%	42%	22%	49%	***	18%	50%	28%	45%	
Offer exemption of expenses	Mild	25%	40%	18%	50%	***	20%	51%	23%	43%	
	Severe	20%	52%	15%	61%	***	13%	59%	20%	56%	
Apologise and offer Exemption of expense	Mild	53%	18%	46%	23%	**	45%	25%	53%	18%	
	Severe	38%	33%	31%	39%	**	30%	38%	36%	36%	
Apologise and promise taking actions	Mild	55%	15%	54%	18%		47%	25%	59%	14%	*
	Severe	43%	32%	34%	39%	***	29%	41%	42%	34%	*

Would come: Respondents who would come to the hospital next time if the doctor takes each action
Would not: Respondents who would not come to the hospital next time if the doctor takes each action
*: $p<0.05$, **: $p<0.01$, ***: $p<0.001$.

offer of exemption of additional expense are even worse than no apology but informing the patient about the event and the future health risk.

Finally, several potential sources of Japanese patients' mistrust can be considered as part of the reasons behind the data of this study and from the results of the former study: experience of being met with little degree of openness [5]; the stream of uniformly negative media reports [5]; and actual staff reluctance

against openness based on fear of sanctions and punishment [7]. Based on these results and discussions, we need to establish a framework which encourages an open style of divulging information to patients. At the same time, as healthcare organisations acknowledge their responsibility not only vis-à-vis patients but also staff, doctors and nurses will gain more protection being pilloried and therefore against the threat of disrepute. Thus, we believe a patient-centred approach is applicable to risk management in healthcare like in other safety-critical domains.

REFERENCES

[1] Department of Health, *An Organisation with a Memory: Report of an Expert Group on Learning from Adverse Events in the National Health Service Chaired by the Chief Medical Officer*, Stationery Office, London , (2000).

[2] L.T. Kohn, J. M. Corrigan, and M. S. Donaldson, (eds.), *To Err is Human: Building a Safer Health System*. National Academy Press, Washington DC, (1999).

[3] W. B. Runciman, and J. Moller, *Iatrogenic Injury in Australia: A report prepared by the Australian Patient Safety Foundation for the National Health Priorities and Quality Branch of the Department of Health and Aged Care of the Commonwealth Government of Australia*. Australian Patient Safety Foundation, Adelaide, (2001).

[4] Japan Nursing Association, *White paper of nursing*, (2002) 143-157 (in Japanese).

[5] K. Itoh, H.B. Andersen, M. D. Madsen, D. Østergaard, and M. Ikeno, "Patient Views of Adverse Events: Comparisons of Self-reported Healthcare Staff Attitudes with Disclosure of Accident Information", *Applied Ergonomics* 37, (2006) 513-523.

[6] H. B. Andersen, K. Itoh, and A. Peraudeau, *Comparative Results of Danish-Japanese Surveys of the Attitudes of Doctors and Nurses to Reporting Adverse Events.* Technical Report, Risø-I-2040 (EN), Systems Analysis Department, Risø National Laboratory, Roskilde, Denmark (2003).

[7] K. Itoh, T. Abe, and H. B. Andersen, *A Questionnaire-based Survey on Healthcare Safety Culture from Six Thousand Japanese Hospital Staff: Organisational, Professional and Department/Ward differences*, in R. Tartglia, S. Bagnara, T. Bellandi and S. Albolino (eds.), Healthcare Systems Ergonomics and Patient Safety: Human Factor, a Bridge between Care and Cure, Taylor & Francis, London , (2005) 201-207. (*Proceedings of the International Conference on Healthcare Systems Ergonomics and Patient Safety, HEPS 2005*, Florence, Italy, March-April 2005).

[8] H. B. Andersen, M. D. Madsen, B. Ruhnau, M. Freil, D. Østergaard and N. Hermann, "Do Doctors and Nurses Know What Patients Want after Adverse Events?", presented at 9th European Forum on Quality Improvement in Health Care, Copenhagen, Denmark, May 12-14, 2004.

[9] J. L. Campbell, J. Ramsay, and J. Green, "Age, Gender, Socioeconomic, and Ethnic differences in Patients' Assessments of Primary Health Care", *Quality in Health Care* 10, (2001) 90-95.

[10] J. K. Robbennolt, "Apologies and Legal Settlement: An Empirical Examination", *Michigan Law Review* 102(3), (2003) 460-516.

Promoting Organizational Knowledge Creation through the Reform of Ba

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***Abstract*—**
Aiming to uncover the Japanese mode of technology innovation, we implement the following three projects: 1. Promotion of organizational knowledge creation through the reform of Ba; 2. Evaluation of organizational knowledge creation capability (KCC); and 3. Institutional management in global innovation enterprise. The academic contribution involves three aspects: 1. Detection and substantiation of the relationship between the reform of Ba and knowledge creation; 2. Proposal of an evaluation method focusing on bottlenecks in SECI; and 3. Construction of an institutional management model balancing efficiency and creativity.

***Index Terms* - Organizational knowledge creation, Reform of Ba, SECI bottleneck, institutional management model**

1 OVERVIEW OF THE RESEARCH

1.1 Methodology of Japanese Mode of Technology Innovation

In this COE program, Senoo intends to uncover the methodology of Japanese mode of technology innovation, and to give it a global competency. This objective involves the following three main research topics. The first one is to find out the factors that accelerate organizational knowledge creation; the second one is to provide approaches to evaluate organizational knowledge creating capability (KCC); and the third one is to construct a model for those global enterprises that aim at organizational knowledge creation.

These three research topics adopt the concept of "organizational knowledge creation", suggesting that high KCC is the source of Japanese strength in technology innovation. At the same time, we use the concept of "Isomorphism", constructing and maintaining institution, to analyze these three research topics in terms of "resistance to isomorphic pressures".

1.2 Key Concepts in the Research

1.2.1 Organizational Knowledge Creation

Organizational knowledge creation is the process whereby individual tacit knowledge is converted to explicit knowledge through the 4 modes of socialization, externalization, combination and internalization (SECI), while individual and organizational knowledge is amplified in both quality and quantity.

1.2.2 Isomorphic Pressures

Isomorphic pressures are the forces that make multiple entities that originally had diverse forms converge into homologous architectures. Isomorphic Pressures span a taxonomy of coercive isomorphic pressure, mimetic isomorphic pressure, and normative isomorphic pressure. Here isomorphic pressures refer to similar features of both enterprises (as organizational culture or organizational structure) and individuals (as value system or action principles) in the same industry. Institutions as the social ground are supposed to be constructed and maintained by these isomorphic pressures.

However, in the modern capitalist market, enterprises must differentiate themselves (differentiation strategy) in order to create value. At the same time, it is also difficult for individuals to assess the value of a product or service that is sensibly different from others. This dialectic highlights the conflict between differentiation and isomorphic pressures.

1.3 Arrangement of main surveys

Main surveys in this research project are presented in Table 1. (next page)

2 FINDINGS IN EACH PROJECT

2.1 Promotion of Organizational Knowledge Creation through the Reform of Ba

2.1.1 Research Topic and Research Methodology

In the first research project of "Finding out the factors promoting organizational knowledge creation", we presented the hypothesis that the main factor is the Reform of Ba. The project of "Promotion of organizational knowledge creation through the reform of Ba" was carried out taking the organization as the unit of analysis, and focuses on "enterprise strategy and reform of Ba" using surveys of multiple enterprises involved in office reformation. Last, taking the

individual as the unit of analysis, the research on "Reform of Ba and knowledge creating activities" uses a questionnaire survey developed with the hel of METI and covering business managers, facility managers, and workers in multiple industries.

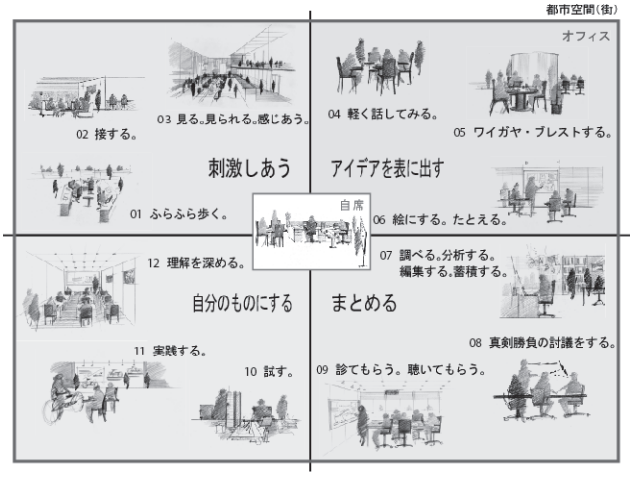
Table 1
SURVEYS IN EACH RESEARCH PROJECTS

Project Topic / Unit of Analysis	Promotion of organizational knowledge creation through reform of Ba	Evaluation of organizational KCC	Institutional management in global organizations
Organization	Organization strategy and reform of Ba (Advanced organizations in office revolution)	KCC and performance (SMEs)	Balance in Efficiency and Creation (American design firm)
Individual	Reform of Ba and knowledge creation activities (no restriction on objects)	Vision and knowledge creation activities as source of competition (employees from advanced organizations in knowledge management)	

*: Contents in the cells are main points of observation
Contents in parentheses are research objects

2.1.2 Contribution Outline

One issue in organizational knowledge creation theory is the ambiguity of the concept of Ba. In response, we segmented the workplace into virtual and physical environments in order to analyze and examine the influence of Ba on organizational knowledge creation [1] ~ [5]. By examining the changes in office layout, the co-evolution process between institution and MOT was brought to light. In addition, a study of organizations having implemented a workplace reformation grounded in the knowledge creation theory revealed 12 individual activities (knowledge creation activities) resulting directly from such change in the workplace [7] ~ [11].



Source: Creative Office report 1.0 (2007).
Fig. 1. 12 Knowledge Creation Activities

A questionnaire survey confirmed the relationship between organizational knowledge creation activities and the reform of Ba (measured by the satisfaction in the space layout or in ICT use), and the fact that managers who regard such office reformation as an investment rather than a cost intended to encourage knowledge creation activities [12] [13]. Some other findings from this research include the following: knowledge creation activities tend to take place when the satisfaction in the space layout is high; knowledge creation activities tend to take place when the satisfaction in the facility is high; companies with knowledge creation activities tend to regard "R&D capability" or "producing design capability" as the basis for competitive advantage, while companies without knowledge creation activities tend to regard "material distribution capability" as the basis for competitive advantage; companies whose profit level exceed the industry average always display a high satisfaction in office space; companies whose profit level exceed the industry average always have show a high satisfaction in IT facilities; managers who exhibit a higher tendency to spend money on the office environment tend to encourage knowledge creation activities; regardless of profit level, 40% of managers regard the expense of office reformation as a cost; managers at companies with a higher profit level tend to regard the expense of office reformation as an investment, while those at companies with a lower profit level regard it as "none of above"; And last, in the case where managers encourage knowledge creation activities, knowledge creation activities tend to take place.

2.2 Evaluation of organizational KCC

2.2.1 Research Topic and Research Methodology

In the 2nd research topic of "Proposal of an evaluation method of Organizational KCC", the evaluation of organizational KCC was carried out focusing on the organizational capability of inter-enterprise collaboration, industry-academia collaboration, Information Technology utilization, and technology visualization. On the one hand, the organization-oriented survey centers on "knowledge creation capability and performance", and uses case studies of high performance companies, questionnaire surveys of all TLO (Technology Licensing Office) in Japanese Universities on IT investment and organizational characteristics to examine the relationship between KCC and performance. On the other hand, the individual-oriented research focuses on "vision and knowledge creation activities as source of competitive advantage", and uses a questionnaire survey of all employees in working in companies advanced in knowledge management, as well as a questionnaire survey on technology visualization in the entire industry.

2.2.2 Contribution Outline

The case study of retail companies with high performance and high social KCC reputation reveals that organizational routine and its supporting activities distinguish the Japanese

mode of technology innovation process and is subsequently conceptualized as the "Driving Objective." [14]~[19].

The research on Japanese university TLOs underlines the fact that the purpose of the role of liaisons in industry-academia collaboration is not only to match scientific findings and market needs, but also to facilitate a long-term relationship to carry on technology innovation. In addition, because these activities are organizational, we found that the balance in sales/legal/strategy time allocation greatly influences the profit of liaisons [20]~[26].

Using data from METI's Information Processing, from an independently-developed questionnaire on organizational characteristics, and from public financial records, we found that IT investment and its changes in organizations and business institutions are positively related to IT production during 4 years, and such influence continues to at least the next year [27]~[29].

A questionnaire answered by the Top 100 SMEs in IT management shows that the difference between the traditional group and new product group in terms of IT capital specialty, and the difference in velocity as organizational specialty are affect investment.

When examining the relationship between KCC and performance, as a proxy for KCC measurement, SECI Bottleneck are found to be the weakest spots of the SECI process and serve as the basis for the questionnaire survey. The correlation between KCC and financial contribution is described in the following chart.

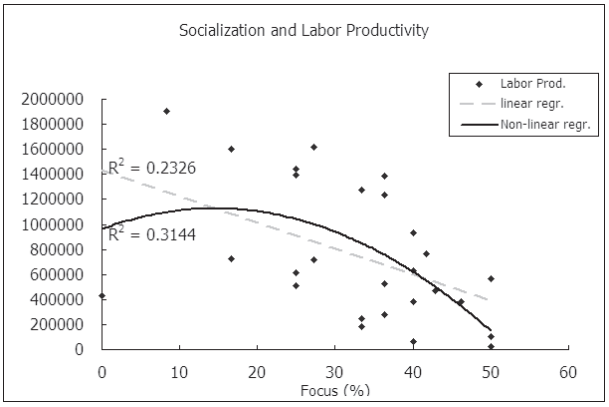


Fig. 2. Correlation of Socialization and Labor Productivity

The survey of all employees working in companies advanced in knowledge management shows that the perceived importance of knowledge management activities, especially combination – or the conversation from explicit to explicit knowledge – appears as the most important source of technical knowledge, and that more time spent on knowledge management tasks, in particular socialization – or the conversion from tacit to tacit knowledge – contributes the most to affective knowledge. Further analysis involves a taxonomy of employees based on their perceived importance of and the time they spend on knowledge management activities: those who both value and spend time on knowledge management are called KM advocates; those who don't value and don't spend time on KM are labeled KM skeptics; those who value but don't spend time on KM are identified as KM busy; and those who don't value but spend time on KM are named KM hopefuls. The taxonomy of employees based on their perceived importance of and the time they spend on knowledge management shows that KM advocates do not believe technical skills and know-how to be important factors of success, that KM busy workers consider documents and databases as a source of competitive advantage, and that KM hopefuls think that love, care, trust and enthusiasm contribute greatly to the firm.

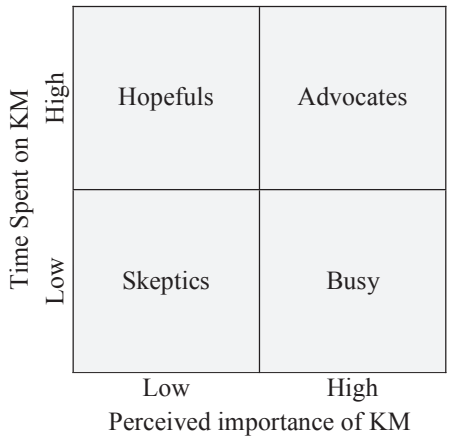


Fig. 3. Taxonomy of workers based on their perception of and time spent on KM

From the research on technology visualization, it appears that while technology visualization and explanation is ongoing in order to develop application probabilities, the explanation effect could be higher if members from non-technical departments are present on both the presentation side and the audience side. In addition, if the members of the presentation side had more opportunities to explain to their audience inside the company, their explanations to people outside the company would never be bad [34]~[38].

2.3 Institutional Management in Global Innovation Enterprises

2.3.1 Research Topic and Research Methodology

The third research topic on the "construction of an institutional management model balancing efficiency and creativity" focuses on the Japanese mode of technology innovation and aims at developing it into a global competency. While the two previous research topics were conducted by Senoo on his own, this last one is the result of the cooperation between Senoo and Nomura.

A questionnaire survey of the employees working for a global pharmaceutical corporation headquartered in Japan with R&D or sales offices worldwide confirmed that the influence of regional institutions (national cultures) on organizational characteristics (organizational structure,

membership, relationship and strategy), and also on the knowledge management value chain (acquisition, storage, diffusion and application).

Then, we did a case study of an American design firm having global offices and enjoying a high reputation as an "innovative company".

Organizational Characteristics			KM Value-Chain	
Structure	Vertical	→	Focused	Acquisition
	Horizontal	→	Opportunistic	
Membership	Individual	→	Selective	Sharing
	Collective	→	Inclusive	
Relationship	Systematic	→	Prescribed	Diffusion
	Ad-hoc	→	Adaptive	
Strategy	Reactive	→	Exploitative	Application
	Innovative	→	Explorative	

Fig. 4. Organizational Characteristics as Prescriptive Factors of Knowledge Management

2.3.2 Contribution Outline

The research on the pharmaceutical corporation reveals that when an international organization expands overseas and when a different organizational form is adopted to satisfy different needs stemming from regional markets, the knowledge management system and knowledge management strategy have to be reformed in order to adapt to these changes [41]. At the same time, it is necessary to review the influence of isomorphic pressures on knowledge management strategies in such a relationship. Case studies on overseas industry are integrated [39], [40].

Based on the case study of the American design firm which implemented a global innovation support project, an institutional management model was constructed to minimize the influence of institutions and achieve a balance between efficiency and creativity.

References (Related works)

[1] 妹尾大, "知が動く場づくり －物理的環境と仮想的環境の相互作用－", *情報の科学と技術* 54, No. 10 (2004) 521-529.

[2] 妹尾大, "ワークプレイス変革が知財創出に与える影響", *日本知財学会第三回年次学筒研究発表会講演要旨集*, (2005) 78-83.

[3] D. Senoo, R. Magnier-Watanabe, "How to Design Active BA: The Interaction between Physical and Virtual Environments", in *PACIS2005 (Pacific Asia Conference on Information Systems) Proceedings* (CD-ROM), Bangkok, Thailand, July 2005.

[4] 妹尾大, "知識創造理論とワークスタイル変革", *組織情報*, No. 72 (2005) 3-13.

[5] D. Senoo, R. Magnier-Watanabe, and M. P. Salmador, "Workplace Reformation, Active BA and Knowledge Creation: From a Conceptual to a Practical Framework", European Journal of Innovation Management 10, No. 3 (2007) 296-315.

[6] 妹尾大, "ワークプレイスとインスティテューション", *Proceedings of The 4th Annual Symposium on The Science of Institutional Management of Technology* , (2008) 353-363.

[7] 妹尾大（委員・ワーキンググループ委員長）, *知識創造を活性化するための新たなオフィススタイルのあり方に関する調査研究報告書*, 社団法人ニューオフィス推進協議会 (2007).

[8] 潮田邦夫, 妹尾大: *魔法のようなオフィス革命,2008,* 河出書房新社, (2007).

[9] 妹尾大, "クリエイティブオフィスに期待するもの（座談会）; O.E.", *季刊誌オフィス環境*, 2007Winter 17, (2007) 6-13.

[10] 妹尾大, "人と人、人とモノとの関係から生まれる創造性", *Ud&Eco style* 17, (2007) 6-7.

[11] 妹尾大, "クリエイティブオフィスレポート 1.0", *NEWOFFICE*, 2008Winter, No. 182 (2008) 11-17.

[12] 妹尾大（委員・調査研究タスクフォースリーダー）, *クリエイティブ・オフィス推進運動実行委員会調査報告書（平成１９年度製造基盤技術実態等調査）*, 社団法人ニューオフィス推進協議会, (2008).

[13] 妹尾大, "クリエイティブオフィスレポート 2.0", *NEWOFFICE*, 2009Winter, No. 186 (2009) 2-7.

[14] D. Senoo, "Knowledge Creation Systems in Seven-Eleven Japan", *Journal of Electronic Science and Technology of China* 2, No. 3 (2004) 92-97.

[15] D. Senoo, "Knowledge Creation Systems in Seven-Eleven Japan", in Paper presented in *the 4th of the 3rd Asian eBusiness Workshop*, Chengdu, China, August 2004.

[16] 妹尾大,, "クリエイティブ・ルーチン - セブン - イレブン・ジャパン", in 野中郁次郎･遠山亮子責任編集, *MOT 知識創造経営とイノベーション*, 第 3 章, 丸善 (2006) 76-104.

[17] I. Nonaka, V. Peltokorpi and D. Senoo, "Knowledge creation in a Japanese convenience store chain: the case of Seven-Eleven Japan", in J. R. Bvyson, P.W. Daniels, (Ed.), *The Handbook of Service Industries*, (2007) 355-376.

[18] 妹尾大, "ナレッジマネジメントと人材育成", in *日本教育工学会第 22 回全国大会論文集*, (2006) 19-20.

[19] 妹尾大, "企業戦略と知識継承", in *東京工業大学科研費シンポジウム「金融リスク管理のための新 IT モデルの研究と開発」要旨集*, (2006) 273.

[20] M. Fukushima, S. Yoneyama, T. Watanabe and D. Senoo, "Decision Making Process of Licencees – How to Evaluate the Invisible Value", *Musashi University Working Paper*, No. 9 (F-6) (2004) 1-13.

[21] T. Watanabe, S. Yoneyama, D. Senoo and M. Fukushima, "Visualizing the Invisible – A Marketing Approach of the Technology Licensing Process", *Musashi University Working Paper*, No. 9 (F-5) (2004) 1-13.

[22] S. Yoneyama, M. Fukushima, D. Senoo and T. Watanabe, "Marketing of Technological Knowledge: Empirical Analysis of Licensing Activities from University TLOs to Industrial Sectors in Japan", *技術革新型企業創生プロジェクト Discussion Paper Series*, #06-07 (2006) 1-21.

[23] D. Senoo, M. Fukushima, S. Yoneyama and T. Watanabe, "Technology Transfer as Team Building − An Empirical Analysis of University TLOs in Japan", *技術革新型企業創生プロジェクト Discussion Paper Series*, #06-09 (2006) 1-20.

[24] S. Yoneyama, M. Fukushima, D. Senoo and T. Watanabe, "Marketing of Technological Knowledge: Empirical Analysis of Licensing Activities from University TLOs to Industrial Sectors in Japan", in *Proceedings of PICMET'06*, (2006) 1865-1874.

[25] D. Senoo, M. Fukushima, S. Yoneyama and T. Watanabe, "Technology Transfer as Team Building – An Empirical Analysis of University TLOs in Japan", in *Proceedings of PICMET'06*, (2006) 1836-1844.

[26] Dai Senoo, Michi Fukushima, Shigemi Yoneyama and Toshiya Watanabe"Strategic diversity in Japanese university technology licensing offices" has been transferred to the Publisher as part of the Special Issue of the International Journal of Knowledge Management Studies, (2008) in print.

[27] 妹尾大, 鈴木勘一郎, "情報技術利用と組織特性の補完関係に関する一考察", in *経営情報学会 2005 年秋季全国研究発表大会予稿集*, (2005) S34-S37.

[28] 妹尾大, "組織･業務体制の抜本的見直しが IT 生産性に与える影響についての一考察", in *経営情報学会 2006 年秋季全国研究発表大会予稿集*, (2006) 328-329.

[29] 妹尾大, "組織･業務体制の抜本的見直しが IT 生産性に与える影響についての報告", in *第２３回 FMES シンポジウム資料集*, (2007) 5-10.

[30] 大森健太郎, 妹尾大, "情報技術投資の効果はどのように創造されるか －中小企業における情報技術資産と組織特性の分析から－", *経営情報学会誌* 16, No. 3 (2007) 63-81.

[31] C. Riera, D. Senoo, and J. Iijima, "A Study of the Effect of Knowledge Creating Capabilities on Corporate Performance", in *The 11th*

Pacific-ASIA Conference on Information Systems (2007) CD-ROM.
[32] Christian G. Riera A., Dai Senoo and Junichi Iijima "A study of the effect of knowledge creating capabilities on corporate performance" has been transferred to the Publisher as part of the Special Issue of the International Journal of Knowledge Management Studies , (2008) in print.
[33] R. Magnier-Watanabe and D. Senoo, "The Effect of Consistent KM Behaviors on Competitive Advantage", in *The 11th Pacific-ASIA Conference on Information Systems* (2007) CD-ROM.
[34] 真許昌之, 野口隆, 妹尾大, "業務プロセス情報の可視化による知識及び組織行動マネジメントに関する考察" in *経営情報学会 2004 年秋季全国研究発表大会予稿集*, (2004) 254-257.
[35] 野口隆, 稲垣武哉, 真許昌之, 三浦正紘, 妹尾大, "組織の知識創造スタイルの評価手法に関する一考察" in *経営情報学会 2004 年秋季全国研究発表大会予稿集*, (2004) 258-261.
[36] 妹尾大, "社会問題の可視化への横幹的アプローチ", in *第 1 回横幹連合総合シンポジウム予稿集*, (2006) 33-34.
[37] 妹尾大, "応用可能性開拓のための技術の可視化の実態と効果：技術はどのように説明されているか";, in *第 1 回横幹連合総合シンポジウム予稿集*, (2006) 41-44.
[38] Y. Takeda and D. Senoo, "How Technology Is Made Visible When Exploring Its Application Fields", in *Proceedings of PICMET '07* (2007)
[39] R. Magnier-Watanabe and D. Senoo, "Institutional Impetus and Knowledge Management for Successful Innovation: the Case of the Smartcard in France", *International Journal of Intelligent Enterprise*, (2008) in print.
[40] R. Magnier-Watanabe and D. Senoo, "Knowledge Management under Institutional Pressures: The Case of the Smartcard in France", in L. Uden and A. Eardley (eds.), *Innovative Knowledge Management: Concepts for Organizational Creativity and Collaborative Design*, Staffordshire University, U.K., (2009) in print.
[41] R. Magnier-Watanabe and D. Senoo, "Organizational Characteristics as Prescriptive Factors of Knowledge Management Initiatives", *Journal of Knowledge Management* 12, No. 1 (2008) 21-36.

Discussions on Patent Strategy based on the Basic Nature and Improvement Nature of Patents

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Abstract— **This paper gives comparative study on the difference between European enterprises and the Japanese enterprises, in respect of basic nature and improvement nature of patents. Together with some interviews to the Japanese enterprises, it gives a certain consideration whether we should change patent strategy from improvement patents to basic patents. It is supposed that the direction will make important aspects towards our future international competitiveness of the Japanese industry.**

Index Terms— **Basic Patents, Improvement Patents, Patent Strategy, Selection and Focus**

1 INTRODUCTION

1.1 Intellectual Property Strategy and its current status in Japan

By Prime Minister Koizumi's policy statement in the 154th Diet in February, 2002, the creation, protection and utilization of intellectual property was positioned as a pillar of the competitive edge improvement of the nation, aiming to realize IP based nation. The decision of the intellectual property strategy outline, the enactment of the fundamental law of intellectual property, establishment of IP strategic counsel, and the promotion plan concerning the creation, protection and utilization of intellectual property are revised every year and concrete measures have been developed, such as IP management at universities, employee invention regulations, increase of patent examiners, establishment of IP High Court, IP crime violation, counterfeit goods and pirate, IP trust system etc, involving all concerned ministries. These measures are under progresses towards the recovery of international competitive by strengthening IP protection (intellectual property strategy headquarters and 2007).

Well, it takes pride in the position as the application leader in the world with about 400,000 a year in Japan. Figure 1(chapter of Patent Office and 2007) shows the number of patent applications, the request for examination and the patent granted. What should be paid attention here is the number of patent granted. We have the number of patent application a year about 400,000. However, only 30% about 130,000 of applications can be patented. And the rest of applications about 270,000 are laid open to public without protection which cannot insist as exclusive rights and can be used freely. It is pointed out that this is a critical situation for a country having a large number of applications with small number of patents granted. Figure 2 shows the number of IP people (chapter of Patent Office and 2007). The number of IP people is growing with 14%-16%, though the application number is almost situations of reaching the ceiling as understood in Figure 1. Moreover, the intellectual property activity expenditure keeps increasing as shown in Figure 3(chapter of Patent Office and 2007), too. It is at the point whether the global competitiveness of industry increases steadily or not, while the number of IP people and the activity expenditure are increasing.

1.2 Ratio of utilization and non-utilization of existing patents

Next, it is a point whether the granted patents have been utilized enough or not. The role of patents is to avoid the third parties participation and dominate its market with the certain period based on the exclusive right. It is this point whether to demonstrate the function by enough utilization of patents. In Figure 4, Patent Office shows the ratio of utilization and non-utilization of existing patents (Patent Office and 2007). In 2005, it is pointed out that the 52% of patents is not utilized though the 48% of patents is utilized including the license to the third party. It is an actual situation that about 60,000 patents are under utilization out of applications 400,000 a year. Uselessness exists, furthermore generates huge volume of technology outflow as the result of a large amount of applications.

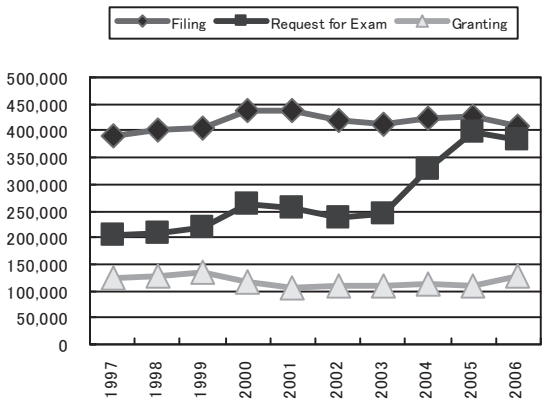

Figure 1: Number of patent applications, request for examination, patent granted (x10000) Source: JPO Data

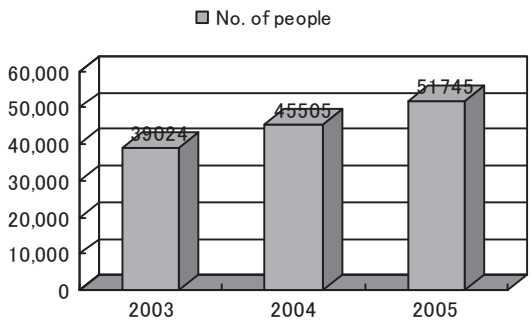

Figure 2: Trend of IP people (number of people)
Source: JPO Data

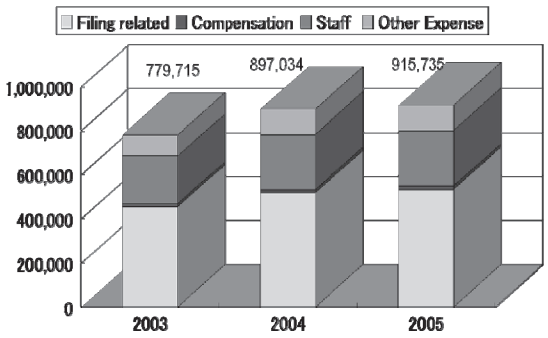

Figure 3: Expense for IP activities (JPY x100 mio)
Source: JPO Data

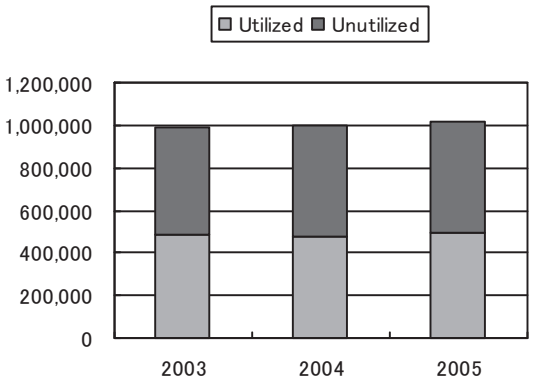

Figure 4: Number of utilized patents and non-utilized patents (x10000)
Source: JPO Data

1.3 International comparisons of the number of patent applications

By the way, how many patent applications are necessary enough to protect one country? Comparing the application numbers that have been performed up to now in advanced each country gives one suggestion though it is not possible to guess easily according to various factors like the market scale, needs, the competition, and the industrial level, etc.

The patent application number of each applicant nationalities in each country is compared with Table 1(WIPO statistics and 2008)(EPO annual report and 2008). The market in Japan is defended from the Japanese nationality applicant by the applications of about 370,000 a year in our country. The US nationality applicant is about 210,000 in the United States. Similarly, it is about 20,000 in Britain. It is about 50,000 application numbers in Germany. We cannot help having the doubt in a large amount of application in our country because we cannot say it is insufficient though the application number to which it is limited in Europe defends European market. That is, an enough examination is not performed to begin with at the time of the application and the doubt whether to do a needless application comes out. Additionally, it is thought that it comes to the stage where the conversion of the conception in the IP management in corporate side is necessary, how to advance the selection and focus at the time of the application, while we see about 900,000 numbers of applications waiting for examination as a back-log in Japan.

Table 1: The number of patent applications by residential in major countries. Source: WIPO Data

	Japan	US	UK	DE
Domestic	397960	207867	17833	48367
EPO	21470	32741	4649	23789
Other Foreign	129181	93342	15253	46681

2 HYPOTHESIS

2.1 The number of a large number of patent applications of Japan enterprises

Here, let's try to find the reasons of a large number of patent applications in our country, with deductive thinking.

First, in the economic reconstruction after the World War II, one consideration can be done in relation to the enterprise's behavior to work on the technology improvement of our country. Toyo Rayon undertook the license of the basic patent of nylon from DuPont Co. in 1951. Tokyo Tele-Communication Industry undertook the license of the basic patent of the transistor from Western Electric Co. in 1952. The Japanese industry that falls behind by the basic technology received the licenses of basic patents from America and Europe, and tried to acquire a lot of relating patents of improvement based around these basic patents, and has advanced the product-manufacturing (Patent Office, History research group of industrial property system, 1982)(Patent Office, 1985). It is said that they have been filing a lot of improvement patent applications even if each patent has small scope of protection, regarding a detailed improvement for a lot of applications, qualities, productivities and performance, and have improved the competitive edge of the product. Inevitably, you may say that the strategy has been taken that applies for a lot of improvement patents to the inside and outside of the basic patent, and it concluded into our current situation of a large number of patent applications.

Secondarily, it is given that the utility model system accomplished the prominent role to the technology

improvement of our country. Statute of Monopoly was enacted in our country in 1885. The utility model system was enacted in 1905 which has the prominent role as an industrial technology though it is a small invention by shape as it opposes against technological monopoly from advanced nations at that time. There was the time when the application for utility model applications that exceeded 200,000 a year was performed in the 1980's (Patent Office, 1985)(Patent Office, 1984). At that time, the utility model is registered with a single claim, and it is a technology that consists of the shape of articles, the structure or the combination. Therefore the scope of protection by one application was small technical range, where it is claimed to the reason by one application small one. It can be thought that the patent application increases at the same time, and the application for utility model registration flowed to the patent application though the application number decreases sharply by law revision afterwards in the latter half of the 1980's. It is thought that the practice of a hashed application in an application for utility model registration at that time having been succeeded to potential also influences as a cause of a large amount of current applications.

Thirdly, it is thought that a cultural side in our country is a cause. According to the data of a cultural comparison where Geert Hofstede made a survey to the employees of IBM in the world, it is evaluated that Japan has a culture with high uncertainty avoidance (Geert Hofstede, Gert Jan Hofstede, 2005). The member of a certain culture with high uncertainty avoidance must smell a threat against an uncertain situation. This feeling appears the situation being nervous with high stress, and the desire assumed to want to raise the predictability by defining a codified rule and a custom rule. Because of the desire to improve the predictability, all consideration is paid, and measures enough for the quality are given in the product-manufacturing. It is thought that it starts the improvement activity and has brought the reason the result of increasing by improvement applications.

Fourthly, it is thought that it connects with inventing of a customer-first policy and an intense inter-enterprise competition a lot of applications. The voice in a lot of markets is received from the consumer when marketing a product. The commodity that cannot answer this cannot help keeping themselves in the market. The enterprise should overcome an intense inter-enterprise competition corresponding to all demands of the customer. It will be able to be estimated that the background with strong and detailed demands from customers can be a reason of a large number of applications.

Fifthly, it is a positioning of the intellectual property department in the enterprise. Recently, a lot of efforts are paid to the intellectual property department making to be able to contribute to Enterprise Management. The positioning as a special post that took charge of a necessary law procedure in accordance with the procedure provided by patent law, utility model law, design law, and Trademark Law, etc. for the acquisition of the right of the intellectual property part was the main role and functions before. Moreover, it is a supporting back office department that doesn't take part directly in the business operation. Therefore, it is a department that has promoted an own special business hardly jointly with the other business segments of R&D, purchasing, manufacturing, business, marketing, human affairs, and financial affairs, etc. The positioning of such an intellectual property department can create large distances from business, markets, and customers, and think that this also has caused a shape of application a large number of applications for safety, not having enough close communication with the other business segment what kind of IPs are necessary for their future business, being in hurry to file applications of proposals under first to file system. Having come doing neither the selection nor the concentration what a really necessary right is incontrovertible. It is considered that the lack of collaborations can be deemed as one of the reasons of a large amount of application and not-utilized patents.

2.2 Aspect of this study and hypothesis

The cause of a large amount of application can be deducted above. In the present study, the Japanese companies' behaviors of improvement patent applications pointed out as the first reason is focused, and it is examined in comparing the feature of the patent applications of the Japanese companies with the foreign companies.

First of all, the mutual relations between the basic patent and the improvement patents shall be examined. The Figure 5 shows a basic patent and the improvement patents having mutual relations, also shows the improvement patents outside of the scope of the basic patent. Company X acquired a basic patent No.1 for which the composition requirement A, B, C, D, E, and it corresponds to the patent related to use mutually with patent No.1 and patent No.2 when enterprise Y acquired an improvement patent No.2 for which the composition requirement A, B, C, D, E, F. In the viewpoint of basis or improvement, patent No.1 is a basic patent and patent No.2 is the improvement patent. Moreover, it is positioned outside of the basic patent No.1 and no relation of mutual use, patent No.3 can be positioned as an improvement patent of the basic patent No.1, which has the basic technical components A,B,C,D.

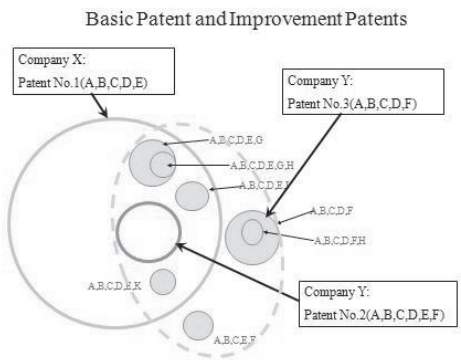

Figure 5: Basic Patents and Improvement Patents

It is thought that the technology of a basic patent is located in the pivot of the upstream side most in the flow of a specific technology. However, judging from the idea that the new technology is created by the combination of prior technologies, there must exist certain prior technologies and it is difficult to define which corresponds to the basic patent. It is not too significant to specify which is the basic patent when the technology of the enterprise is evaluated. It is important to be able to clarify "Basic Nature" or "Improvement Nature" of each patent which the company obtained. About one million patents exist in our country now. Moreover, it is thought that it is realistic and more helpful to have a rough screening tool of basic nature or improvement nature regarding patents, than to evaluate in details in a strict meaning which evaluates with the patent number of tens of thousands of orders in the big enterprise. Then, it was assumed that the index in patent examination process whether the references cited as grounds of the lack of novelty or inventive step or not can be used to show the level of basic nature or improvement nature. Based on the above considerations on the background of a large number of applications of the Japanese enterprises, the following hypothesis can be proposed in this research.

<Hypothesis>

- Ratio of the patents of Japanese firm having improvement nature is bigger than the ratio of patents of European firm. On the other hand, the ratio of the patents having basic nature of European firm is bigger than the Japanese firm.
- It is necessary to build in the ratio of concept of basic nature and improvement nature as an important factor of patent strategy.

3. Comparative study on basic nature and improvement nature of patents between Europe and Japan

It was assumed that European firm and Japanese firm that differed greatly to the patent acquisition number were compared when it undertook a basic and of patent improved international comparison. Moreover, the focus is applied to the comparison in the electric machine and the automotive field where the gap of the number of cases is especially large. It was investigated whether the references cited was presented by the reason of rejection for the examination process in Table 2, for the patents that Japanese firm in the electric machine and the automotive field had acquired in 2004-2008 in a Japanese country. Because the relating technology had already been known about the patent where the references were cited, a patent concerned was judged that the improvement nature was high. While the relating technology had not started in life yet, the patent where the references were cited, a patent concerned was judged that the basic nature was high. The similar investigation has been done to the European firm in the electric machine and the automotive field shown in Table 3. The average of seven European car enterprises is about 40% in the ratio of patents where the references cited exists, while the average of seven Japanese car enterprises is about 85%. The data shows that the European car enterprises have the patents which have basic nature, while the Japanese car enterprises have patents which have improvement nature compared with the European enterprises. In the field of the electric enterprises, the Japanese enterprises have the ratio of patents where the references cited was about 83%, and the European electric enterprises have the average was about 42%. It can be said that a European electric enterprises have the patents which have basic nature than the Japanese electric enterprises, and the Japanese electric enterprises have the patents which have improvement nature higher than a European electric enterprises.

Table 2: Ratio of patents where the references cited on Japanese enterprises

	Prior art	No prior art	Ratio
TOYOTA	47	3	94%
HONDA	46	4	92%
NISSAN	40	10	80%
SUZUKI	44	6	88%
MITSUBISHI	43	7	86%
MAZDA	41	9	82%
ISUZU	36	14	72%
HITACHI	47	3	94%
PANASSONIC	42	8	84%
SONY	38	12	76%
TOSHIBA	43	7	86%
FUJITSU	38	12	76%
NEC	39	11	78%
CANON	40	10	80%
MITSUBISHI	35	5	88%
SHARP	41	9	82%
SANYO	42	8	84%

Table 3: Ratio of patents where the references cited on European enterprises

	Prior art	No prior art	Ratio
Daimler	17	33	33%
Volkswagen	19	31	38%
Peugeot	20	30	39%
Fiat	22	28	45%
BMW	33	17	65%
Renault	17	33	33%
Volvo	15	35	30%
Siemens	15	35	30%
Nokia	32	18	64%
Philips	20	30	39%
Ericsson	19	31	37%

Table 4: Japan-Europe comparison on the Ratio of patents where the references cited

Enterprises	Ratio cited prior arts
JP Automobile 7 enterprises	85%
JP Electric 10 enterprises	83%
JP 17 enterprises	84%
EU Automobile 7 enterprises	40%
EU Electric 4 enterprises	42%
EU 11 enterprises	41%

A technology advanced by foreign countries is assumed to be an example when the technology of the Japanese enterprise improves more than the economic reconstruction period in postwar days. It is no objection that we have received the licenses of the basic patents trying to promote the technology transfer from foreign countries together with development of our technology level by using a lot of improvement patent applications. At the current situation that we have already achieved high international level of technologies, it is required to change our strategy from traditional improvement strategy to a new strategy considering a proper balance between the basic patents and improvement patents.

4. Result and Consideration Based on Companies' Interview

Companies' interview has been made in relation to the result concerning the basis nature and improvement nature. The main points of the interview to a certain Japanese automotive enterprise are as follows.

■ About 20,000 to 30,000 parts are used for one car. The objects for R&D of the car assembly manufacturer is limited to the engine and the main body of the car, and should go in development and the patent acquisition including other parts suppliers as a strategy for sustainable improvement of competitive edge.

■ The cross-license to improve the degree of freedom of a product each other is an important strategy because there are a lot of numbers of parts. It is necessary to construct the patent net and to accumulate the object of the cross licensing.

■ When the use level of the acquired patent is seen in one side, it is about 30% or more, and the situation in which profitable patent acquisition is not necessarily achieved. It is also incontrovertible that the majority are the improvement inventions in the point of the basic nature or improvement nature. The problem of the quality of the acquisition patent naturally becomes important at the substantial negotiation stage though there is the cross licensing by the number of acquisition patents and is respect with importance, too. There is time when the applications of about 6000 a year were filed, and it comes here, and the application number has been decreased. It is thought that the change from the amount to the quality is necessary.

■ Compared with the electric products, the car has long life cycle of the product, the price is expensive, also important to have high quality and low cost, requesting the improvement patents. However, it is not objection that the acquisition of the basic patent with long time efficiency with great influences the corporate competitiveness. I think that it is important that the R&D should work on the strategy with IP department that values the acquisition of the basic patent.

Moreover, following respects were pointed out in an interview to the certain electric enterprise in Japan.

■ It is also true that a lot of applications every year, and a lot of patents not to relate to use exist though the right was acquired. In an electric enterprise, the application competition with the competitor has been pressed. Moreover, it is necessary to apply in advance of the other companies under first to file system. It is said that the application is evaluated from both technical and commercial aspects, however in reality, mainly evaluated from patentability such as novelty and inventive step. The business will be judged again at the time of the examination claim or at the time of the decision of making to the business.

■ Regarding the thinking on basic nature and improvement nature, the basic patent does not cover all the variation of products. The importance of improvement patents cannot be denied, to supplement the lack of basic patent. In the cross licensing, the number of all related patents is also incontrovertible. However, aim at the acquisition of the patent that can be truly used by suppressing the ratio of unused patents is also true.

■ The norm principle in R&D also influences as a background of which a large amount of improvement application goes out. Moreover, the consideration that ties to the application is needed also in the point of R&D people's motivation. It is necessary to think in the strategy as squeezing to an only basic patent but the entire organization. Aiming at the patent that the patent or the basis actually used is high and the influence on others is large might be a place because it moves in the direction of the results amends in the encouragement system not to make a mistake when the future.

■ When the possession patent every year is taken an inventory, the review that abandons the right is advanced about the patent that will not be used in the patent or the future that has not been used. However, the evaluation is not easy either. It is not possible to abandon it easily under the present situation. However, it will be necessary to examine it including the establishment of the evaluation approach in the future.

According to the result of the survey and the interviews concerning basic patent and improvement patent, it is understood that the patents of Japanese firm are improvement patents compared with European firm, and there will be moreover recognition with a necessary conversion to the strategy that values the basic patent in the future. Why so many improvement patents have been made by the Japanese

enterprises can be explained with the deductive thinking concerning the reasons of a large number of applications in the above-mentioned before. There is a situation in which the strategic change cannot be easily done, too. In the intellectual property promotion plan of the government, it is requested to promote IP cycle of creation, protection and utilization to strengthen our enterprise's competence, together with the integration among business unit, R&D and IP department. It cannot be easily revolutionized to have functioned traditionally as a special post based on the law and might be difficultly coordinated with the other business segment. Moreover, the in house position of IP department is also related with difficulty to promote changes, too.

5. SUMMERY

The comparative study of patents between Europe and Japan, in respect of basic nature and improvement nature, has been made by this research. According to the results of this survey, it is obvious that European firm has been focusing on the patent strategy with basic patents, while the Japanese firm has been putting on the importance on improvement patents. To make our international competence with our world class standard of technologies, we can continue to keep our strategy of improvement patents, however we have to increase the ratio of basic patents with balanced patent strategy in the future. A lot of improvement patents shall be maintained in the future, from the points of cross licensing, product life cycle, engineer's motivation, etc. However, it is strongly requested in the business side to obtain the basic patents which can be utilized and gives big influences to others. Moreover, the influence of a huge improvement patent applications on the examination process by JPO. The existence of the basic patent is important to enhance the value of the patent and to maintain the entire system. It is important to keep with creating the favorable environment with high valued patents to contribute to strengthen corporate competitiveness under cooperation among business, R&D and IP department, though the conversion of the strategy is not easy. In the present study, we tried to make a certain consideration regarding basic nature and improvement nature of patents through a simple survey regarding the patents owned by European firm and Japanese firm and interviews to some Japanese industries. It will seek further enlightenment in the future and there exist many subjects to be solved, how press the conversion of the strategy, how it should be positioned on the balance of the basic patents and improvement patents, what kind of concrete actions shall be taken to decrease the number of non-utilization of patents by selection and focus of patents. It is expected to have high valued patents which support with a high basis along direction of the business, and the core technology protected by patents contributes to the improvement of further global competitiveness.

REFERENCES

[1] Yoshitoshi Tanaka, *The establishment of intellectual property department integrated with corporate managemen*t", Japan Institute of Invention and Innovation, (2007).

[2] Intellectual property strategy headquarters, *Intellectual property promotion plan* , (2007).

[3] Patent Office, History research group of industrial property system, *Generation and transition of patent system*, Printing Bureau, Ministry of Finance, (1982).

[4] Patent Office, *Intellectual property activity investigation in 2006,* (2007).
Available: http://www.jpo.go.jp/shiryou/toukei/h18_tizai_katudou.htm (October 8th, 2008)

[5] Japan Patent Office, *Technology-oriented nation and patent*, Japan Institute of Invention and Innovation, (1985).

[6] Japan Patent Office, *Industrial property system in history for 100 years*, Japan Institute of Invention and Innovation, (1984).

[7] Japan Patent Office, *Patent Administrative Annual Report 2007 versions*, Japan Institute of Invention and Innovation, (2007).

[8] *EPO annual report* (2008).
Available: http://www.epo.org/about-us/office/annual-reports/2006.html (October 8th, 2008)

[9] G. Hofstede and G. J. Hofstede, *Cultures and Organizations: Software of the Mind*, The McGraw Hill Companies, (2005).

[10] *WIPO Statistic* (2008).
Available: http://www.wipo.int/ipstats/en/statistics/patents/index.html (October 8th, 2008)

Institutional Management of Itellectual Property

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Abstract– **Management of obtaining and possession of Intellectual Property (IP) to exploit IP is proposed by an analysis of patent applications in Japan. Management of IP according to the characteristics of technologies for electric and machinery, chemicals, and pharmaceuticals companies are suggested.**

***Index Terms*—Intellectual Property, types of industries, characteristics of technologies.**

I. INTRODUCTION

1. 1 The States of Patent Applications

THE number of patent applications are growing in top five Patent Offices, JPO, USPTO, EPO, CIPO and KIPO, other than JPO. Especially, the numbers of patent applications in CIPO and USPTO are increasing much. In JPO, the number of patent applications is around 4,000,000 per year and the number is decreasing gradually (Fig. 1). It is reported that it would be caused by changes from old strategies to file a lot of patent applications and to obtain a lot of patent rights, which was a problem for Japanese companies, to new quality-oriented strategies, and strict selection of domestic patent applications to file by a strategy from global view point (JPO [1]).

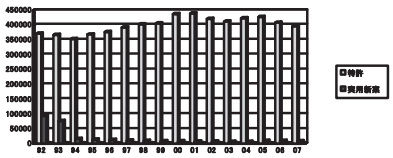


Fig . 1. The trend in patentapplications in JPO (1992-2007).

It is said that there are propatent policies of companies including small and medium-sized companies, universities and so on, and also putting emphasis on Intellectual Property (IP) management by them as a backgound.

1. 2 Intellectual Property Management by companies

Under recent propatent government policies, companies, universities and so on put empahsis on Intellectual Property and they also recognize the importance of IP manegement. IP management is important for small and medium-sized companies as well as large companies and they are required to have a strategy.(Nagata [2], Yoneyama et al.[3], Saiki[4], Samejima[5]). There are generally three points of view in IP management. They are creation of IP, protection to obtain and hold rihgts, and exploitation to practice business exclusively or license by IP rights obtained. (Fig.2)

A patent is a main IP in IP management. As to the trend of patent applications to obtain rights, there is a report which analyze changes of patent applications by Japanese companies coresponding to propatent government policies from the view point of global strategy (Kondo et al.[6]).

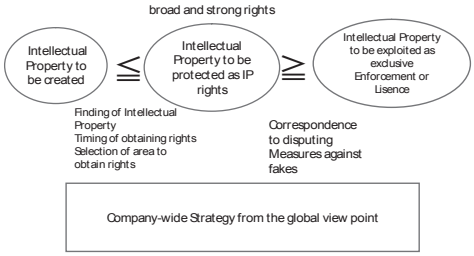


Fig. 2. Intellectual Property Management of Companies.

2. TYPES OF INDUSTRY AND CHARACTERISTICS OF IP MANAGEMENT

2. 1 Exploitation of Rights

As to exploitation, the number of exploitation of patent rights by Japanese companies are increasing. The number of rights possesed is 1,036,868(2006 fiscal year) and the number of rights exploited is still 515,580. The rate of exploitation (exploitation number/total holding patent rights) is only 49.7%. Moreover, the rates of exploitaion are different among types of industries and the exploitation rate in precision instrument industry is the highest(71.0%), that of electric machinery industry is 47.3%, and those of chemical industry and pharmaceutical industry are 43.9% and 43.6%, respectively (JPO[1]). (Table 1)

Table 1 Numbers of patent rights and exploitation rate in Japan

Type of business	Number of holding Patent rights	Exploitation rate(%)
Total	1,036,868	49.7
Food Industry	18,101	47.7
Pharmaceutical Industry	7,717	43.6
Chemical Industry	118,855	43.9
Electric Machinery Industry	181,821	47.3
Precision Instrument Industry	77,671	71.0

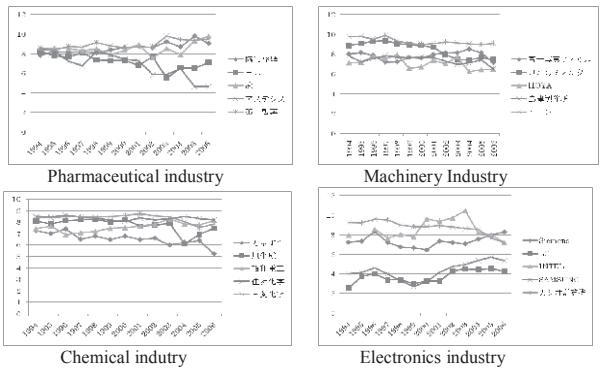
2. 2 IP Management by Types of Industries

It is necessary to obtain and hold IP rights, mainly patent rights, corresponding to characteristics of technologies, which are the objects of IP.

There are reports of IP management, relating to management of technology and from the view point of enterprise value as a group (The First Intellectual Property Management Committee [7], The Second Intellectual Property Management Committee [8], and so on). It is necessary to discuss IP management from the view point of technologies according to the types of industries.

The number of patents possessed are distinctive by types of industries.The number of patents possessed is the most in electric machinery indutry and the number is relatively small in pharmaceutical industry.

The trends in average number of years requested for registration as patent rights are different among types of industries (Fig.3). Fig.3 demonstrates the trends in average number of years requested for registration as patent rights of top five companies in number of patent applications in each industry.



Pharmaceutical industry　　Machinery Industry

Chemical indutry　　Electronics industry

Fig. 3. The trend in the years required for registration of top five applicants in each industry.

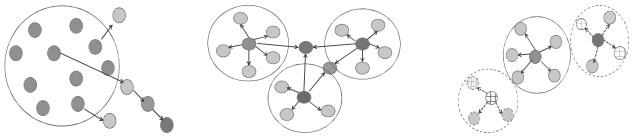
The period for registration as rights from the filing date of patent application depends on the timing to request examination of patent applications to obatin rights by applicant and also depends a lot on the period for prosecution of examination by examiners in the Patent Office. The examination capability of the Patent Office decides the period for prosecution of examination, which applicants could not control. Pharmaceutical companies as applicants adjust the timing to request examination of patent applications for drugs in ordet to control the number of years requested for registration as rights. They ensure the duration period of patent rights corresponding to product process of drugs.

There is a patent extention system for drugs and companies can enjoy the duration period of patent rights by using of the system. It is important for pharmceutical companies to ensure the duration period as long as they can enjoy for drugs, which could be approved and put on the market.

On the other hand, there are many drugs which development as a product would be ended because of their poor pharmaceutical effects or side effects in their development processes. The processes of patent applications for these drugs should be stopped and companies would not request for examination of patent applications for these drugs. They usually do not decide to request for examination untill the deadline in order to make a decision just in time when it becomes decisive that their development as a product should be ended. It can be said that as an individual company manage the period of request for examination as above stated, the average years requested for registration of the top five companies would be similar. The period from the filing date to the deadline of request for examination changed from 7 years (for patent applications filed earlier than Oct. 1, 2001) to 3 years (for patent applications filed later than Sep. 30, 2001) and becomes shorter. Now, companies have little room to adjust the timing of request for examination because of the change of the period.

The success rate of new drugs is one per 1,2000 in the pharmaceutical industry and success in their development is uncertain. It is important for companies to manage the uncertainty (Kuwajima [9]). IP to protect such technologies with uncertainty also shoud be managed with a view of uncertainty.

Generally speaking, many technologies consist one product in electric machinery industry and it is said that the number of patents to protect one product should be several hundreds. In this industry, extremely many patent applications to obatin patent rights are filed as many patent raights are possesed, because technologies are improved in each component technologies to create inventions. It may be usefull to manage every improvements for an indivisual technology as inventions, IPs.



Electric or Machinery　　Chemical　　Pharmaceutical

Fig.4. Characteristics in technology improvement according to industries.
(large circle means one product and small circle means technologies which consist the product. Yellow color of circle expresses improved or application technologies and the darkness of the color corresponds to grades of improvements. The dotted lined circle means candidate technologies which do not be put into the market as drugs.)

The technologies are developed in indivisual material in chemical industry. Improvements of materials would enlarge area of practical applications thereof and characteristics of materials effect requirements in practical applications. The improvements of characteristics to satisfy the requirements would correspond to practical applications. In cases when the practical applications are common, the requirements would be common and then the technologies to improve characteristics of materials would become similar. The technology development would be more effective as the technologies become similar. The selection and concentration of materials to develop corresponding to common practical applications leads to effective technology development. It may be usefull

to manage IP appropriately for effective technology development by common practical applications of materials.

2. 3 Scale of Enterprises and IP management

It is reported that it is usefull for small and medium-sized companies to manage IP including constraction and exploitation of their brands in development of new products, business strategies and marketing strategies (Small and Medium Enterprise Agency [12]).

It is reported that, by the qustionnaire survey to small and medium-sized companies, companies with IP strategies work effective information collection by using specialized information agencies selectively and the companies are divided to four groups by policies of obtaining patent rights (No patent type, Own exploitation type, Strategic exploitation type and know how type) (Tanaka and Saiki [13]).

It is usefull for small and medium-sized companies as well as large companies to plan strategies and manage IP to obatin and possess IP rights according to the strategies.

3. IP Management by types of Industries

3.1 IP Management in Pharmaceutical Industry

It is necessary to ensure a long period of exclusive exploitation by IP rights for drugs put into market in pharmaceutical industry with low success rate. It is reported that, as a method to protect drug patents by kinds of inventions, companies adopt a method to develop many use inventions to protect drugs among several kinds of inventions (Saiki [10]).

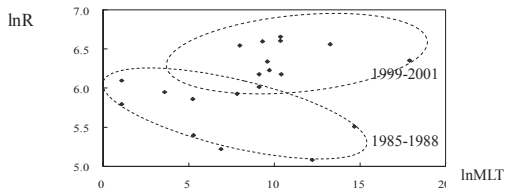
3.1.1 Pro-patent Policy and Correspondence of New drug Companies

It would be an incentive for companies that the inventions can be protected as broader patent rights, which enable companies to ensure the period for exclusive patent rights and recoup R&D investment. Under the propatent policy in Japan, examination practices were revised to enable applicants to obtain broader scope of claim as patent rights for drugs (1993 Revised Examination Guideline).

Correlation between R&D expenditures and broadness of scope as patent rights for inventions of drug compounds are analyzed before and after the revision of examination practices. Multiformity (MLT), the number of combinations of the choices in definition of inventions for drug compounds, is computed to express the broadness of patent rights for inventions of drug compounds.

As a result, the values of MLT after the revision of examination pratices are higher than those before the revision and it is shown that top three new drug companies and middle three new drug companies filed patent applications to obtain broader scope of claim after the revision of examination practices. (Table 2) R&D expenditures are increasing. It is shown that those companies file patent applications with broader claims to protect inventions as a result of R&D in order to obtain broader patent rights and correspond to the increase of R&D expenditure. Under the circumstances of increasing R&D ecpenditures, new drug companies utilize the revision of examination practices made under the propatent policy to obtain broader scope of patent rights. (Fig.5) (Saiki et al. [11])

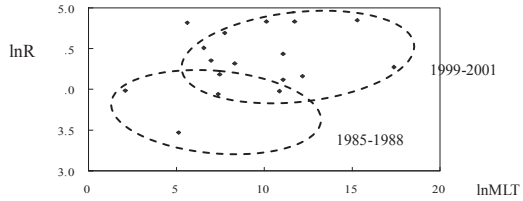
Companies select the inventions to obtain patent rights as the inventions for drugs to be put in the market in pharmaceutical idustry with low success rate. The selected inventions should be protected as patent rights lasting in a loger period. It can be said that propatent policy is usefull to obtain patent rights to exploit corresponding to increasing R&D expenditures for new drug companies which treat technologies as above state.



$$\ln R = 5.97 - 0.05 D \ln MLT + 0.04 (1 - D) \ln MLT \qquad adj.\ R^2\ 0.656$$
(40.71) (−2.47) (2.42)

(R：R&D expenditure MLT：multiformity D ：dummy variables 1985-1988 D=1、others D=0)

Top 3 companies



$$\ln R = 4.24 - 0.01 D \ln MLT + 0.04 (1 - D) \ln MLT - 0.64 D \qquad adj R^2\ 0.70$$
(27.65) (−0.63) (2.81) (−4.99)

(R：R&D expenditure MLT：multiformity D:dummy variables 1985-1988 D=1、othres D=0)

Middle 3 companies

Fig. 5. Correlations between Broadness of claims in patent applications (mutiformity) and R&D expenditures of New drug companies (1985-1988、1999-2002).

Table 2. Comparison of Multiformity of new drug companies before and after the Revistion of Practices

		The number of sample	Before		After		t-value (p-value)
			ln*MLT*	S D [d]	ln*MLT*	S D	
Firms with indigenous capital	*Large firms* [a]	30	3.29	3.28	6.14	4.02	3.05 (0.00) **
	Medium firms [b]	24	3.84	2.08	5.95	2.91	2.82 (0.01) **
Firms with the US capital [c]		20	9.63	10.10	14.15	13.37	1.21 (0.24)

3.1.2 IP Management in M&A

Patent righs for main products of new drug large companies will expire around 2010 and new drugs following the main products are required for the companies to keep their profits. There are some mergers of domestic companies and acquisition of biotechnology companies by large companies.

In new drug development by biotechnology, especially antibody drugs, it is necessary to protect own developing technologies appropriately by using development ability or

money intensified by merger in order not to pay license fees by depending on others' technologies. Also, it is important for companies to manage IP of technologies made up by acquisition of biotechnology companies.

3.1.3 IP Management of Biotechnology Companies

The number of biotechnology start-ups and companies (hereinafter, biotechnology start-ups) have increased in Japan. It is reported that there are 586 biotechnology start-ups and companies in 2006 including 157 new drug companies (Japan Bioindustry Association [14]). Many of them are companies in early stage and with limited number of employees.

IP should be managed effectively in such biotechnology start-ups. As to patent strategy of a biotechnology start-up, it is reported that it files many patent applications as large companies do, by an analysis of one biotechnology start-up case (Tsutsumi [15]).

Biotechnology start-ups which should file many patent applications have limited number of employees and limited amount of capitol. Therefore, they should make decision to file patent applications selectively and collect IP informations to judge whether there are any infringement of patent rights. It is necessary to do such activities effectively by using external expertise.

The followings relating to IP management of biotechnology strat-ups are shown by the questionnaire survey: (Saiki [16])

a. New drug biotechnology start-ups obtain patent rights by filing patent applications to exploit the rights and it is the same as general new drug companies.

b. Large companies play an important roll in licensing activities of biotechnology start-ups.

c. Biotechnology start-ups use customer companies and human net-works the most as a channel to find license partners.

3.2 IP Management of Precision Instrument Industry

3.2.1 Patent Applications for Color Coping Machines

Distinctive patent strategy would be found by a case analysis of company with high profitability.

Canon and Ricoh demonstrate high profitability. Particularly Canon's profitability demonstrates consistently higher than competitors for almost twenty years. While Canon and Ricoh share the similar business model which leading to their high profitability, Canon's profitability demonstrates much higher than that of Ricoh.

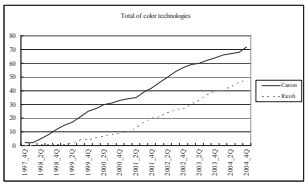


Fig.6.The trend of number in patent application of color printer by Canon and Ricoh (1997-2004）.

Canon and Ricoh are top in the number of patent applications for copying machines and the number of patent applications of Canon relative to color printing technology is higher than that of Ricoh. (Fig. 6)

3.2.2 New Functionality Development and Patent Application Strategy

The analysis which, hypothesized that Canon's colorization stream with its high level of assimilation capacity leveraged the acceleration of a shift from the first wave to the second wave of its copyiing machine development trajectory, core technologies instilled in the copying machines just short of the emergence of functionaity development in its second wave are investigated (Ouchi et al. [17]).

The trend of patent applications of Canon and Ricoh are analyzed by classifing them to (i) assimilated indigenous technologies (AIT), developed by oneself, (ii) assimilated spillover technologies (AST) developed by others, and (iii) newly developed technologies (NDT). (Fig. 7)

Canon filed many patent applications for color copying machines and especially they have large number of NDT. Canon depends largely on AIT than Ricoh. Contrary to Canon, Ricoh depends more on AST. It is shown that Canon utilize their own technology to file patent applications (Takahashi et al. [18]).

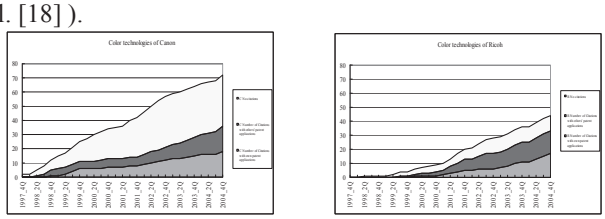


Fig.7.Trends in cumulative number of patent applications in color copying machines by Canon and Ricoh(1997-2004）.

3. 3 IP Management in Chemical Industry

3. 3. 1 Business Fields of Shin-Etsu

Distinctive patent strategy would be found by a case analysis of company with high profitability.

Shin-Etsu demonstrates constantly high profitability. Shin-Etsu Chemical has constructed a highly profitable and resilient structure by focusing its business segments into four core fields.

Aiming at main products in four core fields, material balance among the products would be found and their practical applications are related as technologies. (Fig. 8)

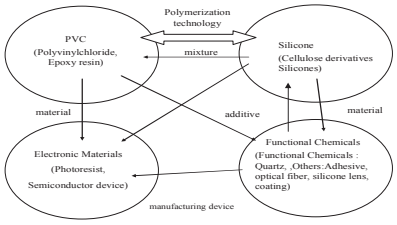


Fig. 8.Material Balance amoung main products in Shin-Etsu

3. 3. 2 Patent Strategy of Shin-Etsu

The patent applications of Shin-Etsu are classified to Functional Chemicals, Silicone, Electronic Materials and Polymer(PVC) corresponding to four core technologies. The trends of number of patent applications in the four fields are demonstrated. (Fig. 9) They demonstrate different trends in three periods (1975-1983 、 1984-1994 、 1995-2004), respectively. The trends in shares of patent applications in each field demonstrate that diversification of the patent application numbers in the four technology fields becomes lower through the three periods. The diversification is the lowest in the third period (19895-2004), which shows that Shin-Etsu could make the degree of technological diversification as the optimal degree. (Fig. 9)

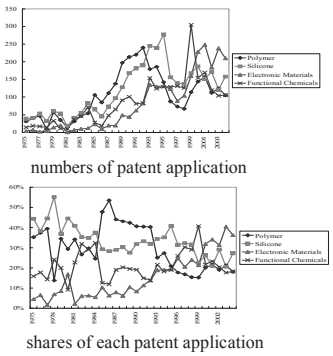


Fig. 9. The trend in numbers and shares of patent applications of four fields (1975-2004).

It is said that Shin-Etsu concentrates its business to four core fields and make main products technologically related as their practical applications to construct material balance, and Shin-Etsu also concentrates its patent applications to technologies in each fields corresonding to the material balance.

4. CONCLUDING REMARKS

It is important to manage obtaining and possession of Intellectual Property Rights appropriately in order to exploit Intellectual Property.

Companies should file patent applications with their strategie to obtain and possess appropriate patent rights, because contents of patent rights themselves depend mostly on examinations prosecuted by examiners in the Patent Office.

The following suggestions are obatined by analysis of patent applications:

In pharmaceutical industry characterized with a low success rate, companies select patent applications to obtain patent rights, have the selected patent applications surely be registered as a patent right and enjoy a longer period of duration time of patent rights. They file patent applications with broader scope of claims correponding to propatent government policy.

In electric machinery industry characterized with many technologies in one product and in chemical industry where expansion of application area for materials is usefull, companies seems to have strategies according to their characteristics of technologies.

It is usefull to manage of obatining and possession of Intellectual Property according to characteristics of technologies in each type of industries.

REFERENCES

[1] Japan Patent Office, *The States and Problems of Industrial Property ～Promotion of Innovation corresponding to globalization～ (Annual Report of Patent Administration 2008*. Available: http://www.jpo.go.jp/cgi/link.cgi?url=/shiryou/toukei/nenpou_toukei_list.htm

[2] A. Nagata, *Managing Intellectual Property*, CHUOKEIZAI-SHA Inc. (2004).

[3] S. Yoneyama and T. Watanabe, *Guide for IP Management*, Nihon Keizai Shinbun Inc. (2004).

[4] T. Saiki, "Obtaining and Management of Intellectual Property useful for Business Administration Strategy", *Powder Science and Engineering* 37, (2005) 61-70.

[5] M. Samejima, *Challenge for Nation founded by IP Revised・Handbook for Patent Strategy*, SHOJIHOMU (2006).

[6] M. Kondo, H. Tomizawa and S. Ueno, "Global Patent Strategy of Japanese Companies", *The Journal of Science Policy and Research Management* 21, (2006) 8-14.

[7] The Second Subcommittee, "The First Intellectual Property Management Committee : Study on What Form Intellectual Property Activities and Management of Technology (MOT) Should Take", *INTELLECTUAL PROPERTY MANAGEMENT* 57, (2007) 1315-13378.

[8] The First Subcommittee, "The Second Intellectual Property Management Committee : Consideration of Group IP Management for Maximization of Group Corporate Value –IP organization, function and methods for selecting concentration or dispersal of IP rights-", *INTELLECTUAL PROPERTY MANAGEMENT* 58, (2008) 1327-1337.

[9] K.Kuwajima, *Management of Uncertainty Answer for R&D to create new drugs*, Nikkei BP(2006).

[10] T. Saiki, "A Proposal of Patent Protection Model in Pharmaceutical Development", *IP Management Review* 3, (2005) 26-40.

[11] T. Saiki, Y. Akano, C. Watanabe and Y. Tou, "New Dimension of Potential Resources in Innovation", *Technovation* 26, (2006) 796-806.

[12] Small and Medium Enterprise Agency, *White Paper of Small and Medium Enterprises 2005 –Structural Changes in Japanese Society and Energy of Small and Medium Enterprises-*, (2005) 60-79.

[13] J. Tanaka and T. Saiki, "Analysis of intellectual property management of small and medium-sized company", *Abstracts of the fourth Annual Conference of Intellectual Property Association of Japan*, (2006) 244-247.

[14] Japan Bioindustry Association: "Biotechnology Venture Statistics Report 2006", 14-16(2007).

[15] E.Tsutsumi, "A Japanese biopharmaceutical venture – Anges MG, Inc.", *JAPAN VENTURE REVIEW* 67, (2001) 259-272 .

[16] T. Saiki, "Intellectual Property Management of Biotechnology start-ups and companies in Japan", *VIPSI-2008 BELGRADE* (CD-ROM),(2008)

[17] N. Ouchi, T. Takahashi, T. Saiki, C. Watanabe and Y. Tou, "Timing of the Initial Functionality Development as a Key to Sustainable Functionality: Comparative Analysis of Copying Machine Development in Canon and Ricoh", *Journal of Advances in Management Research* (2008) in print.

[18] T. Takahashi, T. Saiki, J. Shin, N. Ouchi, C. Watanabe and Y. Tou, "Effective Assimilation of Intra-technology Spillover as a Key to Sustainable Functionality: Comparative Analysis of Copying Machine Development in Canon and Ricoh", *Journal of Advances in Management Research* (2008) in print.

[19] T. Saiki, J. Shin, T. Takahashi, N. Ouchi, C. Watanabe and Y. Tou, Global Co-evolution as a Source of a High-profit Resilient Structure: A Lesson from Shin-Etsu Chemical (unpublished).

The Institutional Supply Chain Management

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***Abstract*—Supply chain management is facing future direction. Reviewing basic inventory theory as the supply chain management research, this article explained three basic problems in supply chain management and three basic approaches to solve problems in supply chain management. Since these approaches are status quo improving approach, for future research direction, a new approach, break through approach to solve complicated supply network problems, will be required. In this article, the author propose a new concept which is called institutional supply chain management, emphasizing evolutionarily improving harmonizing three relationships to get industry competition power toward global competition. Robust optimization, stochastic programming, parametric programming, system dynamics, agent-simulation and state of art human intelligence could be powerful tools for the ISCM research.**

***Index Terms*—SCM, Mechanism, coordination, evolution.**

1 Introduction

Institutional supply chain management (ISCM) is an extension of supply chain management from micro level optimization to macro level evolution. Coordination, harmony and mechanism are three main keywords in the ISCM. With respect to the methodology, most IE&Management researchers are doing quantitative analysis basically. However, in a sense of art, qualitative research is also very important for strategic supply chain management. I believe that ideas for solution, ether macro problem or micro problems are more important than skills of mathematics.

There are two streams on supply chain management (SCM) research. One is management science and engineering field, and another is commercial field. Inventory theory is the basic theory on the SCM research from the management science viewpoint, and marketing theory is for another one.

Basically, we define an inventory problem using several parameters or construct it using some "environmental" (condition) factors. Here I raise three most important parameters concerning researches during the past several decades, the number of stage, time periods or planning horizon, and the demand characteristics. With two levels for each factors, we may generates eight cases:

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1.Single-stage, single period, deterministic case,
2.Multiple-stage, single period, deterministic case,
3.Single-stage, multiple period, deterministic case,
4.Multiple-stage, multiple period, deterministic case,
5.Single-stage, single period, stochastic case,
6.Multiple-stage, single period, stochastic case,
7.Single-stage, multiple period, stochastic case,
8. Multiple-stage, multiple periods, stochastic case,

in which the most complicated problem is the final case, i.e., multiple stage, multiple periods, and stochastic demand case. If we introduce capacity constraint, then the problem becomes further complicated and difficult to get analytic solution.

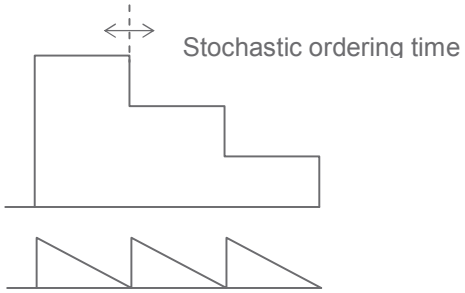

Figure 1: Inventory transition process in two-stage system

What was the difficulty of the multiple stage inventory problem half century ago? Let us consider two-stage problem. The lower side figure represents the average inventory transition process at the first stage, say, the retailer. This is quit familiar so-called saw tooth in inventory theory. The inventory level goes up suddenly, when the ordered inventory comes in, and the inventory will drops slowly with the approximately linear and constant external average demand from customers.

This first stage problem is quite simply modeled and solved using EOQ theory, newsboy model, WW model and other optimization techniques. However, the second stage yields a complicated problem, because the discrete demand from the first stage and the stochastic arriving interval. The order quantity from retailers is no longer linear, or it could not be approximated to be linear due to large error. To overcome this difficulty, Clark and Scarf [1] proposed an idea as shown below. Their idea is very simple. Add the first stages inventory to the second stage inventory, put together to get a linear

approximation when you optimize second stage inventory problem. This new concept is so called "echelon stock". Applying this concept, the hard, and difficult multi stage, multiple period stochastic problem becomes very simple, and easy to solve, because the stochastic integral becomes available for the second stage inventory optimization. Because the echelon stock uses accumulated inventory toward upstages, it means that the upper stage, has the information of inventory at downstream stage, and the optimal results always shows that the synchronized control and action are precondition to make successful installation of the echelon stock. Implicitly, this means that the integrated decision-making is one precondition for applying the concept, echelon stock.

After Clark and Scarf, many researchers published numerous papers concerning about centralized inventory control. Clark's paper has also been cited frequently. With great figure of impact fact, however, their research has not been applied to practice over 30 years, before contemporary supply chain management theory became popular. I feel a big gap between industry and academy, the inventory theory specifically, though this is a never-ending contradiction between theory and practice in all research fields.

2 THREE BASIC PROBLEMS IN SCM

In 1992, president Bush visited Japan, accompanied by a number of VIPs from automobile industry. His purpose was to buy Japanese automobile parts, and sell their parts to Japanese assemblers. The problem was that the Japanese part producer does not sell their part to American assembler, as well as the Japanese assemblers. There was neither Cartel, nor rules and restrictions from Japanese government. Since their activities did not violate anti-trust law, American accused this phenomenon the "structural impediments", and putted a political force to Japanese government to set a "numerical target" on importing American automobile parts.

Why Japanese parts producer doesn't sell their parts to American assembler? The problem rises from so called KEIRETU. Toyota spent long time and huge resources, built up a Pyramid Toyota community, with strategic alliance method. Inside the KEIRETU, they share information such as production planning and delivery schedule, and more importantly, information for new technology, cost structure, which generally recognized as a forbidden secrete in most company even nowadays. They have long term supply contract, therefore they have stronger incentive and motivation on investment to improve product technology and manufacturing technology. In opposite, American parts producer had short-term contact with assembler, therefore they has less incentive to put money to improve manufacturing process and new product technology. As a results, the ratio of outsourcing quite different compare to Japanese assemble, say 30% in GM, while Toyota has 70%.

After Bush's Japan visit, American researchers analyzed quickly the Toyota KEIRETU, and found its advantage and disadvantage. With the leading information technology, American researchers quickly generated a new concept, the supply chain planning which was the first version of the SCM.

Now, let us look back SCM development during last decades. During last decades, many problems lie between suppliers and buyers were addressed. And I believe that most of the problems have its roots to the three basic problems: the bullwhip effect, the bottleneck effect, and the double marginalization.The bullwhip effect was named by professor Hau L. Lee, Padmanaham, and Sungjin Whang [2]. Before their work, Forrester observed same phenomenon, the information distortion along with the information flow. Generally, demand information goes upper stream from customer via retailer, distributor, wholesaler, to manufacturer. A small shock of demand information at retailer may cause a huge fluctuation of order information at manufacturer, as shown in this figure. Sterman in MIT made a bear game for teaching this kind of information distortion, at his class of system dynamics, as a succession of Forester effect in micro economy or business world.

The second basic problem is the bottleneck effect. When we consider a serial supply chain, we can find a weaker chain, among the whole chains. And we call this weaker chain the bottleneck. The important point is that the system capability is determined by only one of the chain, the bottleneck, not the sum of whole strength of the chain. Goldratt proposed that the optimal production schedule could be found easily, deploying the schedule centralizing the bottleneck, say, forward schedule for succeeding processes, and backward scheduling for preceding processes. One important fact is that the supply chain is dynamically improving according to market changing. Then we may have two kind of cost reduction program, one is improve efficiencies for all chains, and the other one is improve efficiencies for bottleneck. In cost world, the efficiency was evaluated using independently for each process. Therefore, the total improvements or sum of the improvement of each process will be evaluated. However, in the throughput world, which proposed by Goldratt, they evaluate the improvement by throughput. In other words, it evaluates systematic efficiency. Which one is better method for system evaluation? I believe that those two methods both are correct and good evaluation method. The problem is that which one is more efficient for strategic and long-tern viewpoint, and support the evolutionarily developing virtuous cycle. In this sense, the bottleneck approach may bring you more cost efficient insights for long-term strategy.

The third problem is the double marginalization. This is one of the reasons why the merchandizing research deeply involved in the SCM research. The definition of the double marginalization is that "the double stage margins at two partner make total profit drops". I will give you a brief explanation of the Spengler's testimony at the court in 1950 for an anti-trust case. As all of us know, that the monopoly will produce inefficient resource allocation and corruptions. Most countries including socialism China, has anti-trust law. Spengler pointed out that there are two kinds of integration, vertical integration, and horizontal integration. And Spengler's argue that the

vertical integration is not evil, even it generate surplus for both consumers and producers. Assume that a supply chain consists of three players: the manufacturer, distributor and the retailer. Each player set price in a manner, put his margin on the variable cost, for example, the manufacturers variable cost is 20$ while his margin is 10$, wholesaler's margin is 20$ with 20$ variable cost, while the retailer's margin is 25$ with 20 variable cost. Market price was set by the retailer finally, 115$ per unit, in the case of independent decision making without vertical integration. If the supply chain is integrated, then the system has rooms for alternative price setting. The minimum price can goes down to 60$ per unit in which system profit is zero. Between the price 115$ and 60$, the integrated system may find an optimal price setting to maximize channel profit. Here, the demand and supply curve acts as key roles, i.e., demand will increase if the channel owner discount the retail price.

In this Spengler's example, it was assumed that if the price discounted to 100 dollars, then demand increase to 64 units from 40 unit at the price 115$. Then total profit will calculates, 2560$, with 360$ surplus for the SCM and 600$ surplus for consumers. Both supplier and consumer bless benefits comes from the integrated decision-making.

3 THREE BASIC APRROACHES

To solve SCM problems bring by the three basic problems, many ideas has been reported, and I would say those efforts or approaches can be classified into three categories: the integrated decision making, the information sharing, and the cooperative supply contract approach.

The integrated decision making can be characterized by, integrate organization, centralize authority of decision-making, and planned control or push control. Using integrated decision making, theoretically, we can remove all obstacles lie between organizations. However, overkill integration may bring crucial by-products, such as, bureaucracy, incentive dropping, and moral hazard. China had experienced an extreme integration, the planned economy. Weakly schedule of a rolling machine in a state owned company was set by central government. This kind centralization deeply restrained automotive activities coping with various uncertainties in factory. As a result, perverted equality has spread over the nation, as well as other serious problems, such as moral hazard, negative incentive, and the whole economy becomes so called "shortage economy".

The second approach to solve SCM problems is information sharing. For those cases if we could not integrate organization, we may apply this approach. The points of the information sharing are, centralize information and make decision in the global viewpoint, and then each organization synchronize their action. By doing so, the information sharing can make the same results as the integration.

The well-known existing approaches are VMI, CRP, CPFR and etcetera. Let me show you two examples. By sharing information with over 200 affiliate bookstores, the Bunkyodo, one of largest bookstore in Japan, reduced the opportunity cost of stock-out substantially, while publishers reduced cost for obsolete stocks. In another case, the major distillery Suntory experienced high inventory levels, as its production division favored large quantities to achieve production efficiencies, and its sales division held onto large quantities to avoid the opportunity cost of stock-outs. By establishing a logistics center which brought together information from the production division and from the sales division, as well as centralized the authority for decision-making, Suntory was able to reduce inventory levels for whiskey by 50%, wine by 30%, and beer by 70% while simultaneously achieving significant improvements in cost, product freshness, and service levels.

The information sharing approach available for wide range of problems. However, it also has some demerits, such as the benefit sharing, organizational barrier and so on.

To cope with the shortcoming or week point of the information sharing, supply chain contract approaches are proposed recent years. This supply chain contract is different with the traditional contract between two commercial decision making units. Cooperation is the main difference.

Supplier design several contracts using the management technology, considering possible system-wide optimization, and then the buyer choose the contract type. Or say, the buyer makes the final decision. Well known supply chain contracts includes the total minimum quantity commitment, the rolling horizon flexibility, which was known as a killer to bullwhip effect, and the option approach to the supply contract, I did some work on this option approach. In last decades, many researches have been reported [3][4][5].

Now, you may conclude that problems in SCM are rooted in three basic problems, and we have three approaches to solve these problems. The combination of the three approaches may provide more powerful methodologies to cope with most operational SCM problems.

However, when we consider the SCM in strategic long-term view, we may find that those three approaches have essential shortcoming. All these approaches could not make break-through, instead these approaches are belong to so-called "status-quo" optimization approaches.

Let me explain the status quo approach using a simple well-known EOQ model.

Costs related to order quantity could be classified into three types. Increase in order quantity increase, decrease in order quantity increase, and constant in the order quantity increase, the fixed cost for example. Only the varying cost affects the optimal order quantity. We depict the inventory holding cost as the representative cost of the increase, and depict the setup cost

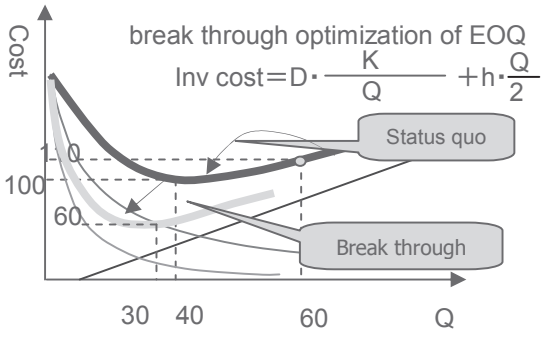

Figure 2: The Status-quo and Break-through approaches

as the representative of the decrease. Then we may draw a total cost curve as shown in figure 2, and find the best order quantity which can provide us the minimum ordering costs. For example, we suppose current order quantity is 60, by decreasing the order quantity each time by 40, we can reduce 10 unit cost in average in the planning horizon. We call this is a status quo approach because we calculate the optimal order quantity under the given condition of setup cots K and holding cost h.

Changing the idea, if we can develop a new technology to reduce K or h, then the order cost can also be reduced, even drastically for some cases. As shown in figure 2, the cost will reduced to 60 from 100. Generally, we call this kind of improving or optimization concept, the "break through approach". The most important point of the breakthrough approach is not the drastic reduction of cost, more important point is the improvement of system capability or competition power in long-term view.

4 WHAT COMES NEXT

Considering future SCM development, we may find that the SCM approaches follow the spirally developing curve. Start form the traditional hostility contract, through integration, information sharing, and cooperative contact, and now we are seeking the next breakthrough approach.

To find the next approach, let us look back the purpose of the SCM. As Simchi-Levi in his SCM book [6] defined, the purpose of the SCM is to place the products at right place, right time, right quantity, integrating monetary flow, information flow, and material flow. I can say this is acceptable, however, an operational level definition. From the strategic viewpoint, I could say that a technology chain and a demand chain are as important as the supply chain. In long-term view, enhance the competition power that consists of technology capability and marketing capability. Considering the global competition, it is simple way to consider not only the competition power of a company, but also the industry power, and extend it to the national competition power.

How to achieve this purpose, or get this goal? The society is progressively improving as well as the competition power of company, industry and nation. Considering the industry and national problem, we can refer "invisible hands", and "visible hand". External and social issues maybe called the invisible hand and the internal and organizational issues maybe called the visible hand, and now it is the time shake hands between visible hand and invisible hand.

Where is the invisible hands come? It is impossible to consider all social conditions into an optimization model. Most important thing for a supply chain is to construct a harmony and co-evolution mechanism of the various social conditions and dynamically changing objectives. And the purpose of the future SCM no longer be restricted on individual company, it rather focused on the whole industry or whole supply network. In this sense, the future competition might be concentrated on the chain power or industry power competition.

One of the answer for the future approach to the SCM, I would like to propose here, is the competition of industry power and evolutionally improving approach, which can be called, the institutional supply chain management.

5 INSTITUTIONAL SUPPLY CHAIN MANAGEMENT

Three harmonies are important for future SCM, the harmony between social environment and company, the harmony between internal activity and external activity, and the harmony between theory and practice. Industry is the base of power of individual company and the company is an element of industrial competition power. Internal activity must be synchronized with the activities of external companies through the supply chain. Otherwise, the supply chain power will drops significantly because of the inefficiency and waist of the resource lie between company and company. The gap between theory and practice is one of never ending conflicts, like matching of seeds and needs, efficient technology transfer. We have more than forty TLO in Japan supported by Japanese government, and as well as the government funding organization, such as JST (the Japan science and technology agency). Efficient activities of these organizations are extremely important for efficient evolution of supply chain as well as for whole industry.

Operations management and researches could provide practical or optimal solution, under given constraints. But the problem is that the boundary of the solution is determined by constraints. Any relax on those constraints may come up with either increase or decrease of previous solution. Which constraint or social environment should be relaxed first or tightened first? Managing scenario of the relaxation might be an issue of state-of-the-art. In terms of this predominant cause of environment change, it is necessary to unveil spirally developing mechanism, so that to grasp central stream of future SCM and make correct decision.

Let us see one example of interaction between social constraint and operations management. As we know, full loading is one important issue for reducing transportation costs. Manufacturing company requires small lot and high frequency delivery for various reasons, such as, reduces inventory space, enhances adaptability to market change, etcetera. And this may increase in logistic cost of the manufacturing companies due to

the original high price of transportation service. To activate and stimulate logistic service supply, the government may decide deregulation. After deregulation, many small carriers enter the market of logistic service. As the result, the price of transportation service will drop down. However, because of the excess supply of service, average loading ratio will drop. Then, a freight matching service will be provided to market, as well as the joint delivery and transportation. This may leads to standardization of pallet and container, and the government will introduce a new regulation on the standardization. In this way, social constraints surrounding logistic problems have complicated interactions and spirally changing mechanism. One action produce consequence, and an efficient evolutionarily improving mechanism will be required for this consequence which could be analyzed before it becomes reality.

Many real world problems should be reconsidered under the framework of ISCM. These problems includes regulation related problems, such as, national policy on privatization on road service and post office, and infrastructure related problems such as, national resource supply network, logistics service network, road construction, etcetera. Waste elimination approach, the "KAIZEN" is one important approach in the evolutional development of supply chain or industry. Classical waste elimination approach is proposed in motion study a hundred year ago, and Toyota contributed significantly in this field and elimination of 3M, the Muri, Muda, and Mura, were central topic of the KAIZEN, the continuous improvement activities in a company. Now it is time to consider social waste. Tons of fashion products, cameras and pharmaceutical products, either brand-new or functionally good for use, were dumping for perish every year in Japan. It was big surprise that I first hear about that R&D costs predominant camera cost, say approximately 80% of the cost components. This means that it has incredible opportunity cost for a lost sale compare to perish cost. Certainly, the manufacturing companies take the strategy, to produce big amount to prevent opportunity cost. Dog-eat-dog phenomenon is one another problem in fiercely competing matured market. At least in the global market, some coordination may be necessary for this matured market. Surely, elimination of social waste should not violate basic principle of market economy.

One important fact is that mass production and small lot production have same effects to environment. Small lot size production doesn't mean smaller violation of nature environment. To realize sustainable development, closed loop supply chain is one important issue. European countries have imposed many environmental regulations to industry. Japanese government also introduced many environmental regulations, such as, packing material recycle law, home appliance recycle regulations, and now the car recycle law has cams to force. Many research topics, for example, design for environment, reverse logistics, closed-loop manufacturing, and other huge number of technology related topics are under researching. And I believe that this is one very promising research field for logistic research to benefits human being.

With respect to the methodologies of the ISCM, quantitative analysis method, such as robust optimization, stochastic programming, parametric programming, system dynamics, agent-simulation might be powerful tools. Same time, case studies, various investigations, and human intelligence are also required for analyzing complicated social environment and consequences of an action to solve a SCM problem.

6 Conclusion

In this article, we discussed echelon stock as basic theory of supply chain management, and explained three basic problems such as bullwhip effect, bottleneck effect and double marginalization in the supply chain management. Three approaches, such as, integrated approach, information sharing and cooperative supply contract are summarized as for the tools solving various supply chain management problems. Further, we pointed out that these existing approaches are status quo optimization approach for short-term operational problem, and introduced a new possible research direction with three harmonies, such as social environment and company, internal and external, theory and practice, to enhance industry competition power toward global competition. We call this research direction or research field the "institutional supply chain management". Three keywords may represent the characteristic of the ISCM research, mechanism, harmony and evolution.

References

[1] A.J. Clark and H. Scarf, "Optimal policies for a multi-echelon inventory problem", Management Science 6 (1960), 475－490

[2] H.L. Lee, V. Padmanabhan and Seungjin Whang: "Information Distortion in a Supply Chain: The Bullwhip Effect", Management Science, 43, No.4, (1997) 546-558.

[3] R. Anupindi and Y. Bassok, "Supply contracts with quantity commitments and stochastic demand", *Quantitative models for supply chain management*, Tayur, S., Ganeshan, R. and Magazine, M. (Editors), Kluwer Academic, New York, 1998.

[4] R. Anupindi and Y. Bassok, "Approximations for multiproduct contracts with stochastic demands and business volume discounts: single supplier case", IIE Transactions, 30, No.8 (1998), 723-734.

[5] A.A. Tsay, "The quantity flexibility contract and supplier-customer incentives", Management Science, 45, No.10, (1999), 1339-1358.

[6] D. Simchi-Levi, P. Kaminsky and E. Simchi-Levi, Designing and Managing the Supply Chain Conceps Strategies and Case Studies, Irwin McGraw-Hill (2000)

Co-evolutionary Dynamism between IT Utilization and Institution

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Abstract— In this paper, we clarify that impacts of IT investment on firm performance depend on the corporate organization and culture. The current situation of IT usage is said that IT investment mind is low and so is actual IT investment in Japan. Adding that, it is not apparent of the positive effect of IT investment comparing to United States, especially for those in non-manufacturing firms. One of the reasons is said that Enterprise Information Systems (EISs) in Japan lack process-orientation, that is, there is a wall between divisions in most of EISs.

In this paper, we propose the concept of POE, Process Oriented Enterprise. A questionnaire based field survey based on the concept was conducted in September, 2008. We clarify the importance of process orientation in IT utilization based on the results of our field survey.

***Index Terms*—Process Oriented Enterprise, POE, IT investment**

1 INTRODUCTION

Current Situation of IT Utilization in Japan

First of all, let us explain the current situation of IT utilization in Japan based on some data. Figure 1 shows IT investment mind ranking reported by Gartner Japan in 2007 [3]. They used seven indices including IT investment growth rate, IT budget per sales and rate of CIO settlement for this ranking. Japan is at the bottom of this ranking. The reason why India and China have high score may be understood that those countries have not yet invested in IT so much and they are now on the way for positive investment. While we have invested in IT very much and then Japan is at the bottom in this ranking. However, it may not be an appropriate explanation for those countries including U.S. , Korea and Singapore that seem to invest enough do not have such a low score. Japan is also at the bottom among G7 countries.

While JEITA reported that IT investment per GDP in Japan is two thirds of that in United States [5]. Although it may not be appropriate to compare two countries directly for there may exist some incompatibility of the meaning of IT investment, there is another survey in which IT investment per GDP in Japan is less than the average of the world.

Consequently, it may be said that the actual IT investment as well as IT investment mind is low in Japan. It is not a bad news if we utilize IT effectively. But the story is different. Some data shows that correlation between IT investment and productivity growth rate is quite low comparing to United States, especially for non-manufacturing firms [9].

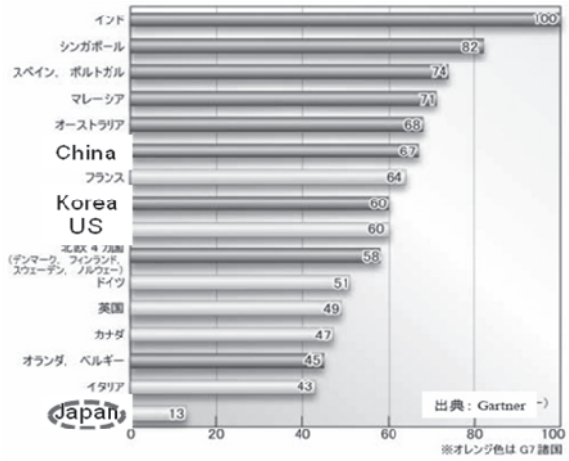

Fig. 1. IT investment mind ranking.

2 WHY PROCESS ORIENTATION ?

IT has been firstly diffused to replace manual labors and then I"C"T makes it possible to communicate trans-divisions, firms and even countries such as SIS in 80's and Internet in 90's.

Now a days, we can exchange and share information to make our business more efficient and effective if we utilize full functionality of ICT. In a standard textbook on MIS, current form of Enterprise Information Systems is called as Enterprise Internet Era [6].

Then essential meaning of utilization of ICT is to realize connections beyond walls of divisions and/or firms. Consequently, a firm does not utilize ICT if it has a weak process-orientation for it does not realize connections beyond walls.

Current Situation of IT Utilization in Japan

Then what is the reason why we do not utilize IT so as to have a fruitful firm performance? Figure 2 shows the IT management maturity model proposed by METI (the Ministry of Economy, Trade and Industry). This model is a linear one that has four phases in IT utilization. In this figure, the first stage is so called "before dawn". The second stage is "optimization in each division" stage. While the third stage is at "optimization beyond walls", that is company level and fourth is at "optimization inter firms", that is supply chain level.

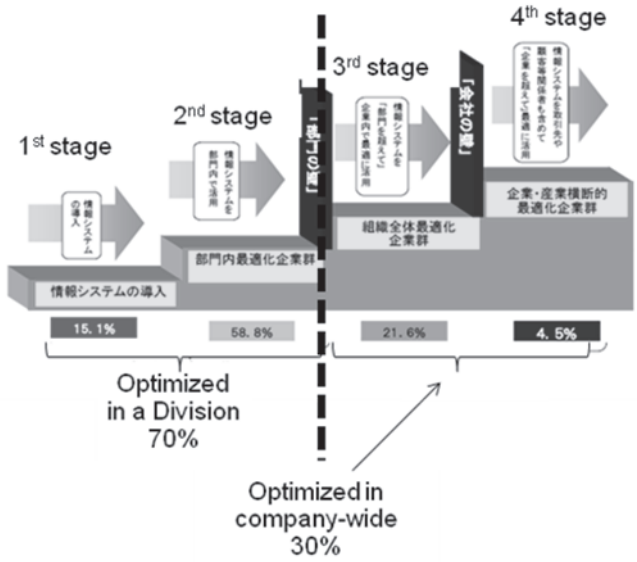

Fig. 2. IT management Maturity model.

Based on MTI survey, it is said that 70% firms are still at the first or the second stage and there is a wall called "wall between divisions" between the second stage and the third in Japan. While half of firms in United States are now at the third or fourth stage. This result shows that it is crucial for IT utilization to proceed process orientation beyond walls trans- divisions.

Then how can we utilize IT beyond walls between divisions? In order to pursue an answer for the question, METI held the first meeting of the IT Management Council consisting of major corporate users of IT and experts on June 20, 2008 in Japan. The council adopted the "IT Management Charter" which briefly describes ten principles for strengthening competitiveness of Japanese corporations with IT. The council also formulated the "IT Management Roadmap" that sets forth measures to improve and disseminate IT management.

Before opening the council, CIO strategic forum consisting of representative CIOs and academia has been established since November, 2007 and there were more than ten meetings in which know-how of those representative firms were presented. In those meetings, it was clarified the importance of process-orientation, especially, not in a firm itself but a larger process including its suppliers and customers.

3 POE-PROCESS ORIENTED ENTERPRISE

Researches on IT Paradox from Managerial Viewpoint

One of the most famous sentence in IT paradox is "we can see the computer age everywhere but in the productivity statistics," which is known as Solow Paradox [11]. It says that we do now have any statistical evidence of the effect of IT besides there are a plenty of PCs around us. In order to answer the question, there were many researches conducted mostly in macro economical viewpoint in 90's. Consequently, there is a consensus that IT is effective in the sense of TFP (Total Factor Productivitiy) . Finally, Solow said "you can now see computers in the productivity statistics" [12].

While there are several researches from micro-scopic viewpoint, that is, firm level, based on a large-scale samples especially in United States in the late 90's. Among them, "Intangible assets" by Erick Brynjolfsson [1], "IT Investment Portfolio" by Peter Weill [14, 15], and "Does IT matter?" by Nicholas Carr [2] are well known. All of those researches said that only IT itself does not effect in firm performance, but usage of IT including organizational characteristics is crucial.

Although there are quite few researches related to this issue in Japan for it is difficult to access those data, our research group stared to work on this issue using the the Actual Survey for Information Processing conducted by METI every year owing to SIMOT project. One of interesting results is that high Organizational IQ (OIQ in abbreviation) firms utilize IT while low OIQ firms spend IT in vain [4]. Another is that CIO itself does not matter but CIO contributes in firm performance if the firm has high OIQ [13].

Organizational IQ

Both of those researches are related to the concept of OIQ. OIQ is a quantitative measure that evaluates of an organization's effectiveness in information distribution, decision making, and execution [8].

It is composed by five core dimensions; each of them is assessed with a set of variables and equipped with a scale-based or numerical metric.

- External Information Awareness (EIA) is the degree to which a company or business unit has developed a deep and consistent understanding of its environment including information about customers, suppliers, technology and competitors.
- Internal Knowledge Dissemination (IKD) ensures that each part of the organization knows what it needs to know when it needs to know.
- Effective Decision Architecture (EDA) ensures that decisions are made at the right level, by people with the best knowledge.
- Organizational Focus (OF) refers to the need to work against information overload and organization complexity, as well as aligning organizations along their

strategy. It includes development of a focused strategy, its communication, and the alignment of incentives with strategic goals.

- Continuous Innovation (CI) refers to the need of reinventing products and services, as well as processes.

Process Orientation

The concept of Process Orientation seems to play an important role in IT utilization described in section one. There is a well-known research by McCormack et al. related to this point [7]. They proposed the concept of Business Process Orientation (BPO in abbreviation) consisting of three dimensions:

- Process Management and Measurement (PM): Whether there are measures in place that includes process aspects such as output quality, cycle time, process cost and variability.
- Process Jobs (PJ): Process related tasks and roles are defined. E.g. a product development process owner rather than a research manager.
- Process view (PV): Thorough documentation and understanding from top to bottom and beginning to end of a process exists in the organization.

And they showed that high BPO firms have high firm performance.

Visualization

Recently, the concept of "visualization" is getting popular in management context in Japan. In this paper, let us consider the concept from the viewpoint of decision making. Based on the failure of MIS in 1960s, we understand a person who is in charge of decision making should handle data by him/herself. Therefore it is necessary to show data related to goal, current state, know-how, process definition for decision makers based on the definition of a "problem". It is related to clarify which alternative should be chosen and what will happen if we select the alternative to visualize know-how and process definitions.

As shown in Figure 3, visualization is necessary to make the flow smoothly starting from obtaining information from EIS that reflects actual state of business to action for business as the result of decision making based on the information.

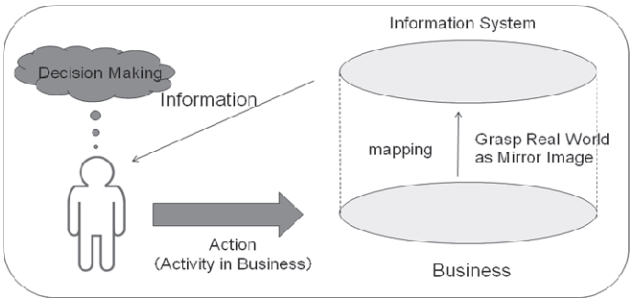

Fig. 3. The meaning of Visualization.

POE

Based on those consideration, we propose the concept of POE(Process Oriented Enterprise) in this paper. POE consists of three layers. Top layer is Process-oriented practice related to visualization and operations management including Kaizen. Second is process-oriented organization including OIQ and supplier/customer orientation. The bottom layer is Process-oriented climate related to conscious or customs in which employees recognize their business as a process.

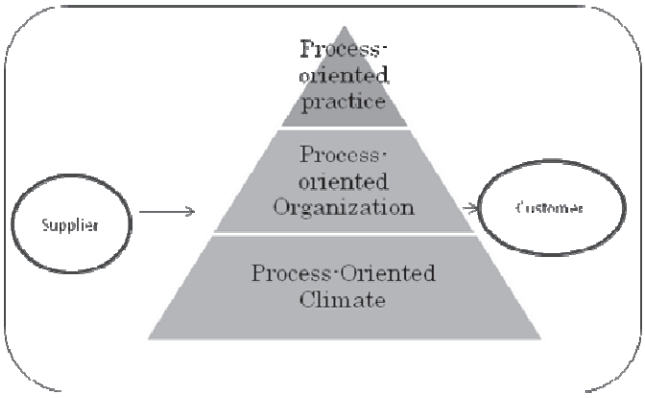

Fig. 4. Concept of POE.

4 FIELD SURVEY

Based on the concept of POE, we conducted a questionnaire based field survey with Japan BPM Association in September, 2008. The survey method is triggered by post or Email announcement and then paper-based or Excel-based questionnaire was conducted. We announced around 3000 firms and obtained 257 effective respondents (response rate is around 9%). As a profile of those companies, manufacturing is 41%, while non-manufacturing is 59%.

The followings are main results:

1) High OIQ firms have high Sales-growth rate (see Fig. 5).

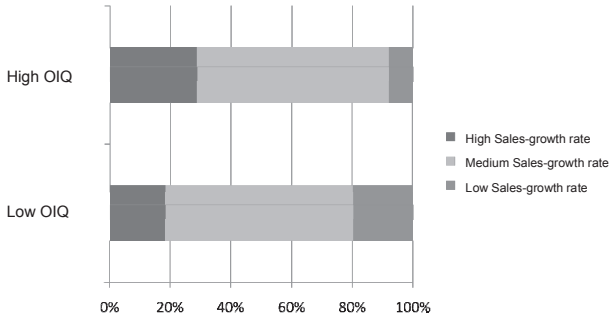

Fig. 5. OIQ and Sales-growth rate.

2) Rich Process Oriented Climate leads high sales-growth rate Process oriented climate accelerates effective utilization of ICT? (see Fig. 6)

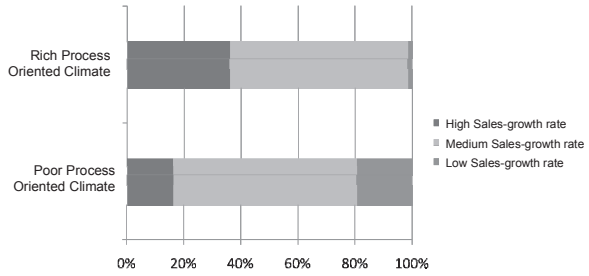

Fig. 6. Process Oriented Climate and Sales-growth rate.

3) Poor Process Oriented Climate does not lead high performance even if it has high ICT facility (see Fig. 7).

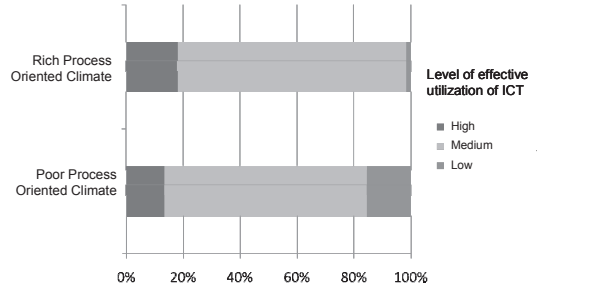

Fig. 7. Level of effective utilization of ICT and Process Oriented Climate

4) Among those firms that have ICT facility level beyond average, 75% of rich process oriented firms have high operating profit ratio in the industry. While more than half of poor process oriented climate firms have low operating profit ratio.

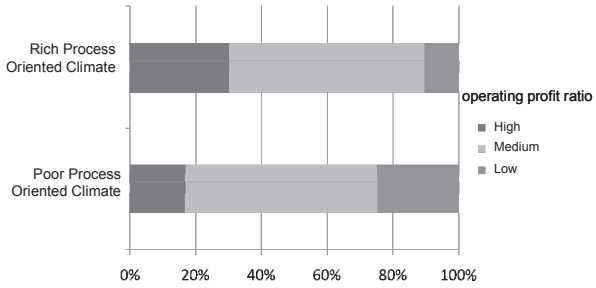

Fig. 8. Process Oriented Climate and Operating Profit Ratio

5) CIOs foster process- oriented climate?
Firms with no CIO have poor process oriented climate.

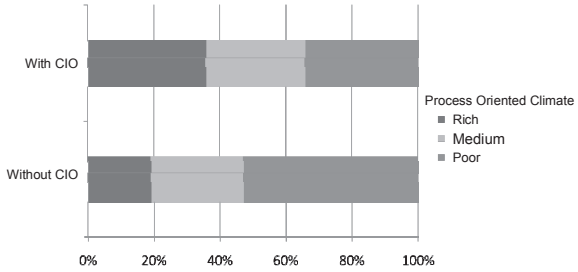

Fig. 9. Process Oriented Climate and CIO.

Hypothetical Proposal

Based on the analysis on the results of the field survey, we have the following hypothetical proposal:

POE has three layers, that is, process-oriented practice, process-oriented organization and process-oriented climate. In those layers, process-oriented climate is related consciousness and customs, then it is difficult to raise the score related to process-oriented climate directly. While process- oriented climate and OIQ have positive correlation (1% statistically significant except EDA). Process-oriented climate also has high correlation with process-oriented practice including visualization and Kaizen.

Consequently, it seems to be possible to foster process-oriented climate if we improve the score of process-oriented practice and process-oriented organization.

5 Conclusions

In this paper, firstly we surveyed the current situation of IT utilization in Japan. It may be said that the actual IT investment as well as IT investment mind is low in Japan. Adding that correlation between IT investment and productivity growth rate is also low comparing to United States. One of the reasons for it is that most of Japanese firms do not leap beyond the wall called "wall between divisions". In order to utilize IT furthermore, it seems to be necessary to proceed process orientation beyond walls trans-divisions.

Then we propose the concept of POE-Process Oriented Enterprise and conducted a field survey in September, 2008 based on POE. The result of the survey says that process orientation including practice, organization and climate plays an important role in ICT utilization. The reasons why rich process-oriented climate leads high firm performance seem to be as follows:

- Business itself is implemented as a process.
- It motivates employees if they understand how their activities are connected and affect others.
- There is a synergetic effect with visualization.

It seems to be true that process-oriented climate becomes rich if we improve operations management and organization as

process-oriented.

REFERENCES

[1] E. Brynjolfsson, (translated by CSK in Japanese), *Intangible Assets*, Diamond (2004).

[2] N. Carr, *Does It Matter?: Information Technology and the Corrosion of Competitive Advantage*, Harvard Business School Pr, (2004).

[3] Gartner Japan, "News Release – IT investment mind in the world 1st India, Japan is at the bottom, whether Japan still remains IT developed country?," (in Japanese), Available: http://www.gartner.co.jp/press/pdf/pr20070517-01.pdf, (2007).

[4] M. Hirano, *Rising company and sinking company with IT investment* (in Japanese), Nihon Keizai Shinbun sha, (2007).

[5] JEITA, "Report on the comparative study on IT investment in Japan and US," (in Japanese) Available: http://it.jeita.or.jp/infosys/report/summary2007/07-kei-1/index.html, (2007).

[6] K.C.Laudon and J.P.Laudon, *Management Information Systems*, Pearson International Edition, (2007).

[7] K. P.McCormack and W. C. Johnson, *Business Process Orientation*, CRC Press LLC, (2001).

[8] H. Mendelson and J. Ziegler, *Survival of the Smartest*, John Wiley & Sons, (1999).

[9] METI, *IT management roadmap*(in Japanese), Available: http://www.meti.go.jp/press/20080625001/20080625001-3.pdf, (2008).

[10] K. Motohashi , *Empirical Analysis on IT Innovation* (in Japanese), Toyo Keizai Sinpo sha, (2005).

[11] R. Solow, "We'd Better Watch Out", *New York Times*, July 12, 1987, (1987).

[12] R. Solow, "Productivity Finally Shows the Impact of Computers," *New York Times*, March 12, 2000, (2000).

[13] O. Sudoh, T. Obi, H. Kudo and R. Gotoh (eds.), *CIO Theory* (in Japanese), University of Tokyo Press, (2007).

[14] P. Weill and H. Broadbent, *Leveraging the New Infrastructure* (in Japanese), Harvard Business School Press, Diamond, (2003).

[15] P. Weill, "IT Assets, Organizational Capabilities and Firm Performance: Asset and Capability Specific Complementarities", *CISR WP*, No. 343 (2004).

Institutional Development of e-Commerce

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Abstract- **e-Commerce (EC) sales has been kept increasing for more than a decade all over the world. While an enormous number of newcomers has been entering into the EC business every year, an equally large number of stores has been exiting from the EC market. Although EC has great advantages over the real commerce, succeeding in EC business is not an easy task due mainly to the lack of tangible aspect in EC. So far EC owners have been relying on unscientific ways to make their decisions. In this paper, a scientific way to analyze an EC site based on trust and value factors, called the TVE model, is discussed. The TVE model was validated through a survey study at one EC site, and the practical use of the model was verified by interviewing seven EC practitioners. The results of these investigation indicated that the TVE model is valid and potentially have a great value in practice.**

Index Terms- **e-Commerce, Trust, Value, Purchase behavior**

1. INTRODUCTION

In Japan, B2C (Business to Consumer) e-Commerce (EC) sales in 2006 was approximately $38 billion (at 116.25 Yen/$ exchange rate), and it was 27.1% increase from the previous year [1]. Also, EC sales (including B2C and B2B: Business to Business) in the US for 2007 were approximately $136 billion, and it was 19.0% increase from 2006 [2]. All these statistics indicate that EC is here to stay and will keep growing.

Unlike the real commerce, EC is location free, that is, the entire network-connected world can be the market. Also operation cost of EC is significantly lower than that of the real commerce, and a typical EC site opens 24 hours a day, 365 days a year. These advantages may be the reason why so many new EC sites open every year.

On the other hand, EC has two major difficulties: trust and value establishment. Establishing trust and value are not easy task for the real commerce either; however, it is much harder for EC because of the lack of tangible aspect in EC. Since EC sites exist only in cyber space, customers can neither physically visit EC shops nor touch the goods on sale.

One other noteworthy difference is the role of customers. Customers in the real commerce are typically passive, whereas EC customers are often active. Real commerce customers make purchasing decision based on the condition presented by stores within a certain physical distance. EC customers, however, can shop around hundreds of competing stores without considering the distance. Therefore, EC customers can possibly possess more information about the goods, competitive prices, and so on than lazy owners of real commerce stores.

The EC market can be seen as a new business frontier and appears to have very promising future. An enormous number of newcomers has been entering into the EC business every year; however, an equally large number of stores has been exiting from the EC market. Succeed in EC is as difficult as in the real commerce and possibly even more so due to the aforementioned lack of tangible aspect.

1.1 Problems faced by EC owners

Several so-called key success factors (KSF) for EC have been discussed and reported in books and by EC consultants. However, those factors actually do not have any explanation power for success and failure of EC sites [3]. It appears that people who claim those KSF are treating EC as one entity (i,e., one institution). In reality, of course, EC as a whole is too big to be one institution (it is almost same as calling the earth as an institution). Unfortunately so-called KSF have been taught to many new EC owners as critical factors for the success of EC business by many EC consultants.

The author of this paper interviewed five owners of successful EC sites (all in B2C) about how they make decisions. Here, a successful EC site being defined as an EC site that has been operating 5 years or more in black. The following four points were mentioned by all five owners as the way they make decisions:

1. Educated guess
2. Experience
3. Superficial numbers (such as access rank, number of visitors, conversion rate, etc.)
4. Hunch

All five owners also agreed that there is no scientific means to support their decision making.

1.2 Objective

Attracting new customers and make them to be loyal customers are the must for the success of any business. This process for EC business is defined as the EC business growth process (EC growth for short) in this paper. A hypothetical model, namely the trust-value establishment model (TVE model), that attempted to explain the EC growth was proposed by Higa et al. [3]; however, there was no means to validate the model then. Recently the statistical method, called Structural Equation Model (SEM), was established that can test causal relationships among factors. Also an EC site that helped to collect data became available. Because of these two reasons, validation of the TVE model became feasible and carried out (see [4]). The objective of this paper is to explain the model and its validation process.

2. RELATED WORKS

As mentioned in the previous section, existing KSF are based on an assumption that the EC is one institution. Most survey research in EC also collected data from customers of all sorts of EC sites, i.e., treating the EC as one institution. However, the EC is a collection of multiple totally different institutions. Naturally, existing KSF and survey findings are not useful for many EC sites.

Nonetheless, some noteworthy research are available in this field, and those research are discussed in this section.

2.1 Research in trust

Because of the lack of tangible aspect in EC, establishing trust is much harder in EC than in the real commerce. Therefore, many research in this topic have been conducted.

McKnight et al. [5] proposed an initial trust building model, and the following research reflected back on the outcome of trust research [6].

Kong and Hung [7] revealed that potential customer trust and repeat customer trust are determined by different sets of factors. Several other research also indicated that there are multiple stages to establish trust in EC [8-10].

These existing research indicate a distinction between initial trust phase and ongoing relationship (repeat trust) phase.

2.2 Research in value

Similarly to trust establishment, letting customers recognize the value offered by an EC site is very difficult task. However, for some unknown reason, value has not been considered as a critical factor for the success of EC, and research of value in EC are few.

Cazier et al. [11] showed that, perception of value congruence between buyer and seller in EC increases trust and enables seller's differentiation, while value conflict decreases or at the worst loses trust. Hall and Paradice [12] discussed the decision bias caused by the difference in value perceptions between decision makers. These research findings implies a close relationship between trust and value factors in EC, and therefore, multiple stages for value establishment is also inferred.

2.3 Preliminary investigation of trust and value

Existing research indicate that the establishment of trust is the critical factor for the success of EC. However, a simple question of "Will people purchase from an EC site solely based on trust?" arises. In order to answer this question, a simple yes-no question survey was conducted at several EC seminars. 106 people with EC purchase experience participated in this survey. Selected questions and responses are shown in Table 1.

Table 1. Results of Yes-NO question survey

Will you purchase from the site if it has:	Number of "Yes"
Q1: the rare item you want	88
Q2: a good discount price	57
Q3: a good reputation	84
Q4: unknown reputation and has the rare item you want at the market price	52
Q5: a good reputation and has the rare item you want at a premium price	51

In Table 1, Q1 and Q2 are strictly about value, and Q3 is strictly about trust related questions. Both Q4 and Q5 contains trust and value factors.

The results indicate that people respond equally positively to Q1(value) and Q3(trust), but interestingly, the result of Q2 implies that people do not necessary purchase just because the price is low. Even more interesting results are the responses to Q4 and Q5. When some additional information are added to Q1 and Q3, number of "Yes" responses dropped sharply. It implies that both trust and value factors influence purchasing behavior of EC customers.

3. A HYPOTHETICAL MODEL

Based on the existing research, it can be said that trust and value factors determine purchasing behavior in EC as depicted in Fig. 1.

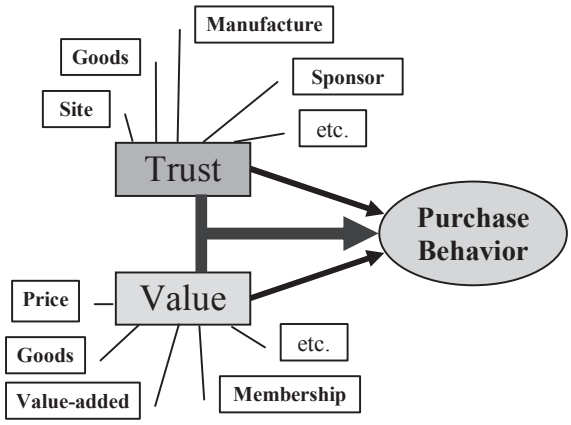


Fig. 1. Determinants of purchasing behavior in EC

Also from existing research, multiple stages exist for establishing both trust and value factors.

3.1 Constructs of the model

The TVE model [3] has trust and value factors with 3 stages for each factor.

Table 2. Stages of trust and value in the TVE model

Customers	*Trust Stage*	*Value Stage*
First time	Just enough to visit the site and try out	Recognizing the value offered
Repeated	Begin to trust the site	Anticipating the value previously offered
Loyal	Trusting the site as well as the site owner	Expecting continued value, added value, and new value

To attract people to visit the site and make them decide to purchase for the first time is the point of the first stage for trust and value factors. Of course if the value offered at the site is not satisfactory to the first time buyer, s/he will never come back for the second time. Therefore, the site must have value enough to convince the customers to repeat purchasing. If the first time buyers have satisfied with their purchasing experience, they will come back for the second time. For the repeated buyers, the site must continuously offer the value anticipated by the repeated buyers. If the repeated buyers become the loyal customers, they will become less price sensitive and try out new products and services offered by the site. They will trust not only the site but also the other site managed by the site owner. To keep the loyal customers, the site must offer the added value and new value that are satisfactory to the loyal customers. Therefore, by satisfying each stage of the TVE model, an EC site should be able to grow successfully.

3.2 Hypotheses

Based on the TVE model, the following two hypotheses were tested by Hayashi and Higa [4].

H1: The purchase behavior of customers in an EC site can be determined by trust and value factors.

H2: Both trust and value factors have multiple discrete stages.

H1 is supported if trust and value factors jointly determine the purchase behavior of the site customers. The SEM method is used to test this hypothesis.

H2 is supported if different sets of trust and value attributes are identified based on customers purchasing behavior (e.g., first time, repeat, and loyal). The multiple comparison method is used to test this hypothesis.

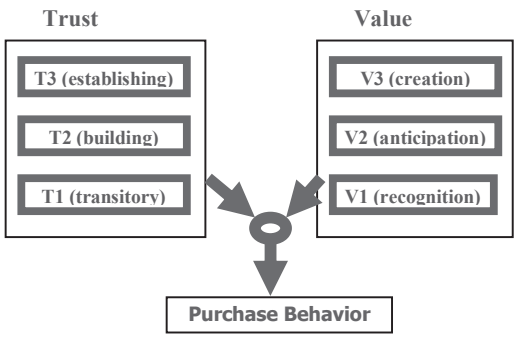


Fig. 2. The hypothetical analytic model

These two hypotheses are depicted in Fig. 2.

3.3 Expected use of the model

If the TVE model is validated, it will have the following meanings to practitioners and researchers in EC.

For EC practitioners:

For the first time, a site owner has a scientific way to analyze own customers and stages the site is in. Therefore, strategy and tactics can be developed, and resource can be allocated with reasons.

For EC researchers:

An EC researcher may be able to determine the reasons for success and failure of EC sites. Also a researcher may be able to compare different sites in the same EC market, and may be able to determine the effects of tactics taken by each site.

4. VALIDATION OF THE MODEL

Since each EC site can be considered as an institution by itself, validation of the TVE model needs to be done by using data collected from single EC site.

The EC site "O" agreed to collect data from its customers, and then Hayashi and Higa[4] tested and verified the two hypotheses and the model by statistically analyzing response data of the questionnaire survey. The subjects of their survey were the mail magazine subscribers of the "O" site.

4.1 Survey design and implementation

The "O" site is in B2C and operating for 10 years. It is expecting total revenue of 75 billion yen in this fiscal year.

Table 3 shows the customer segments of the "O" site, which are categorized by customer type based on their purchase behavior. The word "VIP" is used by the "O" site for its loyal customers.

Table 3. Customer segments of "O" site

Customer Segment	Type of Purchasing Behavior
VIP buyer	Royal users who purchase over several hundred dollars of goods every month
Frequent buyer	Customers who signed up with weekly or biweekly home delivery services
Infrequent repeater	Repeaters who purchase only at the time of discount or similar events
First-time buyer	Customers who purchased once (a cut-price set of goods on trial, usually)
Prospect	Mail magazine subscribers of no purchase experience at "O" site

A questionnaire is designed based on the analysis of trust/value factors and questionnaires used in the existing research. As a result, 15 trust related questions and 18 value related questions are included in the questionnaire (see [4] for details).

The questionnaire survey in a mail magazine was sent by the "O" to registered customers. The number of registered customers was approximately 70,000.

4.2 Results

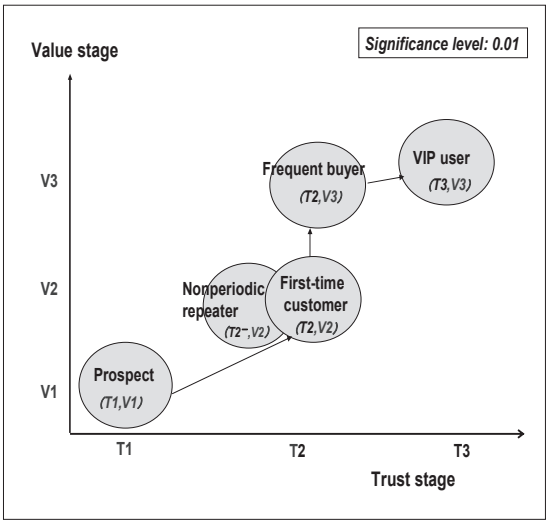
The number of total responses was 511, and the number of valid responses was 502 (9 invalid responses were eliminated). Its breakdowns by customer segments are as shown in Table 4.

Table 4. Customer segments of "O" site

Customer Segment	Number of Valid Response
VIP buyer	126
Frequent buyer	116
Infrequent repeater	89
First-time buyer	68
Prospect	101

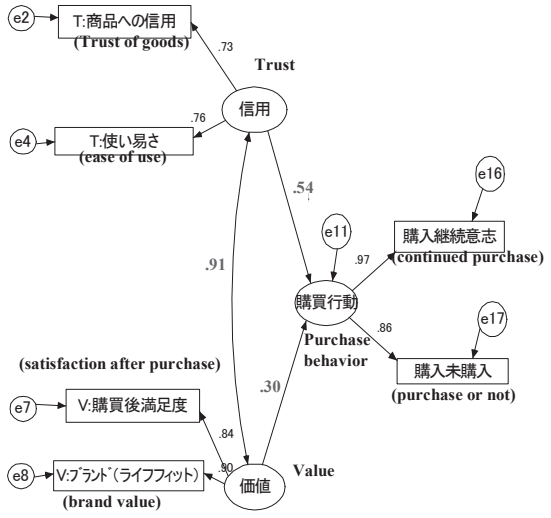
Cronbach's α of 0.84 and 0.87 for trust and value questions respectively indicated high reliability of the collected data.

Results of multiple comparison on trust and value indices of the survey data indicated statistically significant differences among customer segments. More concretely, there exists one trust and one value stage differences between prospect and first-time buyer segment. Similarly, one value stage difference between first-time buyer and frequent buyer segment, and one trust stage difference between frequent buyer and VIP buyer segment. Thus, the results of multiple comparison supported H2 (see Fig.3).



(source: [4])

Fig. 3. Trust and value establishing stages



(source: [4])

Fig. 4. The causal relationships among EC factors

H1 was tested by using the SEM method. Its results supported the hypothesis H1 (see Fig. 4). Thus the survey results proved the TVE model's validity.

4.3 Feedback from practitioners

In order to verify the efficacy of the TVE model, interviews to seven practitioners were conducted. They were EC site owners (2 persons), EC consultants (3 persons), EC managers (2 persons).

The following comments came from all seven people:

1. The model is very unique, and analysis results using this model are quite convincing.
2. The model has a good potential to explain the purchase behavior of the EC users of a certain site.
3. We can use this model to determine the effects of our marketing efforts.

One EC owner mentioned that his site has been using some numbers such as access ranking, conversion rate, time spent per page by visitors, and so on to decide next move, i.e., tactics. However, he always felt that these numbers cannot tell anything to him. According to him, the numbers just go up and down week by week as if they are dancing. The real effects of whatever the tactics he applied remained unknown using these numbers. On the other hand, the analysis using the TVE model appears to be able to identify what needs to be done for a targeting customer groups. Therefore, the effects of tactics applied should be able to be measured as well.

Some comments to improve the model was also provided by the interviewees, but they all agreed that the model is very practical.

5. DISCUSSION

When presented the analysis results of the survey to the "O" site executives, some interesting comments were made by them:

"*We have been working on the infrequent buyers to make them move up to the frequent buyers for quite some time, but not succeeded so far. With this analysis, we can see the reason why. It appears that we should focus our attention on prospects and first time buyers rather than on infrequent buyers.*"

As can be seen from Fig. 5 and 6, the differences between infrequent buyers and frequent buyers are larger than the differences between first time buyers and frequent buyers.

One additional interesting comments made by the "O" site executive is:

"We have also been working on the frequent buyers to make them move up to the loyal buyers, again without much success. However, in last year, the number of loyal buyers increased significantly every time food safety related incident happened in Japan. We were wondering about this phenomenon because we have done nothing special during this period. However, according to the analysis results, we can see the reason why."

According to Fig. 5 and 6, the difference in trust between frequent buyers and loyal buyers is large but not that of value. It appears the food safety problems worked as an external push for the "O" site, which is a leading EC site dealing with safe food.

***Number of attributes with statistically significant difference at α=0.01**
***12 trust attributes**

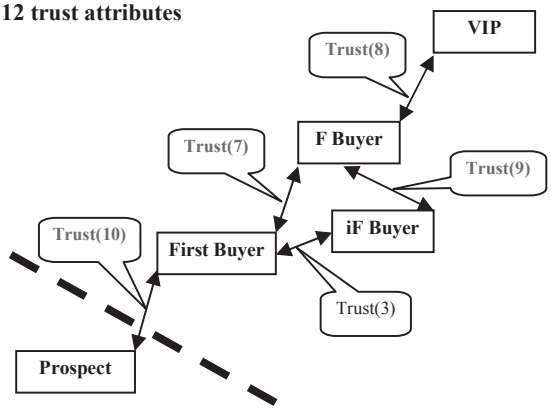


Fig. 5. Results in trust attributes

***Number of attributes with statistically significant difference at α=0.01**
***16 Value attributes**

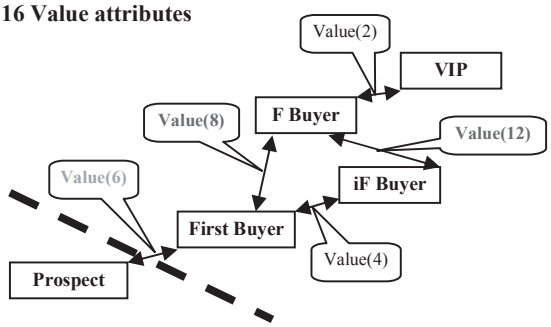


Fig. 6. Results in value attributes

6. CONCLUSION

The model described in this paper is not intended to provide the success factors nor the strategic guidelines for specific EC sites. It is rather intended to provide EC owners with a scientific means to view their own EC sites and customers, as preceding research have failed to provide such views.

Since, by using this model, the attributes required for moving up customers to higher stages can be identified, its usefulness as a framework for analyzing EC growth and factors has been verified. However, in order to enhance this model as a theoretically proven and practically useful framework for the success of EC business, structured analysis of EC success factors and cause-effect analysis of trust and value among stages are further required.

Also additional survey with more B2C sites as well as the analysis of B2B sites will help generalize the findings.

REFERENCES

[1] METI, Japan: "Survey on Electronic Commerce market for FY2006," *METI,* (03/2007), http://www.meti.go.jp/policy/it_policy/statistics/outlook/ie_outlook.htm, accessed in June 2008

[2] U.S. Census Bureau of the Department of Commerce: "Quarterly Retail E-Commerce Sales 4th Quarter 2007," *U.S. CBDC,* (02/2008*),* http://www.census.gov/mrts/www/data/html/07Q4.html, accessed in June 2008

[3] 比嘉邦彦、小海友和、大野麻衣子:E-コマースを成功させるには？:既存成功要因への考察と分析モデルの提案; *第五回日本テレワーク学会研究表大会予稿集*、平成 15 年7月, 135-140 (2003)

[4] S. Hayashi and K. Higa: Analysis of Differentiating Factors among Trust and Value Stages in e-Commerce Growth Process; *Journal of Japan Industrial Management Association,* Vol.60, No.3E, 2009 (scheduled to be published in August 2009)

[5] McKnight, D.H., Choudhury, V., Kacmar, C.: The impact of initial consumer trust on intentions to transact with a web site: A trust building model; *J.Strat.Info.Sys.*, Vol.11, 297-323 (2002)

[6] McKnight, D.H. and Chervany, N.L.: Reflections on an Initial Trust-Building Model; *Handbook of Trust Research*, Edward Elgar Pub, 29-51 (2006)

[7] Kong, W. and Hung, Y.C.: Modeling Initial and Repeat Online Trust in B2C E-commerce; *Proceedings of the Thirty-Ninth Hawaii International Conference on System Sciences*, Vol.6, January 2006, Kauai, USA, http://csdl2.computer.org/comp/proceedings/hicss/2006/2507/06/250760120b.pdf, accessed in May 2007.

[8] Kanawattanachai, P. and Yoo, Y.: Dynamic nature of trust in virtual teams; *Journal of Strategic Information Systems*, Vol. 11, 187-213 (2002)

[9] Jarvenpaa, S.L. and Leidner, D.E.: Communication and trust in global virtual teams; *Journal of Computer-Mediated Communications*, Vol. 3 (1998) http://jcmc.indiana.edu/vol3/issue4/jarvenpaa.html, accessed in May 2007

[10] Oliver, A.L. and Montgomery, K.: A system cybernetic approach to the dynamics of individual- and organizational-level trust; *Human Relations*, Vol. 54, No. 8, 1045-1063 (2001)

[11] Cazier, J.A. et al.: E-business differentiation through value-based trust; *Information & Management*, Vol.43, 718-727 (2006)

[12] Hall, D.J. and Paradice, D.: Investigating Value-based Decision Bias and Mediation: Do you do as you think?; *Communication of the ACM*, Vol. 50, No. 4, 81-85 (2007)

Affective Technology, Affective Management, towards Affective Society

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***Abstract*—In this paper, the term *affective* is defined as "being capable to evoke affects in people's mind" or "being capable to deliberate affects to be invoked in people's mind". This paper discusses potential impact of concept of *affectiveness* on development of technological products and services, management, and value systems of societies.**

***Index Terms*—Affect, emotion, feeling, management of technology, mood, quality, usability.**

1 Introduction: Beyond Usability

1.1 Contributions and limits of human factors

In the later twentieth century, products and services using technologies continued to get complex, and thus, difficult to interact with. The more people have to adapt to technologies, the more errors they tend to make, and the more likely they tend to forget how to use.

One of the goals of human factors and ergonomics is to make products, systems, and/or environments safe and usable, in other words, to enhance *usability*. For this purpose, human factors researchers and practitioners have made efforts to understand characteristics of potential users and to reflect them on design. As pioneers including Norman [1] and Nielsen [2] had established and propagated the concept of usability and methodology of usability engineering, the concept and importance of usability had been widely recognized in design communities.

As the results of the efforts of industries during the last couple of decades of the twentieth century to enhance usability, most of the products and services that can be seen in markets today have high usability. Except for those targeted to special users and special purposes, products and services with low usability can never be successful in the market. That means, usability is now considered as one of the attributes that every product or service must have; usability alone no longer makes a product or a service attractive and distinguishable from other competitors any more [3].

Therefore from the end of the twentieth century to this century, a new idea has emerged across a broad range of fields that design is just not enough to be simple and usable, and that it is now essential to design products and services that user themselves want to use and to continue to use [4]. Thus researchers started to seek for what are necessary in addition to traditional usability.

1.2 Beyond Usability

In his recent book *Emotional Design* [5], Norman reflected back on his own book 16 years ago *Psychology of Everyday Things*, and argued that design had too much emphasized on usability aspect of the products, i.e. to enable users to accomplish their own goals safely an efficiently. Norman also discussed significance of appeal of products to user's emotions.

Some other researchers focused on factors such as fun and pleasure. Csikszentmihalyi [6] defined *flow* as a status where a person is completely absorbed in an activity, forgetting any other things around her. According to Csikszentmihalyi, flow is the happiest and most productive moment people can have in their life. Also in human factors field, Fulton [7] claimed the needs to introduce the concept of pleasure into human factors approach in 1990s. Jordan [3] categorized pleasure into four categories: *physio-*, *psycho-*, *socio-*, and i*deo-pleasures*, and proposed approaches to design products to invoke each of these pleasure categories as *pleasure-based approach of human factors*. Hancock and colleagues [8] coined *hedonomics* as design and scientific studies that aim pleasurable interaction between human and technology. After Maslow's [9] hierarchy of human needs, Hancock and colleagues categorized the goals that human factors should achieve into five hierarchical layers: safety, functionality, usability, pleasurable experience, and individualization. They argued that conventional ergonomics deals with safety to a part of usability, and usability, pleasurable experience, and individualization should be pursued by hedonomics. Furthermore, an emerging interdisciplinary field that studies fun is called *funology*, which attracts researchers from computer engineering, human factors, philosophy, history, education, psychology, as well as practitioners from industries.

On the other hand, scientific studies on aesthetics have also attracted more attentions. There have been more evidences that products that were designed aesthetically beautiful can not only obtain higher subjective evaluation but also improve actual task performances [11], [12]. There are also new evidences that aesthetics is the factors that determine users' engagements with technologies [13]. At the same time, as symbolized by media arts, boundary between technology and art has been blurred illimitably [14], [15]. Now aesthetic design and engineering design have been considered as one inseparable activity.

One common idea among the series of studies described above is that providing emotionally or affectively good experiences such like pleasure, fun, and aesthetics might lead users to have affection and continue to use technological

products and services.

2. Affect and Affection

2.1 Cognition and Affect: Rationality and Irrationality of Human

In the history of human evolution, affects had developed much earlier than rational thinking. In many situations, affect can be responsible to the information (stimulus) from neurosensory system and able to send signals (responses) to body system for appropriate reactions, much faster than rational thinking. This mechanism has been important for humans to survive.

However, modern Western philosophies have tended to recognize affects as primitive and irrational aspects of human, and thus, emphasized on rational and logical thinking as the characteristics that differentiate human from other animals. In the trend towards "globalization" in the last century, Anglo-Saxon rationalism and market-based principles in which efficiency and cost reduction are measured in money became the fundamental rule to participate in competition in the global market.

This rationalistic trend in modern thoughts is also apparent in emergence of *cognitivism* in psychology. Cognitivism is the approach to recognize human mental activity, or cognitive process, as information processing, and to try to model human mental activities as information processing models. Irrational behaviors of human are treated as exceptions from rational information processing and called heuristics or biases. This approach became a major stream called cognitive science, and gave significant influence on various fields even outside of psychology.

Psychological studies on affects, on the other hand, have long been laboratory studies and field studies on human emotional responses, understanding, and expressions. However, there were some major developments in this field in the end of the twentieth century. One was the emergence of the modeling approach that had been successful in cognitivism, which tried to model human affective processes to build *computational models of affects*. Another was the development of technologies for direct observation of brain activities such as positron-emission tomography (PET) and functional magnetic resonance imaging (fMRI). These technologies enabled high precision observations of brain cells, and resulted in significant advance in neuroscience. These two approaches, analytic approach with models and empirical approach based on direct observation of human brain, provided broader ways for scientific research on affects.

In addition, demand for affective studies was also claimed from the fields of social sciences. Goleman [16] pointed out that human emotion could be the significant factor for various modern social problems and argued the necessity of people's ability to understand and control their own emotion. In the marketing field, consumer psychology is now establishing a new research paradigm called *neuro-marketing*, with the help of fMRI technology.

As discussed above, since the end of twentieth century to the beginning of this century, studies on affects have become a major multidisciplinary stream. Fujita and colleagues [17] coined *affective science* as a scientific research field on human affects, rather irrational aspects of human activities, contrasting to conventional cognitive science that studies human cognition, subjecting rational aspects of human. Fujita claimed that affective science is not to replace conventional cognitive science; affective science and cognitive science are to focus on two different aspects of human, and influence each other. Furthermore, as discussed above, emerging interdisciplinary studies on fun and pleasure are not limited within psychology field.

2.2 Affect and Affectiveness

In psychology, the term *affect* is used to represent human affects in general, including emotion, feeling, and mood. Affects include both positive and negative status. However, the English word *affection* is usually used only for positive meanings such as love and gentle care.

In this paper, the term *affective* is defined as "being capable to evoke affects in people's mind" or "being capable to deliberate affects to be evoked in people's mind". For example, *affective products* might mean "products that are capable evoke appropriate affects in users" or "products that were designed carefully considering possible affects users might have." In the same way, the term *affectiveness* is used for the meanings of "how capable to evoke affect in people's mind," or "to what extend affects that people might have are thoroughly considered."

As stated above, affects include both positive and negative status. Thus an *affective product* may evoke positive or negative affects in users. What are desired in many situataions in the world should be *positively affective products*, or products that evoke positive affects and avoid negative affects among users. In some specific situations, it might be necessary to be *negatively affective*. A good example can be roller coasters. By providing negative affect of fear, roller coasters may give riders higher positive affects such as exhilaration or accomplishment. In general, however, careless misuse of negative affects may result in serious damage in human relationships and social climate. Thus being negatively affective, at its heart, requires thorough understanding of human affects and advanced skills.

Affect is not a simple one-dimensional characteristic, such as rational-irrational or cognitive-affect. Firstly, it s necessary to understand the multi-layered nature of affects, which consists of at least two layers: basic emotion including fear and anger, and higher affective responses based on individual memories and value systems. Norman [5] proposed three-level model of human information processing; in addition to *behavioral level* in which rational cognitive information processing is conducted, there are also lower *visceral level* that is responsible to instinctive responses, and higher *reflective level* that is meta-cognition based on human individual strategies and value systems. These three levels are concurrently working,

influencing each other. Basic emotions described above are corresponding to the visceral level, while higher affective responses are considered to be processed in the reflective level.

Secondly, it is also important to understand multi-dimensionality of affects. Many psychologists agree that there exist six basic emotions: anger, fear, disgust, sad, happiness, and surprise. Furthermore, it is also considered that these basic emotions can be mapped onto a two-dimensional space that is spanned by valence and arousal. There are at least five modalities of sensory stimulus that evoke basic emotions. Individual factors that may relate to higher affective responses may include a number of factors such as value systems, memories, experiences, cultures, and religions. As seen above, affective responses and their causes should be perceived in a multi-dimensional way.

3. Affective Technology

3.1 Perspectives on Affectiveness Research

Idea of designing technological products and services to be affective is not very new. In Europe, there has been a long tradition of affective design, or designing artifacts to evoke specific affects, in many cases positive ones, especially in industrial design field.

One of pioneering works of research about relationship between technology and affect might be a series of work called as affective computing [18]. In 1990s, however, major focuses of affective computing research had been how to let computers to understand, express, and *have* affects. It was not until this century that research focus started to shift to the affective responses computers might evoke among users.

This section reviews various researches that have the common viewpoint of how technological products and services might evoke affects among people, both ongoing and supposed to be pursued in near future, including the new trends in affective computing shown above. Research topics are categorized into five groups and discussed on their research significance and research questions, although these five categories are neither definitive nor exclusive; some of research topics may be categorized into more than one category.

3.2 Affective Technology

Today, as discussed above, products should not only be excellent in the conventional aspects of multi-functionality and usability any more, but also be those that users themselves want to use and continue to use: products to make owners pleased and be proud of their owning, products that are comfortable and enjoyable in use, and/or products that provide remarkable affective experience such as excitement and deep satisfaction. Such technological products and services can be *affective technologies*.

There are a number of questions to be answered in order to create such affective technologies. Firstly, in what situations or conditions do people experience affective experiences such as fun or pleasure in the context of technology usage? Secondly, what factors of technological products and services might evoke affects? Furthermore, as discussed in section 2, some of affective responses, especially higher ones, are expected to vary across individuals significantly. Thus individual differences in affective responses and its consideration in design should also be studied.

3.3 Affective Quality

What are the factors to make technological products and services affective? Various qualities built into products and services as a whole provide affective experiences: color and shape, quality material and finish, weight and balance, softness, torque and click of movement, sound, lightness and readability, latency, information provided to users, efficiency and comfort of task, temperature and smell, and so on. Various operational activities throughout whole organizations may contribute to customer's affective experiences: not only aesthetic design, but also production technology, acquisition, information design, usability engineering, marketing and advertisement that form anticipation in users before they actually see and get products and services, and various services to enhance satisfaction after customers have obtained them. All of these kinds of *quality* of products or services that contribute to people's affective experiences are called *affective quality* [19].

As it is generally not easy to provide objective standards to these affective qualities, they are difficult to be numerically measured, and thus methodologies to design these qualities are only empirical in practice and still not systematically established. In addition, as discussed above, affective qualities are created not only by design but also as results of various operations of whole organizations, thus it is not easy to understand affective quality comprehensively. The constructions of affective quality, as well as organizational activities and methodologies to produce affective quality, should be investigated in future research.

3.4 Affective Design

There has been a long tradition of a series of researches on aesthetic and attractive design, particularly in Europe. Those designs, including not only ones aesthetically beautiful, but also those to give a sense of wonder, sensual or vibrant ones, and those make their owners proud of them, may give a variation of affective experiences to people who own or see them. People irresistibly pay much money accidentally for these excellent designs, or become tolerant even if they have poor usability [5].

Such affective designs are not limited only within the category of *fine arts*, but also seen in everyday things such as kitchen ware and stationary. What are essences of such affective designs? For a long time, they have been considered as the territory of arts, or based on quite personal attributes of product designers such as their own sensitivity, skills or talents. However, now that the boundary between aesthetic design and engineering design is blurred, there are emerging researches to systematically investigate the fundamental elements of those *fine arts*.

3.5 Affective Communication

Researches on communication technology have mainly focused on how to transmit as much information as possible to remote sites reliably. In other words, their efforts have been made towards conveying as realistic and as high-quality information as possible to remote counterparts. As a result, in today's workplaces, videoconference systems using high-speed lines and high-definition imaging technology are conveying realistic vision of your colleagues on the other side of the earth. However, when you look at home settings, is the communication technology today connecting our minds with our loved ones? For example, are cell phones and e-mails nowadays connecting hearts of family members living far apart? If you introduce a high-definition videoconference system into between homes of you and your family, can you feel stronger bond?

Communication systems that connect hearts of people far apart and make them warm-hearted feeling emotional bonds with counterparts can be called *affective communication*. Those kinds of communication might not be those that convey true and accurate information of users, such as videoconference systems in workplaces. Then what is the difference between communication systems that can make people smile and those in workplaces? Factors essential for affective communication should be clarified in future study, and actual systems realizing those factors should also be proposed in order to demonstrate the significance of this idea in our life.

3.6 Affective Service

Services, especially that human provides to human, are different in nature from the cases discussed above where human interacts with technology. The difference is that both provider and receiver of a service are human, and that affect of the people on the both sides should be considered.

It would be ideal if both providers and receivers of a service feel happiness from the time they started a service until the end of it. However in reality, in broad types of jobs centered in customer-care, it is often required for workers to *play* or pretend particular emotions that may be different from their own but are necessary to do the job. Hochschild [20] called this kind of jobs as *emotional labor*. This type of selling one's emotions off in pieces often demands heavily on workers' mental health. They may feel stressed, and if they failed to cope with it, they may suffer from serious mental illness such as burnout syndrome. In order to realize the ideal form of services described above, it is necessary to study on multiple issues including how services should be designed, what kinds of customer experiences should be provided, as well as how providers should attend customers and what kind of management is necessary to protect workers from hard feelings.

4. Affectiveness and Institution

As discussed in section 2, human affect can be influenced by various factors. Even if people sensed the same stimulus in the same context, their affective responses may differ across individuals. Factors that are considered to contribute to the individual difference may include institutional factors such as gender, generation and cohort, social group and community, culture and religion, moral and ethics, value systems, and region and country. However, their influences on the difference in human affects are not yet studied comprehensively. In many cases, practices are relying on empirical knowledge of local experts (e.g. information from experts and local residents of a country).

Even after some implications are derived as results of the researches discussed in section 3, it is necessary to carefully consider which implications can be generalized to what extent, and which implications are specific to the institution. One possible approach to answer these questions is to distinguish implications that can be abstracted independent from the context from those that cannot be.

5. Affective Management

5.1 Affective Management

It has been widely believed, and actually practiced, that decision-making in management should be done in principle based on objective measurements such as sales, costs, benefits, and efficiency. In recent years, however, there emerged a new idea that such numerical indices may not be sufficient as a basis of decision. For example, if a company wants to develop a new product that evokes deep affective experiences among users, it is necessary to deliberately build high design, quality materials, skilled finish and tuned movement into the product, usually resulting in additional costs. If the management board emphasized reduction of costs, these elaborations of quality might be replaced with easier and cheaper ways. On the other hand, if the management board recognized that the affective experiences these qualities might bring to users would add much value to the product, these elaborations would never be the target of cost-reduction, and could even be given higher priorities.

The example above illustrates the difference in *affectiveness* of management, or whether the management takes into considerations "what affect this decision may result in customer's mind," and if it gives higher priority to this value system. In other words, a management may clearly recognize the importance of factors that appeal to people's emotion such as aesthetics and pleasure, give higher priority to them, and do not allow sacrificing them. Such management that emphasize the criteria that "if this decision affective or not" in addition to the conventional numerical indices may be called as *affective management*.

The concept of affective management is neither neglecting nor thinking little of conventional numerical and rational indices. This concept is to value affectiveness equally to them. In practice, however, it is very difficult to provide common numerical measure of affectiveness that can be directly compared with the conventional numerical indices. As shown in the example above, it is not easy to convert affectiveness into money amount. If there were already precedent products of

competitors in the market, such as the case of luxury automobiles, it may be possible to estimate the money amount of affective quality value of your product that is planned to get into the market from now on. However, the more innovative the new product is, the harder it is to estimate its affective value in advance. In order to promote the concept of affective management, it is urgently needed to research and develop these quantitative measurements of affectiveness.

It is not limited to affects of customers that management board has to deliberate. For all stakeholders including shareholders, employers, business partners, and society, managements need to consider on what affective experience their managerial decisions may give those people, what affective experience they should provide, and what priority they should give to these issues comparing with other criteria. This is not a very new idea. A number of excellent managements in our country have known, based on their sensibility and experiences, what affective effect of their decisions and behaviors might have on whom, and whether they should dare to do them or not. However, in many times this skill existed as implicit knowledge of excellent managements, and never be one everyone can own. Affective management is one of the important values that have firmly existed among Japanese managements, which have not been explicitly claimed and thus might have remained in the shadows of "rational" decision making.

5.2 Affective Organization

Affective management is not the issue only for the top managements. In order to practice the organization's philosophy, principles, and strategies effectively, they should be shared among all members of the organization, including middle managements and employees in the fields. If the top managements emphasize affectiveness in their operations, this value system should be shared throughout the organization.

In affective management, as discussed above, potential affective responses on all stakeholders should be taken into considerations. Among them, the people who are considered to be more important comparable to customers are employees. Most of the managerial issues inside organizations have been discussed focusing on productivity and efficiency. On the other hand, issues such as climate of workplaces have generally got little attention in such a way that it is always better to maintain a good climate in workplace, though it was actually given lower priority than productivity.

Recent researches, however, have shown a number of new evidences suggesting that affective factors in workplaces have influence on productivity and creativity (e.g. [21], [22]). In the near future when this fact is widely recognized, whether workers in the workplace can have positive affect may be another important criteria to evaluate workplaces in addition to quantitative efficiency and productivity. Then managers would be required to maintain good affective climate in their workplace as one of their management skills.

It is the emotional labor discussed in section 3 that managers have to pay particular attention to positive affects of employees. The emotional labor often demands heavily on workers' mental health, and occasionally they may suffer from serious mental illness. In addition to mental cares such as coping, managerial supports in the workplace is said to be particular important in order to take care of these issues.

6. Conclusion: Towards Affective Society

In the new era when the concept of affectiveness have penetrated among managements as discussed in section 5, affectiveness will also be called into question as a qualification of a manager as a person; ability to deliberate possible emotional responses in other's mind. It would also be true for individual in general. Affectiveness may also be one of the evaluation criteria at recruiting or personnel evaluations. In that era, it will be quite usual for people to think about their own affectiveness. That means, the idea of "to think about other's affect" or "to behave with deliberating possible impacts on other's emotion" are widely accepted as an important value system in the society. Such a society should be called as an *affective society*. Again, this idea is not really new. This can be a reflection on an old issue that Goleman [16] warned more than a decade ago, but has been buried in the shadows of the trends of market fundamentalism and cost-reductionism and has not well reflected by people.

In an affective society, people will be required to grow out of the over-simplified codes of conduct such as they can do anything as long as it is not regulated by law or berated by others, or they should pay efforts for visible results objectively evaluated but not for elusive matters such as human minds. However, it goes without saying that such affective society is the society that is gentle to people, with much less stress, and comfortable and peaceful place to live.

References

[1] D. A. Norman, *Psychology of Everyday Things*, Basic Books, New York, (1988).

[2] J. Nielsen, *Usability Engineering*, San Diego, Moragan Kaufamann, CA, (1993).

[3] P. W. Jordan, *Designing Pleasurable Products: An Introduction to the New Human Factors*. London, Taylor and Francis, UK, (2000).

[4] J. M. Carroll, "Beyond fun," *Interactions 11*, no. 5 (2004) 38-40.

[5] D. A. Norman, *Emotional Design: Why We Love (Or Hate) Everyday Things*. Basic Books, New York, (2004).

[6] M. Csikszentmihalyi, *Flow: The Psychology of Optimal Experience,* Harper & Row, New York, (1990).

[7] J. Fulton, "Physiology and Design," *American Center for Design Journal 7*, no. 1 (1993) 7-15.

[8] P. A. Hancock, A. A. Pepe and L. L. Murphy, "Hedonomics: The power of positive and pleasurable ergonomics," *Ergonomics in Design 13*, no. 1 (2005) 8-14.

[9] A. H. Maslow, *Motivation and Personality* (2nd ed.), Viking, New York, (1970).

[10] M. A. Blythe, K. Overbeeke, A. F. Monk, and P. C. Wright (eds.), *Funology: From Usability to Enjoyment*. Dordrecht, Kluwer, the Netherlands, (2004).

[11] M. Kurosu and K. Kashimura, "Apparent usability vs. inherent usability: Experimental analysis on the determinants of the apparent usability," in *Conference Companion on Human Factors in Computing Systems*, Denver, CO, (1995) 292-293.

[12] N. Tractinsky, A. S. Katz, and D. Ikar, "What is beautiful is usable," *Interacting with Computers13*, no. 2 (2000) 127-145.

[13] R. Solves Pujol, "Personal factors influencing people's ICT interaction: A study of engagement, quality of experience, creativity and emotion,"

Unpublished master thesis. Department of Industrial Engineering and Management, Tokyo Institute of Technology, Tokyo, Japan, (2007).
[14] A. Dunne, *Hertzian Tales*. Cambridge, MIT Press, Cambridge,MA, (2005).
[15] P. A. Fishwick (eds.), *Aesthetic Computing*. MIT Press, Cambridge, MA, (2006).
[16] D. Goleman, *Emotional Intelligence: Why It Can Matter More Than IQ*, Bantam Dell, New York, NY, (1995).
[17] K. Fujita (ed.), *Affective Science*. Kyoto University Press, Kyoto, Japan, (2007).
[18] P. W. Picard, *Affective Computing*. Cambridge, MIT Press, Cambridge, MA, (1997).
[19] P. Zhang, and N. Li, "The importance of affective quality," *Communications of the ACM 48*, no. 9 (2005) 105-108.
[20] A. R. Hochschild, *The Managed Heart: Commercialization of Human Feeling*. Berkeley, University of California Press, CA, (1983).
[21] M. J. Grawitch, and D. C. Munz, "Individual and group affect in problem-solving workgroups", in C. E. J. Hartel, W. J. Zerbe, and N. M. Ashkanasy (eds.), *Emotions in Organizational Behavior*, Lawrence Erlbaum Associates, Mahwah, NJ, (2005)119-142.
[22] S. Meisiek, and X. Yao, "Nonsense makes sense: Humor in social sharing". in C. E. J. Hartel, W. J. Zerbe, and N. M. Ashkanasy (eds.), *Emotions in Organizational Behavior*, Lawrence Erlbaum Associates, Mahwah, NJ, (2005) 143-165.

Impacts by the Changes in Governance Structure of Japanese Corporations

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***Abstract*— The abnormal returns related to ownership structure are found during the 2000s (especially from year 2000 to 2006) in the Japanese equity market. Our study documents that firms in which there are more effective ownership structures, characterized by a market-oriented corporate governance, gain more return after controlling Fama-French 3 factor and momentum factor. The study also describes how the change of investors' expectation of improved corporate governance is one of the reasons for the abnormal return observed during this period.**

***Index Terms*—abnormal return, agency cost, corporate governance, ownership structure**

1 INTRODUCTION

As a result of the collapse of the Bubble Economy and the subsequent financial crisis, the governance structure of Japanese corporations is changing dramatically from a traditional style to a market-oriented style. These two styles have different characteristics. The traditional styles of the Japanese corporate governance mainly features main bank system, cross-shareholding, boards dominated by insiders, and lifetime employment. On the other hand, the market-oriented corporate governance styles is characterized by increase of institutional ownership, market-oriented financing, and introduction of outside directors.

In this study, we analyze whether the corporate governance structure, especially ownership structure, influences abnormal stock return. When investors prefer the market-oriented governance structure to the traditional one, they can expect in their firms a decrease in the agency cost of takeover threats and consequently a relative increase in equity value and the creation of abnormal returns.

2 RESEACH DESIGN

2.1 Hypothesis

Gompers, Ishii and Metrick[11] build a Governance Index for about 1,500 firms and then study the relation between this index and several forward-looking performance measures during the 1990s.They find a striking relationship between corporate governance and stock returns.

Additionally, Cremers and Nair[9] investigate the interaction between the market for corporate control and shareholder activism. In their study, they find that a portfolio that buys firms with the highest level of takeover vulnerability and sells firms with the lowest level of takeover vulnerability generates an abnormal return of 10% to 15% only when public pension fund (blockholder) ownership is high as well.

In the Japanese equity market, ownership by foreign and institutional investors during the first years of 2000s increased, while the number of stable and cross-shareholding arrangements declined. Activists came to the forefront and several firms are targeted for hostile takeover. As the threats of (hostile) takeover rise, investors now expect a difference in agency costs between firms with traditional governance structure and firms with a more market-oriented governance structure.

We focus on ownership structure and investigate whether firms with different ownership structures generate different abnormal returns. Our specific hypothesis is: firms with more foreign and institutional investors have larger abnormal returns than firms with more stable and cross-shareholding arrangements.

2.2 Sample

Our sample consists of firms (excluding financial institutions) listed in the first section of Tokyo Stock Exchange. The financial and performance data is obtained from Nikkei Corporate Financial Database and the stock prices from AMSUS Database.

We divide firms into two groups: those which in their last accounting period had a market-oriented governance structure and those without it. Foreign ownership is adopted as a proxy of market-oriented ownership structure and corporation ownership as a proxy of stable corporate governance ownership. In addition, we discriminate an "institutional portfolio"

(firms in the highest quintile of foreign ownership and in the lowest quintile of corporate ownership) and a "stable portfolio" (firms in the lowest quintile of foreign ownership and in the highest quintile corporate ownership). Table 1 shows the classification of the sample. Each value in this table represents an average number of observations from year 2000 to 2006.

Table 1 sample classification

		corporate				
		large			small	total
foreign investor	large	31	51	79	149	310
		63	81	87	78	309
		89	85	81	52	307
	small	115	93	66	30	304
	total	298	310	313	309	1230

2.3 abnormal return

We investigate whether the firms with different abnormal ownership structure have different abnormal returns. In order to make sure that differences in risk or investment style do not drive our results, we calculate abnormal returns using the Four Factor Model (see Fama and French[10], Jegadeesh and Titman[13] and Carhart[8]).

In the model below, the estimated abnormal return is represented by the constant "a",

$$R_t = a + b_1 \times MKT_t + b_2 \times SMB_t + b_3 \times HML_t + b_4 \times UMD_t + e_t, \quad (1)$$

where R_t is the excess return over the riskless rate to some portfolio in month t, and MKT_t, SMB_t, HML_t and UMD_t are the returns on the market portfolio and the three portfolios that capture the size, book-to-market, and momentum effects. These variables are estimated according to standard procedure of four factor model.

2.4 empirical models

Then we examine the relation between the estimated abnormal returns and the ownership structures using multivariate regression analysis. In the regression model, we use the abnormal return estimated by the Four Factor Model as the dependent variable, and foreign ownership and corporate ownership as explanatory variables. The control variables are the equity ratio (=equity/total asset) and the return on equity (ROE) adjusted by industry.

Table 2 Summary statistics

	abnormal return	corporate ownership	foreign ownership	ROE	equity ratio
mean	2.95	25.26	8.12	-2.23	0.38
median	1.36	20.97	4.19	0.00	0.37
max	383.76	100.00	90.03	18671.24	0.99
min	-367.41	0.00	0.00	-1859.61	-7.34
std. dev.	46.69	16.96	9.98	205.82	0.25
skewness	0.30	0.88	2.34	87.76	-3.36
kurtosis	6.19	3.17	10.88	7974.85	103.06
observations	7610	8198	8198	8500	8913

3 UNIVARIATE ANALYSIS

Based on this model we proceed to explore the behavior of abnormal returns in both the institutional portfolio and the stable portfolio (which, as described above, are constructed by sorting firms according to their ownership structure -foreign or corporate-).

3.1 Long-term abnormal return

In analyzing the impact of the governance structure on stock return, we also compare the means of abnormal returns of both portfolios (institutional and stable) in the periods 1993-1999 and 2000-2006. In the former period, the difference in abnormal returns is not significant (t-statistics of 0.33). In the latter period, however, the mean abnormal returns of institutional and stable portfolios are 41.03% and 2.71%, respectively; which are significantly different (t-statistics of 4.04).

Table 3 long-term abnormal returns of each portfolio

	2000-2006		1993-1999	
	abnormal return	number	abnormal return	number
institutional portfolio A	41.03 (6.23)***	120	-7.35 (0.98)	103
stable portfolio B	2.71 (0.40)	106	-3.9 (0.53)	111
A-B	38.32 (4.04)***		-3.45 (0.33)	

(note) Estimated *t*-statistics appear in parentheses
*, **, ***: significant at the 10%, 5% and 1% levels

3.2 Short-term abnormal return

To confirm the relevance and behavior of abnormal return means for institutional and stable portfolios over the period 2000-2006, we conduct a similar analysis every two years.

Table 4 short-term abnormal returns of each portfolio

	2000-2001		2001-2002		2002-2003	
	abnormal return	number	abnormal return	number	abnormal return	number
institutional portfolio A	18.88 (4.28)***	118	5.06 (1.22)	133	8.53 (2.34)**	150
stable portfolio B	2.90 (0.64)	103	-0.46 (0.12)	111	7.61 (1.85)*	115
A-B	15.98 (2.52)**		5.52 (0.98)		0.93 (0.17)	

	2003-2004		2004-2005		2005-2006	
	abnormal return	number	abnormal return	number	abnormal return	number
institutional portfolio A	0.53 (0.19)	160	-0.87 (0.29)	160	8.72 (2.54)**	172
stable portfolio B	2.83 (0.51)	111	-12.81 (2.98)***	129	-8.47 (2.21)**	123
A-B	-2.30 (0.37)		11.94 (2.29)**		17.19 (3.31)***	

(note) Estimated *p*-statistics appear in parentheses
*, **, ***: significant at the 10%, 5% and 1% levels

The results indicate a significant and positive difference between institutional and stable portfolios in three out of six periods.

4 MULTIVARIATE REGRESSION

In this section, we present the results of multivariate regression analyses that explain the relation between abnormal returns of firms and their ownership structure.

4.1 Long-term abnormal return

Table 5 presents the results of a multivariate regression analysis that considers the long-term abnormal return over 7-year period of the study. Model 1 and 2 explain the relation between the long-term abnormal returns and the proxy of market-oriented ownership (foreign ownership). Model 3 and 4 show the relation between the long-term abnormal returns and the proxy of stable ownership (corporate ownership).

The models suggest a significant and positive relation between long-term abnormal returns and foreign ownership; and a significantly negative relation between long-turn abnormal returns and corporate ownership.

Table 5 regression analysis of long-term return

	long-tern abnormal return			
	Model 1	Model 2	Model 3	Model 4
foreign investor ownership	1.08	1.08		
(FRGN)	(0.00)	(0.00)		
corporate ownership			-0.33	-0.28
(CORP)			(0.03)	(0.08)
ROE		0.03		0.08
		(0.86)		(0.67)
equity ratio		-7.78		0.23
		0.54		(0.99)
intercept	10.07	14.16	26.51	26.15
	(0.00)	0.02	(0.00)	(0.00)
adjusted R^2	0.012	0.010	0.003	0.001
Durbin-Watson stat.	1.75	1.75	1.74	1.74
F-statistic	13.72	4.48	4.48	1.17
prob(F-statistic)	0.00	0.00	0.03	0.32
number	1059	1025	1059	1025

(note) Estimated *p*-statistics appear in parentheses

4.2 Short-term abnormal return

Table 6 presents the results of the regression analysis for short-term abnormal returns. The relation between short-term abnormal returns and foreign ownership is described in Panel A of Table 6. The relation between short-term abnormal returns and corporate ownership is presented in Panel B of Table 6.

Consistent with the results of the long-term analysis, we find a significant and positive relation between short-term abnormal returns and foreign ownership (in Panel A). On the other hand, all models in Panel B confirm a significant and negative relation between the short-term abnormal returns and foreign ownership.

Table 6 regression analysis of short-term return

Panel A: foreign investor ownership

	Short-term abnormal return		
	Model 1	Model 2	Model 3
foreign investor ownership	0.23	0.23	0.25
(FRGN)	(0.00)	(0.00)	(0.00)
ROE		0.06	0.06
		(0.01)	(0.00)
equity ratio			-3.48
			(0.18)
intercept	-1.94	-1.22	0.18
	(0.16)	(0.37)	(0.92)
adjusted R^2	0.058	0.066	0.067
Durbin-Watson stat.	1.80	1.79	1.80
F-statistic	8.14	7.76	7.01
prob(F-statistic)	0.00	0.00	0.00
number	7364	7148	7148

Panel B: corporate ownership

	Short-term abnormal return		
	Model 1	Model 2	Model 3
corporate ownership	-2.33	-1.33	-0.33
(CORP)	(0.01)	(0.02)	(0.03)
ROE		0.03	1.03
		(0.86)	(0.87)
equity ratio			-7.78
			0.54
intercept	10.07	14.16	26.51
	(0.00)	0.02	(0.00)
adjusted R^2	0.049	0.057	0.057
Durbin-Watson stat.	1.80	1.79	1.80
F-statistic	7.10	8.89	6.09
prob(F-statistic)	0.00	0.00	0.00
number	7364	7148	7148

(note) Estimated *p*-statistics appear in parentheses

5. CONCLUSIONS

We analyze the empirical relation between ownership structure and abnormal returns of Japanese corporations during the period 2000-2006. Our findings indicate that ownership structure is strongly correlated with stock returns. In particular, there exists a positive and significant association between market-oriented ownership structures and the returns in the short and long term. In contrast, the relation between traditional ownership structures and abnormal returns is negative both in the short and long-term.

These results suggest that investment strategies that purchase firms with market-oriented governance structure or sell firms with traditional governance structure is indeed effective. Investors, therefore, attach a higher value to firms with market-oriented governance structure and expect that agency costs of those firms decrease.

REFERENCES

[1] M.Aoki, *Keizai Shisutemu no Shinka to Tagensei (The Evolution and Diversity of Economic System)*, Toyokeizai, (1995).

[2] H. Itami, *Nippongata Corporate Governance (J-type Corporate Governance)*, Nikkei Newspaper, (2000).

[3] K. Inoue, and K. Hideaki, "Activist Fund no Kozai (The good and bad aspects of Activist Funds)", *Keizai Kenkyu(Economic Research)*, 58(3) (2007).

[4] K. Iwatsubo and S. Yoshimi, "Gaikokujin Kabunushi no Kabushiki Syoyu to Kigyo Kati no Inga Kankei (The Causal Relationship between ownership by foreign Investors and Firm Value)", *Center for Economic Institutions, Working Paper Series* No.2006-13, Hitotsubashi University, (2006).

[5] H. Osano, "Corporate Governance no Keizaigaku (The Economics of Corporate Governance)", *Nikkei Newspaper*, (2001).

[6] H. Osano and K. Hori, "Nihon Kigyo no Shikin Cyotatsu to Governance (Fund Raising and Corporate Governance in Japanese Firms)", in H. Ito (ed.), *Nihon Kigyo Henkakuki no Sentaku (The Options Japanese Firms have in their shakeup Period)*, Toyokeizai, Chapter 5, (2002) 141-169.

[7] H. Kawakita, and R. Miyano, "Murakami Fund no Toshi Kodo to Yakuwari (The Investment Behavior and roles of Murakami Fund)", *NLI research report* 45, (2007).

[8] M. M. Carhart, "On persistence in mutual fund performance," *The Journal of Finance* 52, (1997) 57-82.

[9] K.J.M Cremers and V.B.Nair, "Governance Mechanisms and Equity Prices," *The Journal of Finance* LX(6), (2005) 2859-2894.

[10] E. Fama and K.R.French, "Industry costs of equity," *Journal of Financial Economics* 43, (1997) 153-193.

[11] P. Gompers, J. Ishii and A. Metrick, "Corporate Governance and Equity Prices," *The Quarterly Journal of Economics, Feb.*, (2003) 107-155.

[12] M. R. Hunson, R. Parrino and L. T. Starks, "Internal Monitoring Mechanisms and CEO Turnover; A Long Term Perspective," *The Journal of Finance* 56, (2001) 2265-2297.

[13] N. Jegadeesh and S. Titman, "Returns to buying winners and selling losers; Implications for stock market efficiency," *The Journal of Finance* 48, (1993) 65-91.

[14] F. R. Lichtenberg, and G.M. Pushner, "Ownership Structure and Corporate Performance in Japan," *Japan and the World Economy* 6, (1994) 239-261.

[15] J. J. McConnell and H. Servaes, "Additional Evidence on Equity Ownership and Corporate value," *Journal of Financial Economics* 27, (1990) 595-612.

[16] S. Nickell, D. Nicolitsas and N. Dryden, "What Makes Firms Perform Well?," *European Economic Review* 41, (1997) 783-796.

Institutional Factors to Explain Earnings Management in Equity Offerings

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***Abstract*— This study examines whether and how the degree of earnings management and ownership structure affects underpricing in Japanese IPO market. A sample of 1,476 firms that went public in Japanese market between 1989 and 2005 indicates that the degree of earnings management is positively related to underpricing and low inside-ownership lessen the positive effect of earnings management on underpricing. These results suggest that aggressive earnings management increases valuation uncertainty and thus leads to steeper price discount.**

***Index Terms*—IPO, Earnings Management, Ownership structure, Underpricing.**

1 INTRODUCTION

Equity offerings (i.e., Initial public offerings; IPO and Seasoned Equity Offerings, SEO) have been often cited as typical occasions where a manager would manage earnings. Few other reliable sources of information are available at the time of IPOs, key accounting numbers such as reported earnings disclosed in prospectus are assumed to have significant impact on underwriters' pricing decisions and investors' buying decisions. Since early 1990s, a number of studies examine the hypotheses that IPO firms, on average, engage in income-increasing activities to extract the highest possible stock prices at the time of IPOs (Aharony[1], Friedlan[2], Teoh[3], Teoh[4], DuCharme[5], DuCharme[6], Ball [7]).

Likewise, Rangan[8] and Teoh[9] argue that managers have incentive to manage earnings upward prior to an SEO in order to issue new shares at higher prices. Consistent with their expectations, they find that the pre-issue income-increasing discretionary accruals are associated with poor post-issue operating and stock performance. Similarly, Yoon [10] find that Korean managers tend to manage earnings upward prior to an SEO.

In this study, pre-IPO earnings management is recognized as one of potential explanations for underpricing. While the impact of earnings management on long-run IPO price performance has been studied(e.g.Teoh[4], DuCharme[5]), no research has investigated the relation between earnings management and underpricing directly. This study is the first to highlight the pre-IPO earnings management as a factor for underpricing.

A number of theories have been suggested for IPO underpricing and one of the dominant the oriesis based on the asymmetry of information between issuers of IPOs and outside investors (Rock[11], Ibbotson[12], Loughran[13], Ritter[12]). The empirical evidence supports the view that underpricing should increase in the ex-ante uncertainty about the value of the IPO firm (Ljungqvist[14]).

When issuer of IPO firm manipulates accounting variables, these variables are less likely to present their "true" financial performance and this leads to enlarge the information asymmetry between insiders and outsiders of IPO firm. Consequently valuation uncertainty in IPO firm would increase. Besides, IPO firms are exposed to higher monitoring by auditors, boards, analysts, rating agencies, press, and litigants, and to greater regulatory scrutiny (Ball[7]).Even though outsiders cannot detect and adjust for the degree of earnings management perfectly, they probably recognize the suspicion of earnings management as a factor increasing valuation uncertainty. The primary objective of this study is to examine whether or not pre-IPO earnings management causes more underpricing.

2 HYPOTHESIS

Theories and empirical studies on IPO underpricing show that underpricing increases in the ex-ante uncertainty about the value of the IPO firm (Ljungqvist[15]). When issuer of IPO firm manage earnings, reported earnings are less likely to present 'actual' financial performance and thus valuation uncertainty increases. In particular, the probability of overpricing becomes higher for firms that overstate earnings with discretionary earnings management.

Underwriters, who play a key role in setting an offer price, have ability and an incentive to detect earnings management, examining the financial statements carefully and underprice the issue when they detect the evidence of earnings manipulation, contrary to DuCharme[5], which demonstrate that inflated earnings with discretionary earnings management raises the level of IPO offer price. As Kim[16] suggests, underwriters are supposed to be able to do superior fundamental analysis and Nagata[17] shows that IPO firms are not mechanically valued on reported accounting variables. These evidences suggest that underwriters have an ability to detect and adjust for earnings management when they price IPO.

Table I
SAMPLE DISTRIBUTION ACROSS INDUSTRY AND STOCK EXCHANGE

Industry	Stock Exchange TSE	JASDAQ	Total
Gas	3	1	4
Rubber	0	5	5
Service	45	343	388
Othe financial business	9	30	39
Other manufacture	8	49	57
Transportation equipment	0	3	3
Pulp and paper	1	6	7
Pharmaceutical	3	8	11
Chemicals	10	44	54
Shipping	1	2	3
Machinery	4	62	66
Construction	15	56	71
Automobile	4	22	26
Wholesale	20	195	215
Retail	10	153	163
Food	10	37	47
Fishery	0	4	4
Precision equipment	1	20	21
Oil	2	1	3
Textiles	2	7	9
Warehousing and wharfing	3	5	8
IT	12	11	23
Iron and steel	0	6	6
Railroad	3	0	3
Electric machinery	12	85	97
Electricity	1	0	1
Nonferrous metal	11	29	40
Real estate	12	51	63
Glass and ceramics	2	18	20
Land transportation	5	14	19
Total	209	1267	1476

Also, as Beatty [18] argue, a good reputation enables underwrites to earn a return in the future for they repeat business with potential purchasers of other new issues in the future. Underwrites' reputations may be damaged substantially if they over-price the issues and the issue concludes with unsold shares or they eventually disappoint investors by underpricing too little. Also, underwriters can build a reputation by providing accurate information that reflects the IPO firms' prospects to investors. Therefore, underwriters not only have ability but also have an incentive to adjust for the effect of earnings management by examining the financial statements carefully and underprice the issues when they detect the evidence of earnings manipulation. Thus, it is more likely that IPO firms suspected for managing earnings aggressively tend to be underpriced more than others.

3 VRIABLES

3.1 Earnings Management

We estimate performance matched abnormal accruals for measuring the extent of earnings management, largely based on Kothari[19].The performance matched abnormal accruals model requires two steps consists of estimating discretionary accruals, based on traditional Jones model or modified Jones model and subtracting performance matched discretionary accruals from that of each firm. We add several modifications to this model.

In the usual process of the Jones model (modified Jones), to separate the normal part of accruals, benchmark accruals are estimated using time series data for the most recent periods or cross-sectional data for comparable firms that do not experience the event of interest in the same period. These approaches provide a measure of discretionary accruals relative to the normal accrual levels without any specific event (i.e., IPOs in this case). However, sufficient data to utilize the time series model are not available before going public. Besides, this study primarily focuses not on whether or not IPO firms on average manage earnings, but on the effect of cross-sectional variation in the degree of earnings management among IPO firms.

Therefore, we use all the sample firms to estimate benchmark accruals, which provide a measure of an "average" IPO firm's tendency for earnings management behavior. In other words, the expected abnormal accruals for an average IPO firm is zero and firms that are identified as having managed earnings aggressively are, in fact, managing earnings more than the average IPO firm does. Likewise, firms identified as managing earnings conservatively are, in fact, managing earnings less than the average IPO firm does.

We estimate parameters of Jones model, dividing samples into three subgroups according to their industries (manufacture, wholesale and retail, and service) and estimating parameters for each subgroup respectively. To control performance, we subtract median of industry and performance matched discretionary accruals from each firm's discretionary accruals in the same performance quintile in each industry subgroup. We use return on assets as performance measure following Kothari [19]. Abnormally high (low) levels of abnormal accruals in this study represent the aggressiveness (conservativeness) relative to the expected level of discretionary accruals, given their levels of performance and their IPO firms' characteristics.

3.2 Underpricing

Underpricing is gauged as the percentage difference between offer price and first day closing market price (IR). To control for the market condition at the time of firms going public, market-adjusted underpricing (MAIR) is also used. MAIR is the residual of IR after subtracting market index performance incorresponding period.

4 SAMPLE

An initial sample is collected manually from JASDAQ Market Annual Statistics, Equity Issue White paper provided by Shoji-homu, IPO Whitepaper provided by Research Group for Disclosure and consists of firms that went public in JASDAQ and Tokyo Stock Exchange (TSE) between 1989 and 2005.

Table II
UNDERPRICING BY YEAR AND INDUSTRY

Panel A.

	Underpricing		Market adjusted underpricing		
Year	Mean	Median	Mean	Median	*n*
1989	0.263	0.05	0.07	0.033	49
1990	0.369	0.08	0.206	0.128	76
1991	0.338	0.103	0.28	0.106	91
1992	0.25	0.093	0.058	0.128	15
1993	0.261	0.09	0.127	0.078	60
1994	0.166	0.078	0.112	0.076	109
1995	0.221	0.082	0.135	0.089	149
1996	0.264	0.139	0.152	0.105	115
1997	0.113	0.039	0.056	0.054	104
1998	0.412	0.184	0.224	0.111	73
1999	1.225	0.754	1.113	0.665	74
2000	0.399	0.104	0.202	0.085	121
2001	0.436	0.307	0.312	0.186	110
2002	0.513	0.16	0.304	0.101	87
2003	0.544	0.31	0.345	0.16	76
2004	1.078	1.017	0.84	0.481	90
2005	1.108	1	0.943	0.741	77
Total	0.454	0.15	0.316	0.112	1476

Panel B.

	Underpricing		Market adjusted Underpricing		
Industry	Mean	Median	Mean	Median	*n*
Gas	1.036	1.197	0.287	0.353	4
Rubber	0.356	0.097	0.36	0.107	5
Service	0.536	0.183	0.427	0.143	388
Other financial business	0.337	0.1	0.109	0.074	39
Other manufacture	0.401	0.071	0.265	0.061	57
Transportation equipment	0.178	0.2	0.183	0.203	3
Pulp and paper	0.533	0.31	0.395	0.171	7
Pharmaceutical	0.59	0.355	0.322	0.151	11
Chemicals	0.502	0.187	0.312	0.115	54
Shipping	0.329	0.023	0.004	0.006	3
Machinery	0.328	0.171	0.268	0.175	66
Construction	0.364	0.13	0.141	0.097	71
Automobile	0.323	0.089	0.188	0.115	26
Wholesale	0.391	0.122	0.305	0.113	215
Retail	0.328	0.099	0.271	0.101	163
Food	0.367	0.127	0.148	0.101	47
Fishery	0.391	0.178	0.393	0.181	4
Precision equipment	0.361	0.156	0.311	0.161	21
Oil	0.789	1.011	0.142	0.148	3
Textiles	0.348	0.109	0.123	0.028	9
Warehousing and wharfing	0.602	0.349	0.228	0.188	8
IT	1.257	0.967	0.736	0.16	23
Iron and steel	0.126	0.084	0.173	0.151	6
Railroad	1.218	1.067	0.23	0.079	3
Electric machinery	0.472	0.176	0.358	0.151	97
Electricity	1.035	1.035	-0.02	-0.02	1
Nonferrous metal	0.385	0.114	0.115	0.088	40
Real estate	0.648	0.353	0.455	0.129	63
Glass and ceramics	0.309	0.09	0.216	0.079	20
Land transportation	0.438	0.082	0.192	0.09	19
Total	0.454	0.15	0.316	0.112	1476

The firms whose financial data in the period two years before going public are not available on the Nikkei NEEDS database are excluded. Also, banks, securities firms, and insurance firms are excluded. The selection process yields 1476 firm observations (209 from TSE, 1267 from JASDAQ (Table I).

5 DESCRIPTIVE STATISTICS

Table II presents the magnitude of underpricing by year (Panel A) and industry (Panel B). Panel A reports both raw underpricing and market-adjusted underpricing. Underpricing is the percentage difference between offer price and first day market price (first day return) and market-adjusted underpricing is the residual of first day return after subtracting market index performance of corresponding period.

The median market-adjusted underpricing during the study period is 0.112 with the mean value of 0.316, which indicates a left-skewed distribution of underpricing. The largest median underpricing is recorded in 1999 with 0.665, followed by 0.741 in 2005 and 0.481 in 2004 and the smallest one (0.036) is shown in 1989.These statistics reflects market condition varies year to year and unusually hot market conditions in 1999, 2004 and 2005 are observed. The gas industry shows the largest median value of underpricing of 0.353, followed by the transportation equipment industry of 0.203, although there are less than five firms in each industry. IT industry shows the moderate level of median underpricing of 0.09, but unusually high mean underpricing of 0.736.

Also other summary statistics of ownership and age of firm (not presented) shows that the director ownership(mean 0.259, median 0.235), business corporation ownership(mean 0.334, median 0.265) and the total of these “inside ownership”(mean 0.515, median0.591) are much larger than those of outside shareholders, such as financial institutions (mean 0.067,median 0.055) and venture capital (mean 0.059,median0.025). Mean and median age of firms which represents number of months until the date of going public are 334.829 and 311, respectively. This means Japanese IPOs, on average, have over 30 years history, and 75 percent of sample firms have over sixteen years history, although some firms have less than one year history of operation.

6 EMPIRICAL RESULTS

6.1 Univariate Analysis

Table III presents the distribution of underpricing and market-adjusted underpricing across abnormal accruals (AAC) quintile portfolios. If aggressive earnings management increase valuation uncertainty, high AAC portfolio should have larger underpricing than others. The mean and median underpricing and market adjusted underpricing of high AAC portfolio are the largest in AAC quintiles. However, the mean and median difference between low AAC portfolio and high AAC portfolio are not statistically significant. But the mean and median differenceS between high AAC portfolio and mid AAC portfolio are statistically significant at 1%. These results suggest that aggressive earnings management tend to enlarge underpricing.

Table III
UNDERPRICING BY YEAR AND INDUSTRY

	AAC quintile						difference test		
	Low	2	Mid	4	High	Total	High-3	*t value*[a]	
MAIR (mean)	0.379	0.258	0.193	0.306	0.446	0.316	0.253	4.399	***
MAIR (median)	0.127	0.114	0.086	0.109	0.149	0.112	0.063	-4.003	***
IR (mean)	0.513	0.376	0.379	0.451	0.549	0.454	0.170	2.710	***
IR (median)	0.161	0.136	0.126	0.131	0.183	0.150		-2.004	***
n	296	295	296	294	295	1476			

[a]*Z-value* for median difference (non parametric) test.

6.2 Multivariate Analysis

In this subsection, we show the results of multivariate regression analyses to investigate whether and how the degree of earnings management affects underpricing after controlling for other confounding factors. In all models, Market-adjusted first day return (MAIR) which captures the size of underpricing is used as dependent variable. MAIR is the residual of first day return after subtracting market index performance in the same period. The key variable of interest is *AAC*, the abnormal accruals in pre-IPO period, which is a proxy for the degree of earnings management.

YEAR is an indicator variable that takes one if the firm went public in 1999, 2004 or 2005 and zero otherwise. *YEAR* is included to control for the unusually hot market condition, as shown in the descriptive statistics section, abnormally high first-day returns are observed in 1999, 2004 and 2005. *PROC* is the natural logarithm of proceeds.

AGE is the natural logarithm of the age of the firm at the time of IPO as measured by the number of months. It is well known that the operating performance of an early stage company tends to be volatile and often less profitable than that of a well established company. Therefore, *AGE* is expected to have positive coefficient.

SIZE is the natural logarithm of sales in pre-IPO period. *Size* is expected to have negative coefficient. *GRW* is sales growth rate in the period prior to going public and is included as a proxy for the growth potential. Firms raise equity in two stages, via IPO and later date. High-quality firms have incentive to signal their quality by underpricing, in order to raise capital on more advantageous terms in the future (Loughran[13], Ljungqvist[15]). We predict the sign of coefficient on *GRW* to be positive.

IND is an indicator variable, which takes one, if a firm is in IT industry. We include this variable because IT companies have abnormally high mean first-day return as shown in the descriptive section. *VC* is an indicator variable, which takes one, if a firm has venture capital ownership. VC is expected to have negative coefficient.

Table IV
EARNINGS MANAGEMENT AND UNDERPRICING

Variables	Coefficient	*t-value*		Coefficient	***t-value***	
Intercept	1.693	7.560	***	2.402	5.657	***
YEAR	0.790	19.267	***	0.734	11.362	***
Proceeds	-0.006	-0.382		-0.010	-0.342	
SIZE	-0.070	-4.074	***	-0.122	-3.674	***
AGE	-0.133	-5.335	***	-0.173	-3.837	***
IND	0.348	2.667	***	0.368	1.681	*
GRW	-0.010	-2.487	***	-0.014	-2.344	**
AAC	0.255	2.823	***	0.285	2.065	**
VC				0.132	1.869	*
Adjusted R^2	0.264			0.218		
N	1405			1405		

The notation ***,**and * denotes statistical significance at the 1%, 5% and 10% level respectively.

The variables of our primary interest is *AAC*; abnormal accruals. If aggressive earnings management increases valuation uncertainty about IPO firm and IPO firm receives intense monitoring when going public, aggressive earnings management could lead to more underpricing.

Consistent with our hypothesis, the coefficients on *AAC* are positive and statistically significant at 1%(the coefficient is statistically significant at and 5% when VC is included in the base model). This implies that aggressive earnings management leads to enlarge underpricing.

Additionally, three variables are included in the regression model above to examine whether inside ownership has any impact on the relation between earnings management and underpricing. Newly included variables are *LowDrec*AAC*, *Low BC*AAC* and *LowInsid*AAC*. *LowDirec*isan indicator variable that takes the value of 1 if a firm is classified into a lowest director ownership quintile, and zero in othercases. Likewise, *Low BC* and *LowInsid* are indicator variables that take the value of 1 if a firm is classified into a lowest business corporation quintile or lowest inside ownership (both director and business corporation ownership) respectively. Therefore, *LowDrec*AAC*, *Low BC*AAC* and *LowInsid*AAC* capture the interaction of low inside ownership and earnings management.

TableV
EARNINGS MANAGEMENT, INSIDE OWNERSHIP AND UNDERPRICING

Variables	Coefficient	*t-value*	Coefficient	*t-value*	Coefficient	*t-value*
Intercept	1.478	5.843***	1.853	7.677***	1.708	7.626 ***
YEAR	0.914	18.208***	0.81	18.965***	0.792	19.324***
Proceeds	0.002	0.16	-0.015	-0.949	-0.006	-0.423
SIZE	-0.066	-3.723***	-0.072	-3.900***	-0.07	-4.079***
AGE	-0.121	-4.392***	-0.133	-5.141***	-0.133	-5.357***
IND	0.363	2.719***	0.64	3.954***	0.358	2.749***
GRW	-0.009	-2.155**	-0.011	-2.724***	-0.011	-2.603***
AAC	0.379	2.122**	0.421	3.953***	0.335	3.153 ***
*Low Direc*AAC*	-0.315	-1.192				
*Low BC*AAC*			-0.595	-2.797***		
*Low Insid*AAC*					-0.287	-1.417
Adjusted R^2	0.269		0.282		0.265	
N	1,405		1,405		1,405	

The notation ***,**and * denotes statistical significance at the 1%, 5% and 10% level respectively.

The results are presented in Table V.All the coefficients on *LowDrec*AAC*, *LowBC*AAC* and *LowInsid*AAC*arenegative, although coefficients on *LowDrec*AAC* and *LowInsid*AAC*are

not statistically significant, while all the coefficients on*AAC* are positive and statistically significant at 1%. These results suggest that basically the more aggressively earnings is managed, the more the issue is underpriced but the impact of earnings management on underpricing lessened when inside ownership is relatively small.

7 SUMMRY AND CONCLUSION

This study examines the relation between the degree of earnings management in pre-IPO period and the magnitude of underpricing. Based on theories and empirical findings in IPO underpricing literatures that underpricing increases in valuation uncertainty in IPO firm, this study hypothesize that firms with aggressive earnings management would be underpriced more than others, since the more earnings is managed, the less likely the reported earnings presents its 'true' financial performance.

In a sample of 1476 firms that went public in JASDAQ and Tokyo Stock Exchange between 1989 and 2005, the results support the view that aggressive earnings management increases ex ante valuation uncertainty of IPO firm, and consequently leads to more underpricing. In conjunction with the findings of the U.S. market which show that aggressive earnings management leads to increase IPO offer price, the results of this study suggest that institutional factor may affect the pricing activity in equity offerings.

REFERENCES

[1] J. Aharony, C. Lin and M. P. Loeb, "Initial Public Offerings, Accounting Choices, and Earnings Management," *Contemporary Accounting Research* 10, No.1 (1993) 61-81.

[2] J. M. Friedlan, "Accounting Choices of Issuers of Initial Public Offerings," *Contemporary Accounting Research* 11, No.1-I (1994) 1-31.

[3] S. H. Teoh, T. J. Wong and G. R. Rao, "Are Accruals during Initial Public Offerings Opportunistic?" *Review of Accounting Studies*3, No.1-2 (1998)175-208.

[4] S. H. Teoh, I. Welch and T. J. Wong, "Earnings Management and the Long-Run Market Performance of Initial Public Offerings," *Journal of Finance* 53, No.6 (1998) 1935-1974.

[5] L.L DuCharme, P. H. Malatesta and S. E. Sefcik, "Earnings Management: IPOValuation and Subsequent Performance," *Journal of Accounting, Auditing & Finance* 16, No.4 (2001) 369-396.

[6] L. L. DuCharme, P. H. Malatesta and S. E. Sefcik, "Earnings Management, Stock Issues, and Shareholder Lawsuits," *Journal of Financial Economics* 71, No.1 (2004) 27-49.

[7] R. Ball, and L. Shivakumar, "Earnings Quality at Initial Public Offerings," *Journal of Accounting and Economics* 45, No.2-3, (2008) 324-349.

[8] S. Rangan, "Earnings Management and the Performance of Seasoned Equity Offerings," *Journal of Financial Economics* 50, (1998) 101-122.

[9] S. Teoh, I. Welch, and T. Wong, "Earnings Management and the Underperformance of Seasoned Equity Offerings," *Journal of Financial Economics* 50, (1998) 63-99.

[10] S. Yoon, and G. Miller, "Earnings Management of Seasoned Equity Offering Firms in Korea," *International Journal of Accounting* 37, 2002) 57-78.

[11] K. Rock, "Why New Issues Are Underpriced," *Journal of Financial Economics* 15, No.1-2 (1986)187-212.

[12] R. G. Ibbotson, J. L. Sindelar and J. Ritter, "The Market's Problems with the Pricing of Initial public offerings," Journal of Applied Corporate Finance 7, (1994) 66-74.

[13] T. Loughran, and J. R. Ritter, "Why don't firms get upset about leaving money on the table in IPOs?" *Review of Financial Studies* 15, (2002) 413-444.

[14] J. Ritter and I. Welch, "A Review of IPO Activity, Pricing, and Allocations," *The Journal of Finance* 57, No.4 (2002) 1795-1828.

[15] A. Ljungqvist, *IPO Underpricing*, in E. Eckbo (eds.), Handbook of Corporate Finance: Empirical Corporate Finance, Elsevier, North-Holland, (2005) 376-422.

[16] M. Kim and J. R. Ritter, "Valuing IPOs," *Journal of Financial Economics* 53, (1999) 409-437,

[17] K. Nagata, and T. Hachiya, "Earnings Management and the Pricing of Initial Public Offerings," *Review of Pacific Basin Financial Markets and Policies* 10, No.4 (2007) 541-559.

[18] R. P. Beatty and J. R. Ritter, "Investment banking, reputation, and the Underpricing of initial public offerings," *Journal of Financial Economics*15, No.1-2,(1986) 213-232.

[19] S. P. Kothari, A. J. Leone, and C. E. Wasley, "Performance matched discretionary accrual measures," *Journal of Accounting and Economics* 39, No.1 (2005) 163-197.

Transfer of Business know-how of Retailers over National Boundaries into Different Institutions

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***Abstract*— The purpose of this paper is to investigate the characteristics of retail internationalization in Taiwan through both the macro-aspect and the micro- aspect of retail development in Taiwan.**

In the first part of this paper, it includes several analyses from the macro-aspect. First, I analyzed the development process of retailing in Taiwan from the 1960s to the 2000s. Furthermore, I investigated the higher rank retailers in the major retail categories in Taiwan. Through these analyses from the macro-aspect, we can say that the development and internationalization strategies of convenience store chains in Taiwan are of the highest importance for the retail internationalization in this market.

In the second part, I focus on the retail internationalization process of the top two convenience store chains in Taiwan. They are 7-ELEVEN Taiwan and Taiwan FamilyMart. I will show you how the development of the convenience store chains affects the retail internationalization in Taiwan as a conclusion.

***Index Terms*—Business know-how, convenience store, retail internationalization, knowledge transfer**

1 INTRODUCTION

The liberalization of capital investment in Taiwan in the service industries (retailing and wholesaling are included) took place in 1986. This is earlier than 1996 in Korea and 1992 in China.

Retail internationalization in Taiwan could have influenced the other Asian countries, especially the internationalization in the Chinese retail market.

It is important to know the characteristic of retail internationalization in Taiwan before analyzing the retail internationalization in Eastern Asia.

The purpose of this paper is to investigate the characteristics of retail internationalization in Taiwan through both the macro-aspect and the micro- aspect of retail development in Taiwan.

Table 1: Top 20 retailers in Taiwan （2007）

Rank	Fascias	Type	Sales (Billion NT dollars)
1	セブン－イレブン統一超商 7-ELEVEN Taiwan	CVS	1023.60
2	家楽福（カルフール）Carrefour	HM	670.00
3	新光三越百貨 Shin Kong Mitsukoshi Department Stores	DS	640.56
4	燦坤実業 TsannKuen	Electrical Appliance Chain	567.37
5	全聯福利センター QuanLian welfare center	SM	350.00
6	全家便利商店（ファミリーマート）Taiwan FamilyMart	CVS	338.52
7	太平洋崇光（そごう）百貨 Pacific Sogo Department Stores	Department Store	335.51
8	大潤發流通（オーシャン）RT-MART (Auchan)	HM	255.72
9	遠東百貨 Far Eastern Department Stores	DS	205.15
10	東森得易購 ET Mall (Dong-Sen)	Non-store retailing	184.39
11	？爾富 Hi-Life Convenience Stores	CVS	177.79
12	遠百企業（愛買吉安）Far Eastern Geant	HM	155.86
13	全国電子 E-life Mall (Quan-Guo electrical appliances)	Electrical Appliance Chain	150.67
14	富群超商（OK便利店）Circle K Convenience Stores	CVS	101.41
15	誠品 Eslitebooks	Specialty Stores	98.31
16	特力翠豊 B&Q	Home Improvement Center	97.71
17	漢神名店百貨 Hanshin Department Stores	DS	95.53
18	三商行 Mercuries Department Stores	DS	87.58
19	三僑実業（微風広場）Breeze	DS	80.00
20	中友百貨 Chungyo Department Stores	DS	72.69

2 DISTRIBUTION DEVELOPMENT AND RETAIL INTERNATIONALIZATION IN TAIWAN

2-1 The retail modernization and internationalization process in Taiwan

Before and1960s: Small traditional retailing outlets and few local department stores

1970s: The appearance of the primary supermarkets, convenience stores and hyper-markets.

1980s: Growth of local retailers and capital investment from overseas

*1980 7-ELEVEN Taiwan entered the market

↓

*1986 The liberalization of capital investment

1990s: The expansion of modern retailers- Drugstores, specialty stores and so on.

2000-present: The growth of shopping malls , oligopoly in the retail industry, and globalization of Taiwanese retailers.

<u>The influence of convenience store chains in Taiwan</u>

Since the 1990s, 7-ELEVEN Taiwan has introduced several foreign retail and service businesses into Taiwan (See detail in next part). It encouraged the internationalization in the Taiwan market.

The development and internationalization strategies of convenience store chains in Taiwan are of the highest importance for the retail internationalization in this market.

Since the years 2000, the top two Taiwanese convenience store chains entered the Chinese market. This influenced the retail structure of China.

Table 2 : Retail modernization and internationalization in Taiwan

1970s and before	Small traditional retailing outlets and few local department stores ↓
1980s	Growth of local retailers Capital investment from overseas ↓
1990s	Expansion of modern retailers ↓
2000-present	Oligopoly in the retail industry The globalization of Taiwanese retailers

2-2 Top rank retailers in the major retail categories

◆ Convenience stores

Table 3 (As of the end of 2007)

	Top Ranking Retailers	Date of First Store Opening	Ownership	Number of Stores	Sales (Billion NT dollars)	Retail rank	*
Convenience Stores	7-ELEVEN Taiwan (President Chain Store)	1979.5	Uni-President Corp. group (processed food manufacturer)(Taiwan)	4705	102.36	1	○
	Taiwan FamilyMart	1988.12	FamilyMart45%, ITOCHU Corporation4%(Japan), Taisun group17.5%, KuangChuan group10.25%, Sanyo Whisbi group10.25%(Taiwan)	1851	33.85	6	○
	Hi-Life Convenience Stores	1989.9	KuangChuan group (Milk, Drink)(Taiwan)	1143	17.78	11	-
	The total number of stores			9079	-	-	-

(* : Internationalization)

◆ Department stores

Department Stores	Shin Kong Mitsukoshi Department Stores	1991.10	Shin Kong group(Taiwan)55%、Mitsukoshi, Ltd. (Japan)45%	10	64.06	3	○
	Pacific Sogo Department Stores	1987.11	Far Eastern group ・Pacific Sogo Department Store group (Taiwan)	8	33.55	7	○
	Far Eastern Department Stores	1967.10	Far Eastern group ・Pacific Sogo Department Store group (Taiwan)	9	20.52	9	○
	The total number of stores			62	—	—	—

◆ Hypermarkets

Hypermarkets	Carrefour	1989.12	Carrefour(France)60%, Uni-President Enterprises group (Taiwan)31%(Sold 9% of theirs stock holding to the Netherlands Bank in the end of 2001)	47	67.00	2	○
	RT-MART	1996.9	Auchan(France)67%、Ruentex group (Taiwan)32%(Sold 67% of their stock holding to the Auchan group in the Feburary of 2001)	24	25.57	8	○
	Far Eastern Geant	1990.9	In July 2000, Far Eastern group (Taiwan) merged with Casino (France), but in September 2006, Casino decide to recede from the Taiwan market.	14	15.59	12	—
	The total number of stores			107	—	—	—

◆ Supermarkets

Supermarkets	Pxmart (QuanLian welfare center)	1998.10	QuanLian group(Taiwan)	394	35.00	5	—
	DingHao Welcome	1987	Predecessor was a local company, DingHao. Initiated in 1971. In 1987, it was sold to the Dairy Farm Holdings Ltd. (Hong Kong) and now it is operate by the Dairy Farm.	220	—	—	○
	Farmers' Association Supermarket	1990	Farmers' association (Taiwan)	94	—	—	—
	The total number of stores			1121	—	—	—

◆ Electrical appliance chains

Electrical Appliance Chains	TsannKuen	1990	TsannKuen Trans-Nation group (electrical appliances manufacturing) (Taiwan)	285	56.74	4	—
	E-life Mall(QuanGuo electrical appliances)	1975	QuanGuo electrical appliances, and in 2000, cooperate with ACER group (30%) (Taiwan)	264	15.07	13	—
	The total number of stores			1006	—	—	—

◆ Drugstores

Drugstores	Watsons	1987	Hutchison Whampoa Limited. (Hong Kong)	396	—	—	○
	Cosmed	1995.9	Uni-President Enterprises group(Taiwan)	258	5.17	27	○

The Characteristics of The Top Retailers:

International retailers

① Most of the top international retailers entered the Taiwan retail market by means of joint ventures with domestic enterprise groups. Examples are: FamilyMart, Carrefour, RT-MART, Shin Kong Mitsukoshi department stores and Pacific Sogo department stores.

② Most of the top international retailers joined the market before the first half of the 1990's. For instance, FamilyMart (1998); Carrefour (1989); Shin Kong Mitsukoshi (1991) and Pacific Sogo(1987); DingHao Welcome (1987); Watsons (1987).

Domestic retailers

①Most of them were developed by a major manufacturing group; Among them, some were a vertical integration or diversification by food manufacturers, others were by an electrical appliances manufacturers.

②The utilizing of know-how and capital from foreign companies to expand their business in Taiwan and in other Asian countries.

→ This example is typified by the top two convenience store chains.

3. COMPARISON OF 2 CONVENIENCE STORE CHAINS IN TAIWAN – 7-ELEVEN TAIWAN (PRESIDENT CHAIN STORE) AND TAIWAN FAMILYMART

3-1 7-Eleven Taiwan (President Chain Store)

(1) The development process of 7-Eleven Taiwan

1st stage (from 1978 to 1982) : Introduced by Uni-President Enterprises Corp. , the largest processed food manufacturer in Taiwan. A standardization strategy under the direction of U.S. 7-Eleven.

2nd stage (from 1983 to 1988) : Changed to the localization strategy regarding store location, product assortments, and target markets.

3rd stage (from 1988 to 1995) : Established their own distribution company. Imitated the management know-how from 7-Eleven, Japan

4th stage (from 1995 to 2000): Innovation by the introduction of the store information systems.

5th stage (from 2001 to recently) : Develop new type stores and started globalization.

(2) Two types of globalization by 7-Eleven Taiwan-
Introducing new business from overseas and entering foreign markets

Introducing new business from overseas

From the 1990s, 7-Eleven Taiwan started introducing foreign businesses into the Taiwanese markets as an expansion strategy (See table 4).

For instance,

1994: Cooperated with Duskin (Japanese cleaning service company)

1997: Cooperated with Starbucks (coffee chains)

2000: Cooperated with Yamato transport Co. Ltd. (Japan)

2003: Cooperated with "MUJI" (Specialty stores, Japan).

2004: Cooperated with Mister Donut (Japan)

2006: Introduced Cold stone Ice-cream chain (U.S.)

2007: Introduced Hankyu department store (Japan)

2008: Introduced Rakuten Ichiba (non-stores shops, Japan)

Table 4 The cooperation of 7-Eleven Taiwan with foreign companies (as of 2008 March)

設立時期	新しい事業	海外の提携先	7-11統一超商の持ち株率（%）	統一企業の持ち株率（%）
1990. 9.	捷盟行銷株式会社（商品配送管理）	三菱商事、菱食（日本）	25. 0	20. 0*
1994. 10.	樂清サービス株式会社（清掃サービス）	ダスキン社（日本）	51. 0	-
1997. 11.	統一星巴克株式会社（コーヒーチェーン店）	スターバックス社（アメリカ）	30. 0	-
1999. 3.	統一武蔵野株式会社（商品製造卸）	武蔵野社（日本）	40. 0	50. 0
2000. 1.	統一速達株式会社（宅配運輸）	ヤマト運輸（日本）	70. 0	20. 0
2001. 1.	統一皇帽汽車百貨株式会社（自動車用品専門店）	イエローハット社（日本）	30. 0*	-
2001. 10.	大葉高島屋百貨株式会社（百貨店）	高島屋（日本）	16. 67	-
2003. 9.	台湾無印良品株式会社（生活提案型専門店）	良品計画社（日本）	41. 0	10. 0
2004. 9.	統一多拿滋株式会社（ミスタードーナツ）	ダスキン社（日本）	50. 0	-
2006. 2	統一百華株式会社（統一阪急百貨、2007年5月～）	阪急百貨（日本）との技術提携	70. 0	30. 0
2006. 10	統一時尚事業株式会社（輸入生活雑貨）	プラザスタイル（日本）との技術提携	100. 0	-
2006. 12	統一酷聖石冰淇淋株式会社（アイスクリーム専門店）	Cold Stone社（アメリカ）	100. 0	-
2007. 1	台湾馬莎株式会社（～2008年夏まで）	MARKS & SPENCER（英国）	40. 0	-
2007. 12	統一午茶風光株式会社（Afternoon Teaの運営）	サザビーリーグ（日本）	51. 0	-
2008. 1	寵物達人株式会社（ペット関連事業）	AHBインターナショナル（日本）	70. 0	-
2008. 2	台湾楽天市場株式会社	楽天株式会社（日本）	49. 0	-

Entering foreign markets

In 2000: 7-Eleven Taiwan purchasing 50.4% of 7-Eleven Philippine's stock.

In 2005: Invested in supermarket chains in Vietnam with Mitubishi Syouzi (Japan) and a local company.

Business in China

2000: Opened the Starbucks coffee shops in Shanghai.

2004: Introduced their Taiwanese drugstores into the China market.

2005: Started several retailing and foods businesses in China (see table 5)

Table 5 The retailing and service business of Uni-President Enterprises Group in China

ブランド名	出店地域	設立時期	店舗数	資本金の出資比率
Starbucks上海星巴克	華東	2000	140	統一超商30% 統一企業20% アメリカ・Starbucks社50%
深? 康是美ドラッグストア	深? 、広州	2004	14	統一超商65% 麗珠集団35%
88優質連鎖	厦門	2004	18	—
聖娜多堡（焼きたてパンチェーン）	武漢	2005	24	統一聖娜多堡100%
山東統一銀座超市(スーパーマーケット)	山東	2005	77	統一超商55% 山東銀座商城45%
四川統一優瑪特量販店	四川	2005	4	統一超商100%
統杰超市（北京、青島）	北京	2005	7	統一超商維京（BVI－ブリティッシュ・ヴァージン・アイランド）持ち株会社48.87% Auberfgine Investments 48. 87% Limited Tushita 2. 26%
Cold Stone（アイスクリーム）	上海、北京	2007	14	統一超商100%
Afternoon Tea TEAROOM	上海	2008	1	統一超商51% SAZABY LEAGUE, Ltd.49%

Recent expansion strategies of 7-Eleven Taiwan

Expanding the same businesses into both Taiwanese and Chinese markets. For instance, introduced the ice-cream chain-"Cold Stone" into Taiwan in 2006 and the same business in China in 2007.

Cooperated with Duskin Co. (Japan) in Taiwan in 1994, and in China in 2006.

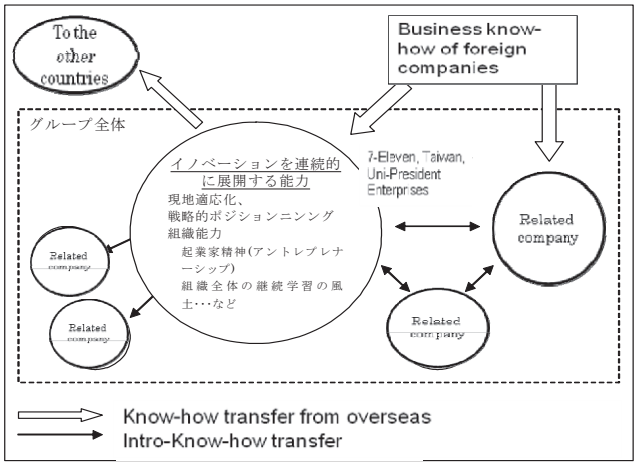
Cooperated with SAZABY LEAGUE Ltd. (Japan) and opened the first "Afternoon Tea" tearoom in both Taiwan and China in 2007.

(3) The diversification and knowledge transfer strategies of the 7-Eleven Taiwan (Uni-President Enterprises Group)

Before 1990s: to complement the main business. For instance, several logistics companies were built for the distribution of 7-Eleven chains. A transport company was introduced to expand the service for customers of 7-Eleven chains.

After the year 2000: Started to expand the whole group by introducing new business from overseas to obtain more business know-how, utilizing the human resources of the group when introducing a new business to motivate their employees.

Figure 1　The know-how transfer and innovation of the Uni-President Enterprises Group



3-2 Taiwan FamilyMart

(1) The development process of Taiwan FamilyMart

・A joint venture company of FamilyMart (Japan), ITOCHU Corp. (Japan) and Taiwan domestic food manufacturer–KuangChuan group, TaiSun group and Sanyo Whisbi group.

・Launched its first store in 1988.

・FamilyMart established its own logistic company (Taiwan Regional Distribution Center) in 1989.

Some features of Taiwan FamilyMart's Strategies:

・Started the FC franchise systems in the earlier stage.

・3 years 500 stores plans (In1997, the 500th branch opened; In 2000, opened the1000th branch ; In 2003 opened the1500th branch; In 2006 opened the 2000th branch). They purchased the 5th largest convenience stores chain in 2007.

・FamilyMart was the first chain to launch bill payment service.

・FamilyMart was the first chain to initiate formal e-commerce (in 1999).

(2) Taiwan FamilyMart's Logistic System

Figure 2

（3） Entered the Chinese market

In 2004, established Shanghai FamilyMart (A joint venture company with Japan FamilyMart, ITOCHU Corp. and Taiwanese Ding-Shing food manufacturer) and opened the first store.

In 2006, established Guangzhou FamilyMart.

In 2007, established Suzhou FamilyMart.

The role as a know-how transferrer

FamilyMart (Japan) strongly asked Taiwan FamilyMart to join with them when they examined the possibility of entering the Chinese market. The reasons are:

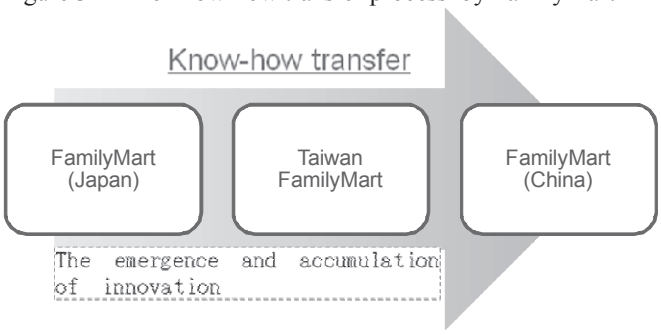
① Culture and language similarity.

② Utilizing the foundation stage's experiences of Taiwan FamilyMart's staff for the new market.

③ Transfer the innovation experience in Taiwan to China.

In 2003, the CEO of Taiwan FamilyMart was appointed as one executive of FamilyMart (Japan) to take charge of the business development in the Chinese speaking countries.

Figure 3　The know-how transfer process by FamilyMart



4. Conclusions

In the first part, I analyzed the development process of retailing in Taiwan from the 1960s to the 2000s. Furthermore, I investigated the higher rank retailers in the major retail categories in Taiwan.

In the second part, I focus on the retail internationalization process of the top two convenience store chains in Taiwan. They are 7-ELEVEN Taiwan and Taiwan FamilyMart.

The introduction of convenience store chains into Taiwan has affected the whole retail structure and retail internationalization process in Taiwan. And the internationalization strategies extending to the other Asian countries, especially China. As a result, it has affected the retail structure of the Chinese market. This kind of retail internationalization process triggered by convenience store chains is one characteristic of retail internationalization in Taiwan.

From this point, we might go on to an even more detailed examination of the development process of the other retail categories, such as department stores, supermarkets, and so on for a deeper understanding of retail internationalization in Taiwan.

REFERENCES

[1] 王樵一, *通路教父徐重仁,* 超邁文化国際出版(2007).

[2] 川端基夫, *アジア市場のコンテキスト[東アジア編]* , 新評(2006).

[3] *1992/93年版台湾地区流通市場年報,* 環球経済社(1992).

[4] 鍾　淑玲, 矢作敏行, *台湾カルフールの現地化プロセス*, in 矢作敏行(ed) 中国・アジアの小売業革新, 日本経済新聞社(2003).

[5] 鍾　淑玲, 矢作敏行, *華僑系資本の中国小売市場への参入動向*, 法政大学イノベーション・マネジメント研究センター, イノベーション・マネジメント, No.2, (2005).

[6] 鍾　淑玲, *製販統合型企業の誕生,* 白桃書房(2005).

[7] 鍾　淑玲, "Competitions and characteristics among Taiwanese higher rank retailers", *立命館ビジネスジャーナル 2* ,立命館大学経営学会(2008).

[8] 鍾　淑玲, *華人・華僑系流通資本の中国市場戦略*, in 矢作敏行・関根孝・鍾淑玲・畢滔滔(法政大学イノベーション・マネジメント研究センター編), 発展する中国の流通, 白桃書房(2009) in print.

[9] 潘進丁、王家英, *当巷口柑仔店変Wal-Mart*, 天下遠見出版(2006).

[10] セブン－イレブン統一超商, *2007年アニュアルレポート.*

[11] 統一企業, *2007年アニュアルレポート.*

[12] *天下雑誌*（天下1000大特刊）, 2008年5月7日号.

[13] *日経ビジネス*, 2008年4月21日号.

[14] *流通快訊*, 台湾連鎖店年鑑各号.

[15] *聯合報*, *経済日報*, *UPAPER*, *朝日新聞*, *日経MJ*の各日刊紙.

[16] *セブン－イレブン統一超商と台湾全家便利商店の社内資料。*

[17] (website) *台湾経済部.* http://www.moea.gov.tw/

[18] (website) *台湾セブン－イレブン統一超商.* http://www.7-11.com.tw/

[19] (website) *統一企業.* http://www.uni-president.com.tw/

[20] (website) *統一夢時代ショッピングモール.* http://www.dream-mall.com.tw/

[21] (website) *統一速達.* http://www.t-cat.com.tw/

[22] (website)*統一星巴克（スターバックス）.* http://www.starbucks.com.tw/home/

[23] (website) *日本ファミリーマート.* http://www.family.co.jp/

[24] ファミリーマートに関しては以下の企業インタビューを実施した。2007年11月、中国全家便利商店倉掛直董事長室経理（上海）、2008年8月、台湾全家便利商店の葉栄廷副総経理（台北）。

Technological Development in Post-War Japan and its Social and Institutional Organization

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***Abstract*—This paper looks at technological development in Japan after WW ll, outlining its social and institutional characteristics. It emphasizes that without studying dramatic changes in the organizational structures and social frames of institutions surrounding technological enterprises we may not be able to understand the nature of post-war technological growth in Japan. Because a reading of mere accumulation of past technological changes may not reveal the nature of the historical trajectory of technological change. This trajectory could be understood by exploring relationships between technology and social structures and institutions surrounding them in both broad and narrow sense.**

***Index Terms*—Technological development in postwar Japan, social institutions and technology, decline in Japanese coal industry, petrochemical industry, Minamata disease**

1. Introduction

To understand the characteristics of overall technological development in post-War Japan, it is not enough to refer to the rapidity of technological development focusing on some specifics areas such as automobile industry, electronics or iron manufacture. Because, by looking at ‘pure” technological developments within each enterprise alone we may not be able to grasp the nature of general technological development and its characteristics. A fuller picture becomes possible only if we take into account social conditions and political environment in which technological development occurs.
For example, technological development in post-war Japan may not be understood without studying political relations between Japan and the United States at the time. Because this relationship played a significant role in the transfer to and growth of technology in Japan.

Another aspect of technological development becomes clear when we take into account the true nature of big enterprises such as Chisso Company. Chisso was one of the most “advanced” technological enterprises in Japan. Its motto was: "technology" is Chisso, Chisso is technology. " Yet it caused the biggest and most miserable case of pollution in Japan.

In the last couple of decades, social constructionist [1]interpretations of technological development have become highly popular. T. Hughes, a noted historian of technology, talks about the "seamless" connections between social and artificial factors in a technological system[2].

This idea of the "seamless" relationships however, may not be readily applicable in the world of the material artifacts. Because the “logic” and ”relationship” involving artifacts and natural things differ from those of economic and social bodies or systems. Even they are interrelated ‘seamlessly’, they don’t act in the same way.

In this paper the term of “institution” is used not only to describe social organizations established to conduct research and have concrete bodies, but also describe organizations that are not concrete but exist only informally. Such an institution might be described as ‘invisible’.

2. Technological development in Japan after the war

2.1 Innovation

As many scholars have discussed well, innovation is more than sole technical improvements in a machine or a process. It may also involve social organization and labor management. Process innovation, for example, concerns with the control of production or manufacturing mechanism, while product innovation concerns with products. That is, the improvement in the quality and productivity of man labor makes up a major part of technological innovation, Innovation studies are not yet in a satisfied level, for example, to reveal a more comprehensive picture of the dynamic change in the production process. Even Schumpeter neglected the labor problem in production process[3]. Furthermore, innovations are often classified under a single category, or "innovations" of various dimensions are often put into one bag. But such a grasp of innovation may not allow us to do a satisfying analysis of technological development in Japan. A more satisfying approach is to put labor means at the center of analysis, and

then to explore their relations to social structures and institutions.

2.2 Techno-social development in Japan after the war

There were restrictions imposed by the GHQ on industries such as aviation and petroleum during the occupation. However, the change in American foreign policy toward Japan, and the Korean War created a good opportunity for a dramatic growth in automobile, steel, and petroleum industries..

After the Korean War Japan adopted American technologies in steelmaking, the blast furnace and the rolling mill section by using "the tied loan"[4] lent from such international institutions as the World Bank. But changes in steelmaking using American style technology made Japan all the more dependent on the imported raw material needed for American style steel making, because American blast furnace needed not Japanese coke but American coke for chemical reasons.

Though a chance, economic democratization, dismantling policy of the occupation forces on exclusive ownerships created a major breakup within the first Japanese power transmission incorporated company, dividing it into a 9 electric-power company system. This 9 electric-power company system increased heat and waterpower generation of electricity. The breaking up of the Japan Power Generation and Transmission Co., into 9 companies made electric power production and distribution systems in post-war Japan quite different from that of prewar time.

This new institutional system did not result from pure technological changes alone. The new social organization was responsible for a rapid increase in power generation in each region. Therefore big scale power plants and hydroelectric power from dams were required, and then needed appliances and machines that were imported from America. But the influence of the American technology derived from the new social organization wasn't just confined to the electric power technology. The dam water power system, i.e. large scale waterpower electric power which created damp truck and large construction machines such as a power shovel to be introduced from America for the big-scale dam construction for the waterpower generation of electricity. This entailed the use of large scale construction machines in Japanese civil engineering.

There was also a remarkable change in coal industry for iron making based on American furnace model, as already briefly mentioned. American blast furnace required not Japanese coal but American or American coal like one in various qualities, and made no use of Japanese coal. This led to the decline of the Japanese coal industry. Economists at that time could not make a sense of this, but only insisted on the coming of the age of “energy revolution”. In reality, coal did not become useless, but only Japanese coal became useless, for those technologies introduced from America required a different type of coal. Japan abandoned its own coal and became obliged to import foreign coal. This, in turn, led to the building of even larger ships in Japan. For many "the iron industry [was] the transport industry " for the fact that the iron industry where long-distance transport was the most necessary. It would also earn Japan a position among the advanced countries in iron industry. To decrease transport cost, a special combination conveyance ship of the raw material resources was developed. Therefore Japanese ships styled as ‘short and dumpy’ became bigger and bigger for economic reasons, then developed by the block construction method. It should be noted that Japan was not good at the construction of ships of any type with the exception for special ‘short fat’ type for oil and raw material transportation. For this Japan was described as ‘the country of big ships’.

The strong desire of the Japanese government to promote industry affected Japan’s computer industry. At the turning point of computer development, from the stage of individual research to the stage of commercial production, around 1960, MITI persuaded IBM to let Japanese computer companies use the IBM’s fundamental computer patent. Without this strong power and the introduction of peripheral device technology from USA, Japan couldn’t produce computer products on commercial scale. MITI guided the Japanese computer companies by forming special organizations to develop computers with generous funding and other special protective policies. We can see here an invisible social institution. This institution succeeded in making computers like IBM’s, but likewise failed in developing future machines or small seized machines, where IBM failed.

The rise of Japan in the production of relatively cheaper tool machines controlled by computers was a mode of this computer production system supported by the ‘invisible institution’ and a Japanese innovation mode of "foreign technological imitation: first a machine was introduced, second that machine was imitated domestically.

3. Technological development in Japan and its institutional organization

(3.1) A chain of technological change supported by social structures and institutions

First, dividing power transmission incorporated company into nine companies in accordance with GHQ policy caused a major change in power technology in Japan. Though there was a strong opposition to making this organizational change, it was

nevertheless enforced. Each of nine companies became responsible for one of nine areas, and a supply and demand balance system was consequently to be established in each area, not in the whole of Japan. To fill the demand, they were asked to increase thermal power generation in industrial areas and the development of the large dam-type waterpower technology in the gorge areas. These new innovations were made thanks to American technology and the "tied loans" from the World Bank and American banks. The forced division policy on Japan's power industry after the war, 'created', however, negative results too, such as the disunity of electric power frequency, and areas too big for the management of the electric power.

The technological changes induced the changing chain in technology related fields. Big dam construction led to the introduction of the large scale construction machines, also foreign. This construction industry was based on American technology.

There was a similar tendency (originally promoted by the new US-Japan political and industrial relationship) in other technological fields. As described above, the "tied loan" capital forced the introduction of American technology in iron production,

This in turn led to a further increase in import coal and a decrease in demand for the domestic coal after that. This situation led also to further technological chain changes. At the same time, it prevented efforts to create technology on the base of domestic conditions. For example, the effort to develop special iron production method using Japanese coal at Muroran steel manufacture did not succeed since political power to introduce foreign coal was stronger.

It is an important to remark that the collapse of the Japanese coal industry was not "the necessary result of technological progress" of "the energy revolution", that is, "from the solid energy into liquid energy", which was a popular theory with economists of the time. On the contrary to the economists "energy revolution theory", coal itself could not be eliminated from the cutting-edge technology.

Though the coal industry really declined in Japan, and petroleum became a major substitute for coal, and new technology based on petroleum was produced, the total demand for coal in the country did not decrease. The part of decreased domestic coal was replaced with import coal. The decline of domestic charcoal was the "consequence of technological progress", just as economists discussed, but this 'technological change' did not result from using petroleum instead of coal, but it was a change caused by introducing foreign technology into iron manufacture under 'tied loan', that is, it was a replacement not of coal for petroleum, but coal for coal. In the consequence of this change, even research into coal in Japan was curtailed, and the chair related to the coal in Japanese universities was abandoned. The research on coal was discouraged to an extent that security in old coal mines was neglected, as in the case of coal dust explosion at [5] in 1963. The reason for explosion there was not made public. Here we can see also two different types of scientist and engineer; some stand for workers and tried to make clear that the explosive was caused by coal dust, others stand for the coal capital and government, that is, involved to a institution, insisted that the cause was coal gas or unclear. But here further discussions are to avoided owing to pressure on our space. One more point: two similar groups of scientists and engineers were involved as the case with the Minamata and other environmental disasters.

3.2) Chisso is technology, technology is Chisso

Minamata disease was caused not by a single company, Chisso Co. It was a result of the larger institutional structure in Japan of the time, composed of enterprises, business communities, local government authorities, and the government. Some scientists were also involved in this institution.

Chisso was the symbol of technological advancement in Japan then. Its motto makes this clear :"Chisso is technology, technology is Chisso.' Its core technology was based on building the production system of coal and carbide leading to a production of acetylene and acetaldehyde, and then finally octanol which becomes the raw material of DOP, plasticizer of the vinyl chloride. But in the late 1950s, the so - called old carburet coal raw material of coal chemistry faced the rivalry of petro-chemistry technology. As a result, the two decided on a joint management enterprise with the American capital in the mid-1950s.

Enterprises then began to organize their own 'Calcium Carbide Association' to protect their own profit. And so did carburet, coal relating industrial enterprises the same thing, and they began to ask for government protection in this rivalry.

The Ministry of International Trade and Industry introduced a new law "carburet industry and tar industry" (1956.3) to support the industry. Even a carburet chemical laboratory (1966 renamed as 'material foundation laboratory') is established at Yokohama National University, and the professor of this chair stand later for Showa-Denko Co., which caused the second Minamata Disaster, and insisted wrong theory of agrichemical theory for Niigata-Minamata Disease.

The profit came from the old technology. Enlargement proceeded through the carburet manufacture technology of the foundation raw material of the old technological system for big scale profit, and a Japanese carburet manufacture fireplace reached its best scale in the world at last.

It was one of three big industrial policies at the time to promote the petrochemical industry[6]. To protect Chisso, which tried to introduce the petroleum technology using the profit of its old technology, was thought as a consequence policy of MITI. Even when the number of victims of Minamata disease increased, MITI didn't change its policies. Cooperating with these policies, the Ministry of Health blocked applying the Food-Hygiene Law to prevent emerging further patients, declaring that there was no clear evidence to show that all fish and shellfish were poisoned, and so Chisso could continue its production and self accumulate

capital for transform its production system to new petrochemical technology[7].

A scholar of Kumamoto University who worked seriously to find out the reasons for the disease was obstructed and dismissed by Chisso. On the contrary, scientists of famous universities in central Japan complied with this official policy. This situation can be described as invisible institution of Japan's 'enterprise-business-government complex'. A popular phrase of the time was: "Which do you believe, the theory by famous scholars, or the one by nameless provincial scholars ?"

It is clear that the spread of Minamata disease and its long misery were not just a result of Chisso's effort to become more productive. It can't be understood without taking into account the scientists who followed "the national policy" and pursued the interests of the business world and enterprises that formed an invisible complex.

3.3) Institution, invisible institution and technological development

The development of the computer industry cannot be described merely as the history in the form of accumulation of knowledge and innovations. Because it was not possible for a single computer enterprise in Japan to reach the stage of commercial computer production in the 1950's.It is now well known that it was MITI's power that manipulated the use of a basic patent possessed by IBM for Japanese enterprises, and later it delayed intentionally the production of integrated circuit in Japan for a US enterprise. In addition to enormous subsidies and deductions in tax, MITI guided enterprises to organize research cooperations[8]. It means another institution was organized and in this case it was the combination of various kind of institutions that interwoven together. People might say that an invisible governmental organization was also inbuilt within this institution. Thanks to this institution, projects were developed to construct a computer having the same ability as IBM's machine such as IBM 701, 360 or 370. But when the Japanese project to construct a 701-like machine, IBM had produced a further machine, 360. So this Japanese institution was obliged to plan a project to construct a 360-like machine. But when it reached the stage of IBM 360 machine, IBM had developed 370, and this continued. If we see only one side of the story –catching up with the IBM- might make MITI's policy sound successful. But this catch up policy has failed in producing next generation computer technology, i.e. downsized computer, together with IBM. The project to construct a fifth generation computer has also failed. The power of MITI as an institution was too big and strong. We can find another such a kind of institution made up by a governmental body and businesses, i.e. Den-Den family which initiated a project to construct a computer machine called DIPS and later optical fiber.

Another type of invisible institution was in the automobile industry. As it is well known, Toyota Co., has made up of several special product systems, 'just in time system' involving affiliated factories in the region. Toyota has developed an enormous mass-production system. ...

Automobile enterprises belong to the same business organization. This organization, big institution, embodying one big leading enterprise, also mainly controlled by this big enterprise, could not function effectively in technology innovation in preventing air pollution. It acted not to accelerate innovations in producing 'clean engines'. Remarkable was that Toyota was not the leading enterprise to innovate engines to fit to new gas emission norm in the 70s. It was not the leading company, but the very last. The opinion of the institution was that it was technologically impossible to design the required clean engine. And by developing the ' year 50 standard' fitting engine, and also 'year 51 standard' fitting engine, it was not big enterprises such as Toyota or Nissan, that innovated new engines as Honda and Matsuda. It was the strong public opinion and women's movement, and also a number of scholars who advocated the public opinion that broke the invisible complex of the automobile institution.

4. Concluding Remarks

To find the structure of the development of technology in post-war Japan, it is need to distinguish the chain of technological change from the social frame at first, and then to find the relationships of technological changes to social organizations and institutions. To see the relationships of social organizations a concept of 'invisible' institution is introduced in this paper.

A invisible institution relating to universities in Japan is now growing to be a big problem. Now the universities in Japan are forced to change their social functions rapidly. A small group of the universities are gaining more and more research funds, and in contrast, many universities are loosing their research abilities because of small funds from the state. A invisible social network is working through universities and the Ministry of Culture and Education, which we call as an invisible institution. As a social organization, the university might be given an important role in matters relating to science. Scientists at a university are supposed to work to create innovations to be used in industry and businesses. But today only a relatively small percentage of total work and activities done at universities and by their scientists concerns science and technology directly and involve innovations. Recently, science research funds are becoming bigger and bigger, but concentrating on small number of research institutions, i.e. a small number of universities in Japan. About 50% of whole research funds goes to 10 top universities[9]. Other universities get very small amount of research and education funds. Then business world and enterprises seem to want to include these ten big universities into their research projects. Then a new institution appears in the academic world in Japan, which is made up by the business world and one of ten big universities. Numerous other universities are denied these research funds. If we compare this to American funding for universities, there is a big difference. In America, the difference in amount of funds between top ranking universities and middle class is not so big.. And the scholars of middle ranking universities are producing more articles. What

kind of role this new emerging institution in Japan may play in its scientific and technological development? It is not easy to guess. But one thing is clear: the role of universities in Japan in technological innovation needs more attention and further study.

References and Comments

[1] E. Bijiker, T. P. Hughes and T. Pinch (eds.), *The Social Construction of Technological Systems,* New York (1987).

[2] T. P. Hughes, *Networks of Powers, Electrification in Western Society*, New York, (1983) 1880-1930.

[3] H. Akashi, 'Will Japanese policy get success in creating Innovation—Policy for Innovation, Science and Technology and its Comprehensiveness and Accuracy' *Japan Scientis*t 44, No.2 (2009) (in Japanese) 21.

[4] K. Kitada, "Postwar Japanese Capitalism and Innovation", in *Rekishi-Hyouron : special issue・Social history of Technology,* 6 (*1*979) (in Japanese) 112-142. is one of the best contributions on the history of technology in postwar Japan. The presented article also owes to the discussion of Kitada's essay.

[5] On the explosive accident at Miike in 1963, seek Mori and M. Harada, "Miike Coal Mine—Searching Coal dust explosive in 1963", NHK Publishing (1999) (in Japanese).

[6] Akiyama, the Heavy Industry Agency Head spoke for Chisso Co.,'It is inorganic mercury that the company is using.・・・and the inorganic mercury never turns into organic one ',about 40 yeas later he recollected,「MITI had three big tasks at that time・・・・・To promote the petrochemical industry was one of them.' Some engineers in the Chisso factory at Minamata made clear at that time that inorganic mercury turned into organic mercury in the process making acetaldehyde. This was known by chairman of the company, and of course it was Remained and limited to top secret.

[7] The most excellent study that made clear the relationship of Minamata Disease to Industry is K. Kato's 'Minamata Disease and Japanese Chemical Industry' in "Gendai-Hyouron" (in Japanese).

[8] On the development of Japanese computer and MITI's relation to it, see ed. by Information Processing Society, "A Developing History of Japanese Computer", Ohm Publishing (1998), S. Takahashi's "Computer Chronicle", Ohm Publishing (1996) (both in Japanese).

[9] J. Takeuchi, 'For Future Research and Education Power in Japan'', *Gendai Shiso* 9 (2008) 164 (in Japanese).

Science and its Bases: An Institutional Approach to History of Science

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***Abstract*— The histories of science policy in two different institutional settings, the Cold War America and post babble–economy Japan are explored. A mathematical model of development of science is introduced, and the conditions for science to help economic growth are examined based upon the model proposed.**

***Index Terms*— history of science, cold war American science, Japanese science policy since 1980, and mathematical model of development of science, technology, and economy**

1 INTRODUCTION: SOCIAL BASES OF SCIENCE AND INSTITUTIONAL APPROACH

WHAT are the social bases of science or what relationships science has with technology and other social activities has been one of the fundamental questions of the history of science since it started as an academic discipline in the 1930s, yet there is necessarily no common view among historians. Boris Hessen of the Soviet Union, for example, argued from a Marxist view of history that modern sciences, especially Newtonian mechanics, emerged from various technological questions and their solutions when Capitalism was developing in Western Europe. [1] Robert Merton, American historian and sociologist of science, maintained, based upon Max Weber's thesis that Protestantism developed Capitalism, that the faith of Protestantism encouraged the pursuit of science in seventeenth century England. [2] Another but reverse question why modern science did not emerge in China also arose. [3] It is called Needham's Grand Question because Joseph Needham, British biochemist and historian of science, first asked it. As Chinese Capitalism did not appear before it appeared in the western countries, the development of Capitalist economy may have some relationship with the emergence of modern science.

Another general theory of the history of science is Stephan Mason's thesis that was suggested in his book on science history: Science started in seventeenth century Western Europe through the conversion and combination of the tradition of the philosopher and that of the craftsmen that had a long separate history. [4] Mason's thesis may be applicable to Needham's Grand Question because there was a great social and class barrier between intellectuals and craftsmen in China. It may also explain why Western modern science and technology were easily accepted by the Japanese in the Meiji era. Although the majority of them were from the *samurai* class, they had similar mentality and jobs similar to those of craftsmen.

However, when one looks more closely at the detail of the historical process of science, one finds many issues that cannot be explained by such simple theories as described above. As a result, institutional approaches appeared in the 1970s to find close links between science and social and technological demands for science (See, for example, Cardwell [5].). The Royal Institution of London, Cavendish Laboratory of Cambridge University, the Physikalisch-Technische Reichsanstalt (PTR) in Germany, and so forth have been focused on in this approach. The Institute of Physical and Chemical Research (RIKEN) in Japan is one of good examples where scientific activities were successfully encouraged. In general, one can find some institutional basis wherever there were great scientific achievements, but the reverse is not necessarily true. The the Korean Institute of Science and Technology（KIST）established to win the Nobel-Prize-class scientific achievements, and the Indian Institutes of Technology (IITs) aimed at a MIT-style higher education and research system in India were regarded as *failure* at least in their early period. [6], [7] Some other factors including the management to encourage academic freedom are needed in institutional settings in order to achieve a great scientific performance.

This paper explores the histories of science policy in two different institutional settings, the Cold War America and post babble -economy Japan. Sections 2 and 3 are devoted to them. In section 4, a mathematical model of development of science is introduced, and the conditions for science to help economic growth are examined based upon the model.

2 SYMBIOTIC MECHANISM BETWEEN OBJECT-ORIENTED RESEARCH AND BASIC RESEARCH: US MILITARY AND SCIENCE COMMUNITY IN THE COLDWAR ERA

The Cold War saw a period of an extraordinary transformation in the pace and scale of scientific pursuit. [8] The United States and the Soviet Union heavily invested in science for military purposes, cementing a close relationship between the military and science. The relatively recently declassified vast records of the Cold War era, and a large body of scholarly

works for the last two decades have highlighted the crucial role of military funding in this relationship, to the extend historians of science coined the phrase "the Cold War Science." [9]

The relationship developed between science and the military, and the involving groups and institutions during the Cold War is a kind of symbiosis. The scientific community and the military became interdependent. Scientists needing funding accepted government money, and in return they conducted research useful to the military. The military used research to develop and manage new weapons systems. Thus as many historians have argued, the Cold War was beneficial to both scientists and the military. This is essentially a relationship of mutualism.

Before the Second World War, except for agriculture, there was no significant funding from the Federal Government to science communities in the United States. Shortly after the outbreak of the war in June 1941, US President Franklin D. Roosevelt approved the creation of the Office of Scientific Research and Development (OSRD) to mobilize scientific research for the war effort. By the end of the war, OSRD successfully developed the atomic bomb, radar, penicillin, and so forth.

Given unrestricted access to funding and resources, it was run by Vannevar Bush, former dean of the Faculty of Engineering of the Massachusetts Institute of Technology , and then President of the Carnegie Institution. It reported only to President. Through an effective funding system, OSRD engaged for the war effort the services of individual scientists and engineers, universities and research institutions. [10]

The OSRD was a temporary wartime institution, and discontinued in 1947. It proved extremely productive and useful to the war effort, and had helped forge strong ties between science and the military. At the close of the war, there was a strong desire to put this cooperation on a more permanent footing. Vannevar Bush was a strong advocate of a similarly centralized powerful agency in peacetime. In his notorious 1945 report "Science-The Endless Frontier" to President Harry S. Truman, he proposed the creation of "a National Research Foundation" that oversaw the cooperation between science, industry and defense. [11] What he had in mind was something akin to a Science Department that would exclusively oversee all postwar scientific activities. Unfortunately for Bush, however, soon specialized individual mission agencies such as the Department of Defense (DOD), the Atomic Energy Commission (AEC), the successor of the Army's Manhattan District, later the National Aeronautics and Space Administration (NASA), and National Institutes of Health (NIH) quickly staked out their own research territories and shared the responsibility for funding. This created a plural but complex funding system for scientific research in the United States. [12]

Historian Paul Forman has argued persuasively that between 1940 and 1960 American physics underwent a qualitative change in its purpose and character. That is, the pursuit of physics was integrated into the pursuit of national security, and the military discreetly supported basic physics research that promised military application. Forman believes that physicists selected research topics that promised funding often at the cost of more interesting questions. This suggests that the military manipulated the scientific talent by offering scientists the incentives of money and prestige. [13]

If the military manipulated basic research, then how did "pure science" survive during the Cold War? In fact, during World War II American basic research came to more or less a virtual halt due to the mobilization of science for the war effort. But after the war scientists enjoyed a degree of freedom in their research and spending. At least a small percentage (Roger Geiger suggests the round figure of 5 percent. [14]) of total R and D in the technological enterprises including military-related agencies was spent on one's own research. This flexibility may account for why "pure science" continued to grow under the military patronage.

In the US where the major task of the Federal Government are national defense and foreign affairs, the allocation of federal research funds for national security to research institutions of university and others, and the technological spin-off of its products to civil uses was, right or wrong, a *rational* financial support system during the Cold War. Moreover, in the Cold War era, winning more Nobel Prize helped to appeal the advancement of the US in science and technology.

Is this research money flow through the Military-Industrial-Academic Complex also rational in the post Cold War era? It is obvious that it is not applicable to such countries as Japan that has no large scale military industry according the restriction by its Constitution.

3 SOCIAL JUSTIFICATION FOR BASIC RESEARCH: THE CASE OF JAPAN

Research and development (R&D) expenses in Japan increased very rapidly in the 1980s. In 1989, Japanese R&D expenditures as percentage of GDP became the highest among countries with highest GDP. (See Figure 1) The major part of Japanese R&D money came from the industrial sector. The governmental budget was seriously suppressed at the time due to the "zero ceiling" budget policy. As a result, the share of governmental R&D expenditures declined to the lowest level among developed countries. [15]

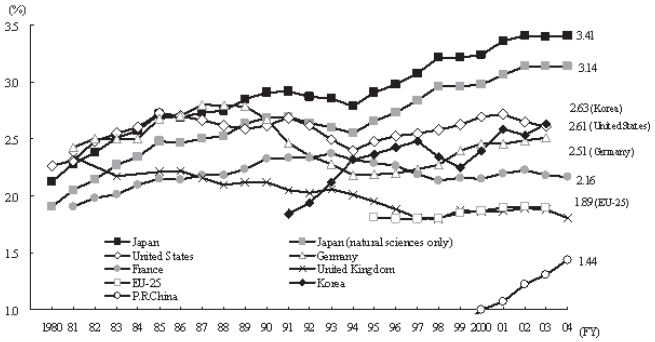

Figure 1 R&D expenditures as a percentage of GDP in selected countries
Source: *WHITE PAPER ON SCIENCE AND TECHNOLOGY 2006*

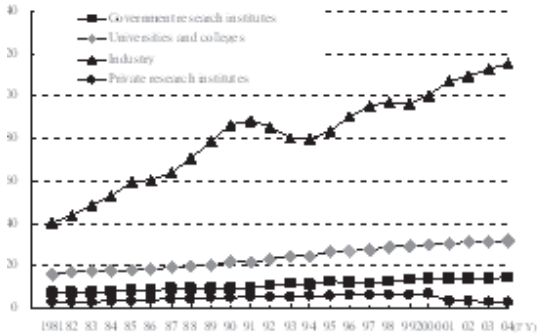

Figure 2 R&D expenditures growth (in real terms) by sector in Japan
Source: ibid.

After the collapse of bobble economy, in the early 1990s R&D expenditures of industry declined and the expenditure consequently also decreased. This was the first such experience since Japan's modernization began in the Meiji era with exceptions of war times. (See Figure 2) This shock was also worsened by the policy of foreign counties on the protection of intellectual property rights. Then in 1995, a major reform of the national policy of science and technology was undertaken, and the Science and Technology Basic Law was established. An additional resolution at the Diet aptly described the situation at the time:

> Regarding science and technology, our country is approaching the end of the so-called catch-up period when developed countries and the goal was always there, and a lot of areas of technology were available from there. We have to look ahead as a front runner to challenge to open new areas of science and technology, maximizing our creativity, and increasing the scope of the future. [16]

The law was adopted unanimously, and from the following year a new comprehensive policy started based upon the Science and Technology Basic Plan. As a result, COE projects at universities and other big projects started in order to encourage selected research fields. With the enforcement of the basic law and plan,

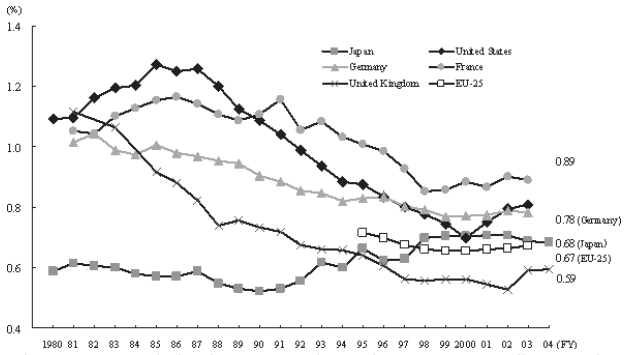

Figure 3 Trends in the proportion of government-financed R&D expenditures to gross domestic product (GDP) in selected countries
Source: ibid.

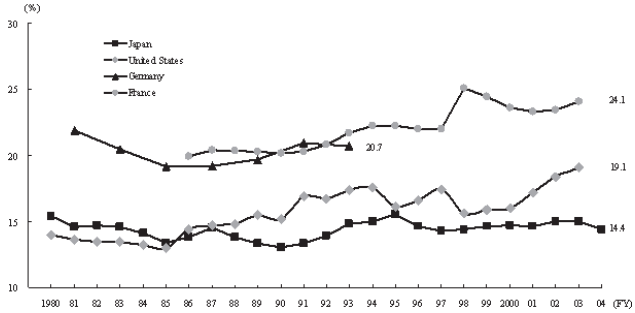

Figure 4 Trends in the proportion of basic research expenditures in selected countries
Sours: ibid.

the share of governmental R&D expenditures was improved. (See Figure 3)

The financial situation of basic research, however, changed little: The share of basic sciences has remained almost constant even after the establishment of the Science Technology Basic Law. (See Figure 4) Very few non-economic arguments can be discerned in the governmental reports about basic sciences. A report by the Ministry of Economy, Trade and Industry entitled "Science and Technology Policy for Innovation" stated in 2005 that "Basic sciences (so-called pure basic sciences) are … expected eventually to contribute the *sustainable development* as mentioned in the declaration of the World Forum on Science in Budapest." (Italics by the author emphasizes) [17] It is very curious why they had to connect basic sciences with the sustainable development. Even *The Third Science and Technology Basic* in 2006 stated that "Japan lags behind the United States and Europe in accumulating intellectual achievements to make leaps in knowledge." [18] We now need less directly economy-dependent framework for basic sciences.

For Nobel Prize winner Hideki Shirakawa in 2000, basic research concerning the discovery and development of conductive polymer has wide application fields, and certainly contributes to economic development. However, Masatoshi Koshiba's pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos, for which he received the Nobel Prize in Physics 2002 never found any technologically and economically applicable area. At the moment at least, no one knows if Professor Koshiba's achievement will have any relationship with the sustainable development.

Basic sciences or basic researches have aspects that are difficult to explain socially. From historical perspectives it is difficult to find clear distinctions between basic research and applied research. Most "basic" research eventually finds its way to technological applications. Boolean algebra was considered one of the most abstract theories in mathematics when it was introduced by George Boole in 1847. In 1938, almost one hundred year later, Claude Shannon, an American electric engineer, found that Boolean algebra was a useful tool for mathematical analysis of electric relay and switching circuits. Boolean algebra is now the most basic tool in computer sciences. Even Einstein's general theory of relativity, one of the most fundamental theories in the twentieth century physics, is now

used in the time adjustment between satellites and the surface in the global positioning system (GPS). Looking back at history, one finds that we need long term perspectives of fifty to hundred years to discuss the social effects of academic achievements. It is for this reason why one can hardly forecast when some specific basic research will be applicable in the future. Professor Koshiba's neutrinos might be useful as a communication tool in the future of one hundred years or so.

Basic sciences have another difficulty especially in institutional approaches. Their place of application is sometimes different from their place of birth. We can find many such examples in the 1980s that American basic ideas were industrialized in Japan. Scientific achievements develop trans-institutionally.

There are several approaches to justify basic sciences. Typical one is the econo-technical approach or the "knowledge is power" approach that claims science can help produce technological inventions and innovations. Another is the cultural approach that argues science can help people understand the nature deeply. [9] The econo-technical approach is popular, but not appropriate for the justification of basic sciences whose economical outcomes appear in the future of fifty to one hundred years. Basic sciences always are justified as one of such cultural activities like sports and arts. The arguments of the cultural justification, however, might easily change to soaring "science for science" justification.

4 QUANTIFICATION OF SCIENCE ACTIVITY

The fact that it takes fifty to one hundred years before the result of basic research becomes a reality is another perspective of so-called Valley of Death or Darwin's Sea. [20] Inventions and results of basic research sometimes stay in the Valley of Death without escaping from it, but in other cases they come out of it and create real innovations. In these cases, the results of basic research are not dead in the Valley of Death but just sleeping there and eventually will awake from a long sleep. We may call this phenomenon the *awaking effect* of scientific ideas.

If it takes fifty to one hundred years before results of current basic research become realities, it is surely difficult to estimate their technological and economic effects with our current knowledge. However, we remember that almost four hundred years have passed since the modern science started, so we have a huge accumulation of scientific ideas. Then we may be able to estimate, with our current knowledge, the technological potential of the accumulation of scientific ideas in our days. If any results of basic research create innovations, say in 100 years, when one gathers one hundred scientific ideas, one idea among them should be turned out to be applicable and create an innovation.

Letting S science activity, the awaking effect will therefore be proportional to

$$\int^{t} Sdt . \tag{1}$$

The change of technology stock T in unit time is given by

$$\lambda \cdot \int^{t} Sdt \tag{2}$$

with an appropriate factor λ .

The time derivative of the technology stock can be obtained from research and development expenses R_t and obsolescent rate ρ_t as follows. [21]

$$dT / dt = R_t - \rho_t T . \tag{3}$$

When the above mentioned awaking effects occur, the time derivative of the technology stock will be as follows.

$$dT / dt = R_t - \rho_t T + \lambda \cdot \int^{t} Sdt . \tag{4}$$

For science activity S a similar equation to Equation (3) for T may hold:

$$dS / dt = R_s - \rho_s S + \mu(S \cdot T) , \tag{5}$$

where R_s and ρ_s are science research funds and the obsolescent rate of science activity, respectively. The last term $\mu(S \cdot T)$ is added in order to include Mason's thesis that claims that positive effects may emerge in science when science and technology meet together.

The economy gain V through technology stock can be expressed as

$$dV / dt = b \cdot (dT / dt)V = b \cdot (R_t - \rho T) \cdot V , \tag{6}$$

where b is a factor that changes slowly in time in comparison with V , T , and S , and is given by

$$b = (\partial V / \partial T) / V . \tag{7}$$

When we assume that the total research funds

$$R = R_t + R_s = R_t(1 + \sigma) \tag{8}$$

is proportional to V ;

$$R = \varepsilon V , \tag{9}$$

we can calculate the time development of V , T , and S under their popper initial condition if the values of b , ε , σ , ρ_t , ρ_s , λ , and μ are given. ε and σ are factors that can be chosen according to our science and technology policy. When we adopt the Forman Rule, σ will be several percent. John Ziman, British physicist and historian of science, suggests 10 percent. [19]

Equation (4) can be written as

$$dT/dt = R - \rho_t T - R_s + \lambda \cdot \int^{t} Sdt \,. \qquad (10)$$

The first two terms of the right hand side of Equation (10) express the change of technology stock with no investment in science, so we can find that more economy growth can be expected than that without investment in science, when the following inequality holds:

$$\lambda \cdot \int^{t} Sdt \geq R_s \,. \qquad (10)$$

This inequality is easy to understand. The left hand side of it expresses the awaking effect in the technology stock, and its right hand side, the investment in science. Accordingly, we may conclude that the economic gain will be expected when the increase of technology stock originated from the accumulation of scientific ideas (the awaking effect) is greater than the investment in science. We should remember that we need the active pursuit of science right now in order to secure the future accumulation of scientific ideas. In this sense the right hand side of Equation (10) needs some considerable value.

5 CONCLUSION

In this paper, beginning with a survey of arguments on the relationship of science with technology and ecomic growth, the followings are shown.

① A close analysis of the history of the symbiosis between science community and the military in the Cold War era suggests an important role of the so-called Forman Rule.

② Despite of the rapid growth of Japanese R&D activities in the 1980s, the traditional science policy emphasized the practical value of natural sciences is still dominant in Japan.

③ The conditions for science to be helphul to economic growth are examined based upon the matematical model proposed in this paper.

References

[1] B. Hessen, *The Social and Economic Roots of Newton's 'Principia'*, Howard Fertig, New York, (1971) (First Published in 1931 in *Science at the Cross Roads*: Paper Presented to the International Congress of the History of Science and Technology).

[2] R. K. Merton, "Science, Technology and Society in Seventeenth Century England," *OSIRIS*, **IV**, pt. 2 (1938) 360-632.; *Science, Technology and Society in Seventeenth Century England*, Harper & Row, (1970).

[3] J. Needham, *The Grand Titration*, George Allen & Unwin, (1969).

[4] S. F. Mason, *A History of the Sciences*, Routledge & Kegan Paul, (1953).

[5] D. S. L. Cardwell, *The Organization of Science in England*, Heinemann Educational, (1972).

[6] K. Dong-Won and S. Leslie, "Winning Markets or Wining Nobel Prizes? KAIST and Challenges of Late Industrialization," *OSIRIS* Second Series, **13** (1998) 154-185.

[7] S. Leslie and R. Kargon, "Exporting MIT: Science, Technology, and Nation-Building in India and Iran," *OSIRIS* Second Series, 21 (2006) 110-130.

[8] M. Yamazaki and Y. Bektas, "Military Funding and Cold War Science," paper presented to the second International Symposium on SIMOT, (2006).

[9] J. Wang, "Science, Security, and the Cold War: The Case of E. U. Condon," *ISIS* **83**, (June 1992)238-69.

[10] A. Roland, *Military-Industrial Complex* (Washington DC: AHA、2002).

[11] Foreword by E. Bloch, V. Bush, *Science-The Endless Frontier*, National Science Foundation, (1990).

[12] A. J. Morin, *Science Policy and Politics*, Prentice-Hall, (1993).

[13] P. Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," *Historical Studies in the Physical and Biological Sciences* **18**, no.1 (1987) 149-229.

[14] R. L. Geiger, "Science, University, and National Defense, 1945-1970,"*OSIRIS* second series, **7** (1992) 26-48.

[15] M. Yamazaki, "Japanese Policy of the Promotion of Basic Sciences," paper presented to the third International Symposium on SIMOT (2008).

[16] http://www.mext.go.jp/b_menu/shingi/kagaku/kihonkei/kihonhou/futai.htm

[17] "Science and Technology Policy for Innovation," [Japanese]; http://www.meti.go.jp/policy/economy/gijutsu_kakushin/innovation_policy/pdf/kihonmondai.pdf

[18] http://www.mext.go.jp/a_menu/kagaku/kihon/06032816/001/001.htm

[19] J. Ziman, *The Force of Knowledge the Scientific Dimension of Society*, Cambridge University Press, (1976).

[20] L. M. Branscomb and P. Auerswald, *Between Invention and Innovation: An Analysis of Funding for Early-Stage Technology Development*, NIST (2002).

[21] C. Watanabe (ed.), *Quantitative Analysis of technological innovation*, [Japanese], Nikka Giren Shuppansha (2001).

2. Education and Human Resources Development

2. Education and Human Resources Development

2.1 Overview

(1) Integrated Activities with the Graduate School of Innovation Management

(i) Co-evolution between SIMOT research and the graduate school's education systems was facilitated by the cooperation of students at the school.

(ii) The framework of the Japanese way of management of technology was shaped.

(2) Teaching Staffs

(i) The research focus of students was induced by first-hand lectures initiated by SIMOT core members.

(ii) Values identical to the SIMOT educational system were promoted by means of interdisciplinary subjects, including historical reviews, mathematical analysis and social sciences.

(iii) Organic integration of theory and business reality was realized by integrating internship experiences and studies abroad.

(iv) Opportunities to participate in and/or initiate high-level activities with academic associations were made available.

(3) Training

(i) Strong ties with leading firms and institutes in Japan and abroad were established.

(ii) Invaluable working experiences at leading firms and academic institutes (including GE, BCG, Burumburg, IIASA, Institute of Statistical Mathematics) were offered.

(4) Development Human Resources

(i) Five Ph.D. students in three business and academic fields accelerated their graduation via the Super Doctor Track.

(ii) A priority system with competitive circumstances was introduced.

(iii) Close cooperative relationships with leading institutes in the USA; Europe, including the UK, Germany, France, the Netherlands, Spain, Switzland, Finland, Austria and Russia; Asian countries, including China, Korea, Thailand and India; and Australia were established. International students from various nations, including Germany, France, Spain, Argentine, Columbia, Ecuador, Hong Kong, China, Korea, Taiwan, Bangladesh and Tailand were also accepted.

(iv) The core classes SIMOT I and SIMOT II were further developed through the direct involvement of SIMOT core members, including visiting professors with first-hand experience in business and government.

As a consequence of the foregoing, the following noteworthy outcomes were obtained:

(i) The positioning of leading universities and businesses in Japan and abroad was clarified.

(ii) Co-evolution between fundamental research, international joint research and education has been attained.

(iii) Global leaders have been created, particularly (i) MOT leaders contributing to the advancement of firm MOT, (ii) international business leaders contributing to the transfer of Japan's explicit systems to the global community, and (iii) young research leaders contributing to the advancement of SIMOT as a new innovative science, as demonstrated in the following examples.

(a) Creation of Global Leaders

(b) Experiences in Global Institutes

i) Publication of articles in international peer-reviewed journals

ii) Holding of international symposiums/workshops

(c) Training through Collaboration with Leading International Institutes

i) Publication of articles in international peer-reviewed journals.

a) IIASA

b) University of Yuvaskyla

c) Dalian University of Technology

ii) Global Firms

Training by experiencing meaningful business opportunities and positioning at leading global firms

Creation of Global Leaders

Fields		Education support programs		Category of global leaders	Reference Affiliation
		Program	Internship, IIASA		
Firm R&D	MOT	Super Dr track [1]	IIASA, Canon	MOT leaders	Hitachi
	SCM	COE Post-Dr	Xian Jiaotong University, Chinese high-tech firms		Toshiba
Intl. comparison	CSR	Super Dr track [1]	Bloomburg, High-tech firms in Europe	International business leaders	Bloomburg
	Market analysis	Acceleration of Ph. D. graduation [1]	IIASA, BCG High-tech firms in Taiwan		BCG
Model analysis	Model analysis	Super Dr track [1]	National Institute of Statistical Analysis	Young research leaders	Tokyo-tech
	Innovation diffusion	Special acceleration of Ph.D/Master graduation [2]	IIASA, Dalian Univ of Technology, GE		Waseda University

[1]. Completes doctor course in two years

[2]. Completes master course in one year and completes doctor course in two years

2.2 Noteworthy Accomplishments by SIMOT Young Researchers

An Elucidation of Canon's High Profitability Mechanism

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1. Introduction

Sustainable functionality development is decisive to firm's profitability in a mature economy. Since paradigm shift from industrial society to information society lead the shift of the spot where innovation takes place from supplier's domain toward consumer's domain, the new growth model is required. Contrary to the low profitability of Japanese electric machinery firms, Canon has consistently kept high profitability. Canon has achieved extremely high operating income to sales by relatively equivalent input as other firms. This study attempts to elucidate the Canon's high profitability mechanism to provide important suggestions for firm's new growth model based on the following hypothesis:

(i) Canon developed functionality by effective utilization of indigenous technology.
(ii) Canon created new functionality by effective assimilation of external technology.
(iii) Canon domesticated external technologies through competitors by inspiring the market's self-propagating function.

2. Effective Utilization of Indigenous Technology

The sharing of learning and spillover effect between copying machines and LBP were analyzed to verify the effective utilization of indigenous technology. It was demonstrated that Canon's technological diversification based on its core technologies increased the learning effect and spillover effect. This enables Canon to develop new functionality effectively.

3. Functionality development due to High Assimilation Capacity

The timing of copying machines' functionality development in Canon and Ricoh were compared to analyze functionality development due to high assimilation capacity. It was demonstrated that assimilation capacity played a significant role for functionality development. Canon's assimilation capacity was higher than that of Ricoh. Consequently Canon was able to undertake new functionality development much earlier than Ricoh.

4. Domestication of Market's Self-propagation Function

The factors governing profitability of mobile phone related firms and Canon were analyzed. In addition, an analysis of external leaning of Canon's printer from PC market was conducted. Furthermore, the impact of inspiring external technology and domesticating external technology on a firm's profit were simulated by means of system dynamics. It was demonstrated that Canon has accomplished conspicuous performance by domestication of the market's self-propagating function.

5. Conclusion

This study elucidated the Canon's high profitability mechanism providing the significant suggestions supporting to firm's MOT in new paradigm. It was suggested that virtuous cycle between inspiring the market and domestication of market's self-propagating function in a synchronizing way should be conducted.

Institutional Structure Governing the Diffusion of Mobile Phones

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1. Introduction

During the 1960s, 1970s and 1980s, Japan has revealed an impressive economic success in an industrial society by its innovative manufacturing technology. However, it fell into stagnation due to its insufficient adaptation to the information society in the 1990s. This recession resulted from the differences of the features formation process between manufacturing technology and information technology (IT). Despite of the depression of many industries, mobile phone industry has demonstrated great achievement in the 1990s. Such an exceptional development of mobile phone market is considered to result from Japan's unique institutions that construct a co-evolutionary mechanism not by only the demand side but also by the supply side.

2. Demand Side with High Learning Ability and Demanding for New Functions

Customers in Japan demonstrate high learning ability that enables them to get used to new technological innovations quickly. Although the price is an important factor, customers in Japan demand for high quality and new functions more. Such high learning ability also causes Japan's customers to lose their interest easily and forces the supply side to provide innovative products and services all the time.

3. Supply Side Responding to Customers by Vertically Intertwined Tie-up

Due to Japan's customers' attributes such as demanding attitude toward new functions, high quality and affluence of products and services, companies are forced to intertwine with each other to form close relationships vertically in order to satisfy the customers. Although this vertical tie-up may intercept the market to be open, it may also create a closed but exceptionally advanced market such as the mobile phone market in Japan.

4. Co-evolution of the Closely Intertwined Supply Side and Smart Demand Side

The foregoing attributes of the demand side and vertically closed intertwined relationships of the supply side construct the exceptionally advanced development of the mobile phone market in Japan. However, such unique co-evolutionary mechanism also results in the failure of global handset vendors to enter Japan's market and failure of Japanese handset vendors in other markets.

5. Conclusion

The results of empirical analyses demonstrate that the conspicuously advanced mobile phone market is constructed in Japan on the dual co-evolutionary mechanism that is formed by demanding customers who value new functions and adapt themselves to new innovations quickly and the supply side that forms vertically intertwined cooperation ensure the high quality and innovative functions. Such unique institutions enable Japan to construct the most advanced mobile phone market but also intercept Japanese companies to achieve success in other markets.

Adaptability to Co-evolutionary Dynamism between Technological Innovation and Institutions: A Case of Japan's Firms

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1. Introduction

In light of the declining profitability in Japan's R&D due particularly to the decrease in adaptability and flexibility to external circumstances, this research analyzed the adaptability to co-evolving dynamism between Japan's technological innovation and its institutions.

Prompted by the intensive analysis on the Japanese firms' R&D activities over the last decade, the following four hypotheses are postulated:

i) The more firms diversify R&D activities, the more their profitability increase,
ii) The higher is R&D adaptability, the more firms' profitability increase,
iii) The higher is interaction among diversification and adaptability of R&D, the more firms' profitability increase, and
iv) Institutional influence accelerates more interaction effect between diversification and adaptability of R&D.

2. Empirical Analysis and Results

By means of an empirical analysis taking techno-economic behavior of 27 leading firms focusing on their R&D, patenting, sales and profit behavior, foregoing hypotheses were demonstrated.

Noteworthy findings include:

i) Firms that devote diversified R&D activities gain higher profitability,
ii) The more the numbers of interchanging the order of IPC codes increase, the higher are profitability of firms,
iii) R&D adaptability is influenced by past experiences and learning, and its interaction with R&D diversification contributes to the increase of firms' profitability, and
iv) This interaction depends on the co-evolutionary dynamism with institutional systems.

3. Conclusions

These findings provide the following significant policy implications supportive to firms' sustainable development under a mega-competition:

i) It is essential for firms to leverage a significant interaction among R&D diversification, R&D adaptability and institutions.
ii) Co-evolution between diversification and flexible R&D options based on respective institutions can lead a way for leveraging a significant interaction between them.
iii) Further works should focus on the identification of sectors/nations specific institutional factors, thereby further general postulates development can be expected.

Successful Trajectory of New Venture Development in an Information Society – The Role of the Venture Leader Initiative

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1. Introduction

Notwithstanding the strong expectation that new ventures can induce new innovation leading to national vitalization, Japan's new venture start-up ratio is far behind the ratios for other industrialized countries. This can be attributed to Japan's indigenous institutional systems and consequent business models that incorporate not a few barriers impeding the successful trajectory of new venture start-ups and succeeding initial public offerings (IPO).

In line with the advancement of ICT, new production model has been observed recently in Japan's high-performance firms (HPF) such as MPF (new venture firms associated with mobile phones and allied business performance) firms in their IPO accomplishment.

Given such a new production model, it is anticipated that new ventures can be developed in Japan.

2. Intensity of Ventures Publicizing Efforts

First, the case of Japan's mobile phone firms (MPF) is examined and it is demonstrated that the intensity of ventures publicizing efforts induce broad supporters involvement in a co-evolutionary way and activate self-propagating dynamism can be expected also in EOY firms.

3. Self-propagating Dynamism in High-performance Firms

Second, prompted by the foregoing analysis, structural source enabling HPF (consists of MPF and EOY) such a self-propagating dynamism is examined by comparing performance in 59 HPF firms and 518 non-HPF firms. It is demonstrated that sophisticated acceleration and brake functions are incorporated in HPF firms leading to optimal timing for IPO by restraining from rushing to excessive rapid accomplishment.

4. Entrepreneurial Sence and Mind of Venture Leaders for IPO

Third, prompted by these analyses, given that the entrepreneurial sense and mind of venture leaders are decisive to trigger the sophisticated self-propagating dynamism, the impact of leader characteristics on IPO performance is analyzed by means of eligible responses of 92 leaders obtained by a questionnaire survey and utilizing the Enneagram approach.

5. Conclusion

Noteworthy finding include the identification of the characteristics of EOY leaders contributing to the well managed acceleration and brake functions for self-propagating dynamism.

Inter-sectoral Technology Spillover

– Elucidation of the Inside the Black Box of the Technology Spillover

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1. Introduction

On the basis of the analysis focusing on the interactions between Japan's 47 prefectures as well as manufacturing sectors in each respective prefectures over the last quarter century encompassing both periods of an industrial society and an information society, the inside the black box of technology spillover dynamism is analyzed by means of the analysis of the interaction between prefectures as a well as manufacturing sectors and subsequent two dimensional technology spillover, and also to create a new concept of co-evolutionary dynamism between inter-prefectural and inter-sectoral technology spillover.

2. Nationwide Productivity Increase based on Homogeneity in an Industrial Society

Japan achieved conspicuous economic development during the course of an industrial society up until the end of the 1980s which can be attributed to the nationwide efforts toward inter-regional and intra-regional productivity increase.

In this period, homogeneity in the nation as a whole led to a virtuous cycle between homogeneity and productivity.

3. Shift to Heterogeneity in an Information Society

Contrary to such conspicuous achievement, Japan experienced long lasting economic stagnation in an information society that emerged in the 1990s. In this period, Inter-prefectural heterogeneity is expected to achive the objective of an information society functionality development.

This heterogeneity in inner-prefectural level is also expected for the effective utilization of spillover technology as large dependency on indigenous technology can not be anticipated, due to economic stagnation.

4. The Role of Cluster Policy

Consequently, shifting from homogeneity to nationwide heterogeneity is expected in an information society.

While shifting trend from inter-prefectural homogeneity to heterogeneity has been observed, this shift is hardly satisfactory for the requirements corresponding to the paradigm shift from an industrial society to an information society. Thus, policy impulse to accelerate such shift by minimizing the impediments of an organizational inertia while maximizing the effective utilization of potential resources in innovation has become crucial.

5. Conclusion

On the basis of the analysis on the inter-prefectural technology spillover in an industrial society and also an information society, inside the black box of technology spillover dynamism was analyzed and demonstrated the significance of cluster policy for this spillover.

Institutional Sources Governing Sustainable Development in China

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1. Introduction

Contrary to the relative stagnation of economic growth in industrialized countries with mature economies, the BRIC countries: Brazil, Russia, India and China have shown conspicuous economic growth in the early 2000s. While they currently depend on their geographic advantages for economic development, BRICs' sustainable economic growth is subject to a co-evolution between innovation and institutional systems, as institutions cultivate innovation or effective utilization of potential resources.

2. Institutional Structure Leading BRICs Sustainable Development

Since recent dramatic advances in information and communication technology (ICT) in BRICs have had a significant impact on the advancement of their institutional systems, ICT is expected to trigger such co-evolution, leading to sustainable development in BRICs.

3. China's Locomotive for ICT Advancement

Among BRIC countries, China has demonstrated an economic miracle. It has experienced a long-lasting evolution of its institutional system, characterized by rapid economic growth, large-scale urbanization and dramatic development of education. The cyclical mechanism between these institutional factors is essential for the resilience of China's economic development. The advancement of ICT and the Chinese government's informatization strategy contribute to the development of education and urbanization, leading to a virtuous cycle between economic growth and further advancement of informatization.

4. Lesson to Japan

In line with the rapid growth of national economy, the development of regional economies in China has been very divergent. Since the 1990s, China's nationwide economic development has shifted from an inter-regional homogeneity to an inter-regional heterogeneity corresponding to an information society. Such and inter-regional heterogeneity results in China's unique transitional institution that evolves dynamically with the heterogeneous economic development, which in turn, contributes to sustainable economic development in China. Contrary to Japan's slow paradigm change and its economic stagnation in the 1990s, due to its organizational inertia in an industrial society, China's institutional systems react elastically to the disseminative, interactive, co-evolutional, global and invisible features of ICT.

5. Conclusion

Based on empirical analyses, the foregoing hypotheses essential for BRICs/China's sustainable development were demonstrated. First, the co-evolutionary dynamism between innovation and institutional systems was identified in 40 countries. Second, considering China's economic and education development and urbanization along with advancement of ICT over the last two decades, the institutional cycle and the role of ICT in constructing this virtuous circle were analyzed. Third, by investigating the economic development in China's 31 regions, the paradigm change from an inter-regional homogeneity to an inter-regional heterogeneity in an information society was identified.

An Empirical Analysis of the Development Trajectory of Chinese Software Industry: Focusing on Outsourcing and Industry Clusters based on Viewpoints of SIMOT

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1. Introduction

Information and communication technology (ICT) has been at the heart of the ongoing debate about economic growth and performance since its emergence in the 1990s. In ICT, the software market has shown rapid growth and the development of ICT largely depends on advances in software technology. Thus, many nations have been actively developing and pursuing the most qualified resources for software development for nations' competitiveness. China began to develop its software industry at the beginning of the 1990s, and then has been making rapid conspicuous development in China. This research, attempts to elucidate the development trajectory of Chinese software industry by focusing on outsourcing and industry clusters related to Chinese unique institutional systems, which have been playing a crucial role for the industrial development and more innovations.

2. Software Outsourcing Dynamism in China nad Japan

Firstly, the software outsourcing dynamism between Japan and China and Chinese institutional systems for its software industry's development are analyzed by empirical analyses. By measuring the potential of software development, co-evolutionary dynamism between advancement of economic level, ICT and the potential of software development is elucidated. Then the co-evolutionary dynamism is demonstrated by substitution dynamism; by means of Bass model, it is also demonstrated that high functionality development can be sustained by substitution of imitator (China) for innovator (Japan) through outsourcing. Consequently institutional structure governing the potential of software development is analyzed; thereby institutional factors essential for the software development are identified.

2. Exploration of Competitive Advantages in an Industry Cluster within Local Institutional Systems

Secondly, qualitative analyses on the exploration of competitive advantages in an industry cluster within local institutional systems are conducted with the case of Dalian Software Park (DLSP) in China. The "diamond" model analysis and SWOT analysis gain insights into the exploration of the institutional sources behind the competitiveness. Industry clusters, which encompass a series of interconnected firms in designated geographic concentrations, show competitive advantages for industrial development with substantial resources rooted in local institutional systems including government, industry and academia aspects. The interview results help to pursue the clustering effect by visualizing the relationships among the clustered firms. Then clustering effect in DLSP is regarded as an important contributor for the success of an industry cluster.

2. Comparative analyses of software industries between China and India

Finally, since the emergence of new innovation depends on co-evolution with institutional systems, conspicuous software advancements in China and India can be attributed to their unique institutional systems. Comparative analyses of software industries between China and India are conducted to identify the similarities and differences of their institutional systems to stimulate more competition and cooperation and promote further sustainable industrial development by learning from each other. Then, from the perspective of risk management, by means of portfolio analysis of India's software export market constitution, it is clear that risk management is undoubtedly crucial for sustainable and healthy growth of software outsourcing industry.

4. Conclusion

These analyses inevitably urges to identifying the key role of outsourcing and industry clusters for the development of Chinese software industry. Software industry, as a kind of high-tech industries, its sustainable development is deeply connected to nation's unique institutional systems, which implies the necessity of co-evolution between institutional systems and industrial development.

Tripolarization of R&D Profitability Structure in Japan's High-technology Firms

- Co-evolutionary Domestication Leads a Way to Sustainable Functionality Development

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1. Introduction

Confronting the paradigm shift from an industrial society to an information society and to a service-oriented economy, locomotive of the innovation has been shifting from manufacturing technology to information technology (IT). Given the structural differences of manufacturing technology and IT, and also subsequent shift of the place where innovation takes place from development sites to diffusion and utilization sites, traditional Japanese firms (J firms) have demonstrated a notable shift to tripolarization.

Notwithstanding such a notable structural change, the classification of industrial sectors still remains a traditional classification by means of labor productivity based homogeneity resulting in firms strategies to non-correspondence to timely demand in a new paradigm.

2. Re-classification of Industry toward a Service-oriented Economy

In light of the foregoing increasing discrepancy, a new classification of industrial sectors depending on the R&D elasticity to operating income to sales (OIS) was first developed identified a clear contrast between hybrid firms (primarily IT firms and new ventures) and leading technology-based firms (primarily high-technology electric machinery and transport equipment firms). While both firms belong to high-technology firms, the former demonstrates a high R&D elasticity to OIS, the former demonstrates a lower elasticity.

3. Functionality Development Dynamism in a Diffusion Process

This finding further prompted us the significance of the leaning efforts for self-propagating assimilation capacity essential to sustainable functionality development (FD).

Based on these findings, the dynamism in emerging sustainable FD was then analyzed. An empirical analysis was conducted taking Japan's mobile phones (MPs) development trajectories. While it is generally accepted that IT has a self-propagating function which ensures the more widespread use endorsed by sustainable FD as demonstrated by leading technology-based firms, its emerging dynamism remains a black box.

4. Co-evolutionary Domestication through Coopetition

Inspired by this correspondence, co-evolutionary domestication initiated by Canon which demonstrated a notable R&D profitable performance was analyzed thirdly. It was identified that Canon has constructed a comprehensive co-evolutionary domestication dynamism consisting of (i) market stimulation by providing attractive innovation, (ii) inducement of self-propagating FD in the market, (iii) fertilizing new innovation in the market in its self-propagating dynamism, (iv) domesticating and inducing innovation of rival firms through coopetition, and (v) intra-firm technology spillover. This dynamism can largely attributed to its intensive fusing efforts between its indigenous strength developed through its indigenous intra-firm technology spillover and effects of cumulative learning of global best practice through its unique coopetition strategy.

5. Conclusion

All foregoing findings provide constructive suggestions to high-technology firms for their technopreneurial strategies in open innovation.

Optimal Trajectory of Hi-technology Development through R&D, Learning and Market Competition

-An Empirical Analysis of Canon Printers' Growth Trajectory

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1. Introduction

Japan's electrical machinery firms are typical high technology firms and have been playing a leading role in Japan's economic development. The technology stock of these firms has converged over the last two decades, which can be attributed to the contrasting performance between gigantic and follower firms. While challenging to new functionality development, the gigantic firms were impeded by organizational inertia, and the follower firms could be free from it leading to active development of new functionalities, which guarantees them successfully securing their R&D funds by shifting from their operating income to market place. Among the follower firms Canon demonstrated a conspicuous increase in both its operating income to sales and technological diversification through effective utilization of potential resources for innovation.

2. Effective Utilization of Potential Resources for Innovation

Such effective utilization of potential resources for innovation is a potential strategy way to construct an optimal techno-economic development trajectory. Since technology knowledge stock is considered a significant contributor to the gross value of firm, R&D investment is significant part of sales allocation, the balance between firm's profit and R&D investment is rather complicated. In this regard, a strategy that contributes to increase firm's high performance through the optimal balance between indigenous R&D investment and learning effects become crucial for firm's strategy.

Facing emerging new technological paradigm, high-technology firms have to make every effort to seek and explore new technological opportunities, when targeting new generation innovative products, high functionality and high prices through fusion of indigenous R&D investment and market learning should be the important policy to realize it.

3. Emprical Analysis

Prompted by the foregoing observations, first, taking Japan's electrical machinery firms, empirical analyses are attempted to elucidate the impacts of converging trend of technology stock to the economic performance of gigantic and follower firms. In addition, Canon's technology diversification strategy and its mechanism leading to high economic performance are analyzed. Second, by means of optimal theory, optimal techno-economic trajectory of Canon printers is analyzed. Third, an empirical analysis of Canon printers is attempted to demonstrate the co-evolution between R&D investment and market learning. Finally, further analyses are attempted to identify new innovative products with high functionality and high prices through fusion of indigenous R&D investment and market learning.

4. Conclusion

Based on the noteworthy findings obtained from the foregoing analyses, this research demonstrates the optimal trajectory of high-tech products through effective R&D investment and market learning for sustainable growth in the competitive market.

Sustainable Functionality Development Dynamics in Open Innovation toward a Post-oil Society

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1. Introduction

In line with the advancement of information technology (IT), the place where innovation occurs has been shifting from development sites to diffusion and utilization sites. Consequently, integration of production, diffusion and consumption functions has become indispensable. An integrated function suggests that self-propagating functionality development (FD) can only be an option for sustainable growth.

Thus, optimization of utmost gratification of consumption under certain investment would be crucial for firm strategy. Optimal functionality development dynamics is analyzed in this research by integrating production, diffusion and consumption functions, and using Pontryagin maximum principle. The result demonstrates that supra-functionality can be developed through gratification of consumption substitution for resistance to new innovation. Furthermore, the sharp hike in international oil prices to US$ 140 a barrel in mid-2008 dramatically impacted the technopreneurial structure of global firms. While oil prices have since eased, the International Energy Agency (IEA) warned in its World Energy Outlook 2008 that prices will rise to beyond US$ 200 a barrel in 2030. Such a dramatic increase may stimulate a transformation of external crises to a springboard for new innovation as Japan accomplished in the 1970s against the energy crises of 1973 and 1979. On the basis of numerical and empirical analyses, this research attempts to demonstrate this hypothetical view.

2. New Functionality Development through Follower Substitution for a Leader in Open Innovation

This section analyzed the dynamism of imitator substitution for innovator in the diffusion process. Mathematical analyses with respect to diffusion dynamism in the Bass model identified that the early emergence of FD enables sustainable FD and the foregoing substitution plays a decisive role in early FD emergence. This was then demonstrated by empirical analyses utilizing the Bi-Bass model on the diffusion trajectories of leading technologies such as mobile phones, Web 1.0 and 2.0, liquid crystal displays (LCDs) and photovoltaics (PV).

3. Optimal Level of Functionality Development

Inspired by these findings, this section analyzed the optimal trajectory for sustainable FD under certain investment constraints. Given the foregoing integration between production, diffusion and consumption functions, optimal dynamism in this integration was analyzed by utilizing optimal theory. Prompted by the finding obtained in the preceding analysis that a new stream of innovation characterized by follower (imitator) substitution for a leader (innovator) is a reminder of the significance of gratification of consumption in self-propagating FD, it was identified that optimization endeavors aiming at maximizing the significance of consumption under certain investment constraints creates supra-functionality which satisfies not only economic value but also social, cultural, aspirational, and emotional needs.

4. Utmost Fear Leveraging Innovation toward a Post-oil Society

This can be realized by accelerating follower substitution for a leader by shifting from resistance to FD to a habit persistence hypothesis leveraged by utmost gratification of functionality ever experienced. Utmost fear ever experienced would have similar leverage, and this hypothetical view was demonstrated by an empirical analysis of Japan's PV development trajectory.

5. Conclusion

Consistent prolongation effort to FD is important in enhancing higher level of FD, which in turn induces the acceleration of earlier emergence of FD leading to constructing a virtuous cycle would be essential. Integrated approach between production, diffusion and consumption functions is indispensable for technopreneurial strategy in open innovation and also sharp hike in oil process should be utilized for transformation of crises to springboard for further innovation. Utmost fear hypothesis should be applied for leveraging new innovation toward a post-oil society. PV development should be accelerated for new institutional innovation in a post-oil society.

Institutions and Renewable Energy – The case of Solar Photovoltaic

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1. Introduction

Climate Change is one of the most important and pressing problems humanity faces in the contemporary world and its sustainable development. According to IPCC Intergovernmental Panel on Climate Change, climate change is man-made and is due to the emissions of Greenhouse gases such as carbon dioxide. To slow down or to rectify the climate change problem, one overall strategy is therefore to migrate to a low-carbon society.

One of the key components to facilitate this societal transition is the de-carbonization of the incumbent fossil-fuel based energy regime. The deployment of de-centralized renewable energy, while a direct contribution, faces the carbon lock-in problem which dramatically slows down the adoption of alternative energy sources such as solar photovoltaic.

2. Significance of Technology Improvements in Solar Photovoltaic

There are now significant technology improvements in the solar photovoltaic conversion process in terms of energy efficiency increase due to development of new solar cell materials. The so-called first generation of solar cell is silicon-based while subsequent generations are increasingly dominated by organic thin-film based and nano-materials compound systems. In addition, volume-based learning by doing in the economics of solar cell production also significantly drive down the cost of solar cell in a solar photovoltaic system. Due to the globalization of the technology markets, new technological development and production economy can be assumed to be available to users worldwide. The deployment of an overall solar photovoltaic system, especially those of small scale residential, grid connected, roof-top system, is therefore dominated by how local institutions facilitate the system integration process.

3. Framework

I compared two conspicuously different deployment strategies of solar photovoltaic (PV) in Japan and the US in my SIMOT study. Japan's policy has focused upon the aforementioned standardized small scale residential system with extensive vertical integration in the design and installation process. This gives rise to a *closed* deployment model. The US decided to deploy solar photovoltaic as a broad based innovation emphasizing one-off customization without a particular application focus with significantly less integration in the PV system integration process which can be summarized in terms of an *open* deployment model.

4. Emprical Analysis

The *production learning* economy of these two deployment models is demonstrated empirically to be very different. The closed model not only has a lower per kilowatt based system (integration) cost but also see its learning coefficient decreases and saturating. The open model has a higher per kilowatt based system (integration) cost but also see its learning coefficient improving gradually. In other words, learning effectiveness is low in the open model due to dis-organization of system integration process and a lack of deployment focus rendering the cumulative learning slow and taking place over a diffused spatial and temporal context. The technological diffusion pattern for this dis-aggregated category of PV application is also demonstrated to be different across the deployment models. These empirical verifications give creditability to our theoretical postulates and development to the Science of Institutional Management of Technology (SIMOT).

5. Conclusion

The effectiveness of these deployment models should also be examined in a *longitudinal and forward fashion*. Here, I attempt to interpret each deployment model and contexts in terms of the technological trajectory associated with each model. I examined the possible development of these models with respect to the trend of smart grid development. I examined how earlier deployment would constrain and enable the future innovation focus of such small PV systems as they need to be retrofitted with ICT (Information and Communications Technology) functionalities to interact with other decentralized energy sources and the utility grid. This represents a future and ongoing research possibility. Another even more general research outlook is to compare trade-off of learning effectiveness in earlier stages and functionality development in subsequent stages. The *mitigation* of such inter-temporal trade-offs, if any, would constitute the focus of energy and technology policy. Here, it is suggested that institutional co-evolution would be an essential element in such policy development.

Nanotechnology Innovation System: Technology Fusion Trajectories and Evolution of Innovation Infrastructures

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1. Introduction

Nanotechnology has been regarded as a science and technology-based innovation and is recognized as a promising new growth innovator of 21st century. Hardly any other technology has attracted so much public and private funding globally as fast, and generated as much hype and science-fiction-like speculations about its technical, commercial and social potential, which has encouraged a dramatic rise in research and development (R&D) in all developed countries and many developing countries. Additionally, organizations (e.g. universities and public research institutes and company R&D laboratories) have strongly focused on nanotechnology to grasp competitive scientific and technological advantages. A few studies on innovation and technology management related to nanotechnology exist so far. For years, it has been said that innovation is achieved by breaking through the boundaries of existing technologies. I assumed nanotechnology is a highly multi-disciplinary and multi-domains fused technology, which affects versatile areas. Both, gaps in the literature and the government-prioritized initiatives of nanotechnology reveal a need for guidelines on exploring and implementing Nanotechnology Innovation System (NanoSI), and thus make it an excellent case for a study.

2. Framework and Methodology

This research aims at closing this gap by making major contributions in the areas of theory and practice. I have argued how nanotechnology is driven by science and technological research and in what way fields are exploring the technology. The central purpose of this study is to provide an empirical analysis of the dynamics of technology evolution, which is typically a focused area in innovation studies and explore the attributes of innovation structures within NanoSI. The analysis proceeds to examine how scientific disciplines are fusing into nanotech from its emerging stage and what are the determining factors. This research constructs a research framework to analyze NanoSI using Systems of Innovation approach along with Techno-Economic Network concept, which provides a coherent analytical tool for handling the disparate processes of nano-knowledge creation, distribution and use, and identify obstacles for the well functioning of NanoSI. The embryonic fluid stage of NanoSI represents a methodological challenge, conceptually as well as data wise. A hybrid research methodology adopts, which appears a fist attempt in analyzing NanoSI's case by utilizing both quantitative and qualitative method, creating a more solid foundation to synthesize nanotechnology fusion trajectories and its innovation infrastructures. I chose both inductive and deductive research strategies, which I think exert a high impact to explore NanoSI.

3. Findings

The findings explore the macro level study of nano-scientific infrastructures, analyzes the actors structures, their roles and linkages within NanoSI, and nanotech domain-level competencies. It also establishes the technology fusion pattern and its similarity and disparity between Japan and Europe, identify demand and push factors for driving nanotech innovation, including an assessment of the performance of science and technology structures, and other framework conditions shaped by government policies. Finally, it suggests a multi-level framework of nanotech fusion trajectories and a model of nanotech innovation paths, and design nanotechnology roadmapping that seem a unique study in the case of NanoSI, particularly important in seeking to capture the attributes related to its co-evolutionary nature.

3. Conclusion

From the findings, it would be indicative that divergent scientific disciplines and technology domains are bridging to establish NanoSI. The main academic contribution to theory is that it has made an original effort to shed light on the process of measuring technology fusion related to nanotech. Promoting technology fusion with scientific fields and its spiral way of innovation attracts much interest of policy makers, because such innovation pattern could be considered a major generator of future economic development opportunities. This research confirms the importance of collaborative research network between divergent scientific fields as well as institutions in respect of nano-scale, and suggests universities and industry to be more open to non-traditional collaboration to ease technology transfer. The evidence in this research indicated that NanoSI contributes to innovation studies in a quite different way.

Abstract of Research in SIMOT COE

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1. Introduction

The mobile telecommunication market in Japan has seen explosive growth annually due to the rapid development of communication technology, the growing demand for multimedia services, and due to competition among different mobile operators. The mobile telecommunication market has become saturated, and service differentiation is now hard to achieve. This makes it more difficult for mobile operators to obtain new subscribers. Thus, mobile operators have started to introduce new services to squeeze more sales from fixed number of subscribers.

Japanese mobile operators are still going strong in its home market, but it is not clear if the success in Japan will be repeated abroad. This is attributed to ineffective utilization of IT strength that can lead to failure of new source of growth. This research attempts to find the solution for Japanese mobile operators to enhance their long-term competitive edge both in domestic and oversea market.

2. Attractiveness of mobile sector in this research

Mobile sector is the industry that continuously emerges innovations. These mobile innovations create new fields and new values. In addition, mobile sector has a great influence on other sectors. New business models are introduced by merging different technologies or different services, and mobile sector often converge with other sectors, such as broadcasting (DMB service), building and construction (smart home), finance (e-banking, e-commerce) and automobile (telematics). Mobile sector is also important for national potential.

3. Relationships between mobile actors and mobile service innovation

In the mobile industry, new technology creates a new market that doesn't exist in the past. On the other hand, the growing progress in mobile technology gives new market entrants a chance to be a market leader. Under these circumstances, collaboration and cooperation is essential for developing the capabilities for producing and packaging advanced converged technologies on a mass market and be first to market them. Mobile operators do not innovate in isolation but depend on external sources such as other mobile manufacturers, customers or public institutions in the creation of new innovative services. Thus, mobile actors should dynamically form collaboration with other actors.

In Japan, collaboration among mobile actors is evident in mobile sector. Mobile operators often rely on external linkage in the form of joint ventures or technological collaboration and these dynamic processes determine the competitive advantage of an industry actor. For example, win-win relationship with contents providers affected the success of NTT DoCoMo's i-mode.

4. Opportunity for Japanese mobile actors in the global market

The analysis of Japanese mobile sector (the type and role of mobile actors, the structure and dynamics of production, the rate and direction of innovation, and the effects of these variables on the performance of mobile firms and country) identifies the relationships among mobile actors under dynamic industry environment and traces the process of mobile service innovation. This provides the strategic implication of Japanese mobile operators and manufacturers for their effective utilization of IT strength in oversea market.

5. Conclusion

This research looks back at the year past and seeks to learn its lessons in Japanese mobile sector, understanding how the sectoral environment affects the relationship between mobile actors and suggesting specific measures to improve the policies of Japanese mobile actors. The research develops the ongoing study about mobile sector and approaches from not only Japanese domestic industry but also from a global competitiveness point of view. It seems that Japanese mobile actors can get some implication from Korean mobile actors that are doing in oversea market compared to Japan.

Study on Decision-Making Procedures at SIMOT

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1. Introduction

The Industrial Engineering and Management Institute of Technology (SIMOT) aims to elucidate the dynamism for the co-evolution of Japan's Institutions and Innovation and to elevate these to world standards (values) applicable also to other countries with different institutions from Japan. In order to achieve this it is thus not enough to have only a qualitative understanding of the Japanese-style co-evolutionary dynamism, rather it is essential to consider how we should apply the insights we have gained in practice.

The purpose of this study has been to identify the way in which decisions are made in matters concerning the way in which decisions should be made in real economy activity. The climate in which decision-making actually takes place, is extremely complicated due to the many restrictions that apply. In this study, we pursued from a theoretical viewpoint the methodologies for effective decision-making by expressing these conditions in a linear programming model.

2. Problem of Linear Programming and the Interior Point Method

The problem of linear programming is that this method only permits the modelling of the extremely common and numerous problems that arise in industry, in other words, in factory and industrial as well as transport logistics programs. The Interior Point Method provides a powerful algorithm for solving linear programming models. To make the Interior Point Method a more effective algorithm it is essential to comprehend the theoretical behaviour of the technique. While the Interior Point Method is an algebraic algorithm a geometric interpretation is also possible. This study is an attempt to gain a deeper understanding of the theoretical nature of the Interior Point Method by using a geometric approach for Interior Point Method analysis.

3. New Findings on the Reiteration Frequency of the Interior Point Method

The Interior Point Method constitutes an approximation algorithm that comes infinitesimally close to the optimum solution through a repeat of reiterations. In deterring this reiteration algorithm it is important to estimate how many reiterations are necessary in the worst-case scenario. With the geometrical algorithm referred to in 2 above it has been possible to prove in a mathematical manner the new results according to which the reiteration number in the worst case scenario depends only data that are only a part of the problem.

4. Layered Least Square Method versus Least Square Method

In this study, we have considered the theoretical nature of the layered least square method that featured in the research work described in 3. This method is different from the general least square method in that it involves a breakdown into layers making it necessary to repeat the least square method consecutively layer by layer. The layered least square method has therefore attracted much attention as a modelling tool in recent years. This study has shown that under certain extreme conditions, the layered least square method results do agree with the least square method solutions. It is important to note that this suggests that the least square method is a useful tool for modelling.

5. Conclusion

In this study interest with regard to the decision-making process at SIMOT has in particular focused on the linear programming method. The Interior Point Method constitutes an algorithm that helps solving problems of linear programming. Analysis was therefore conducted using the Interior Point Method as a geometrical approach and it was possible to obtain new data on the reiteration frequency in the word-case scenario. With regard to the layered least square method encountered in our analysis work it was possible to confirm that this method has properties suggesting its usefulness as a practice tool.

Future research will focus on numerical programming models descriptive of the real economic phenomena.

Optimization Approaches for Support Vector Classification

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1. Introduction

The problem of classification arises in a broad range of fields such as text categorization, image retrieval, and marketing analysis. In these areas, developments in computer technology have made it possible to store a tremendous amount of data. As a result, the set of collected data is too huge to be dealt with by human experts. Therefore, there is a need to devise algorithms which can handle such huge datasets.

In these years, support vector machines (SVM) has been considered as one of the most powerful methods for binary classification problems. Several formulations and some sophisticated algorithms have been developed, which enable us to solve a broad range of real-world classification problems such as text categorization and image recognition. However, it is difficult to solve huge datasets by SVM due to some limitations. In this research, we considered the classification methods based on SVM. We proposed several optimization approaches for support vector classification which can deal with huge datasets.

2. Support Vector Machines

In Chapter 2, we review some basic concepts and the formulations of the SVM. We first introduce the SVM, which generates a linear classifier. After introducing slack variables into the formulation of the SVM, this approach is applicable to deal with outliers and noises in the datasets. We also review some theories of kernel functions, which can be combined with the dual formulation of the SVM to provide nonlinear classifiers by mapping the input data points into a high-dimensional space.

3. Feature Selection by the SVM Discriminant Boundary

In Chapter 3, we propose SVM-based feature ranking and selecting methods and their application for text categorization. The task of text categorization consists of classifying documents into predetermined categories based on their contents. Each distinct term, or word, in the documents is a feature for representing a document. In general, the number of terms may be extremely large, which will reduce the performance of classification. Using several properties of the discriminant boundary generated by SVM, we propose an efficient method for classification. The results of experiments on several real-world datasets show that the proposed method achieves better performance than the existing feature selecting methods for text categorization.

4. Multiclass Classification and Algorithms

In Chapter 4, we propose new procedures which solve the multiclass problems using a cutting plane algorithm. We demonstrate that the multiclass problem can be optimized by adding a finite number of cutting planes, and each cutting plane is obtained efficiently by solving a simple optimization problem. The results of experiments on several real-world datasets show that the proposed method achieves higher performance of classification than the conventional method. Moreover, when the number of classes is large, the numerical results indicate that the newly proposed method requires less computational time than the conventional method.

5. Semi-supervised Classification and the Optimization Approaches

In Chapter 5, we introduce new semi-supervised learning methods for two-class, multiclass, and one-class classification problems. The proposed semi-supervised one-class SVM (1-SVM) methods are also derived from the formulation of the supervised 1-SVM. The formulations of the proposed 1-SVM are similar to the one of semi-supervised multiclass classification, which can be efficiently optimized. Several numerical results indicate that the proposed approaches, i.e., semi-supervised multiclass classification and semi-supervised 1-SVM, provide higher performance than existing methods.

6. Conclusion

In this research, we proposed several optimization approaches for support vector classification which can deal with huge datasets. Moreover, the results of experiments on several real-world large scale datasets show that the proposed methods achieve better performance than the existing methods in many areas such as text categorization and customer recommender system.

Shedding Light on the Mechanism for Customer Satisfaction (CS) Building and A Japan-US Comparison

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1. Introduction

This study related to customer satisfaction, an important management issue for today's companies, has discovered and substantiated the existence of new omnipresent results through the passage of time based on a consideration the mechanism responsible for the generation of CS and on CS data from Japan and the United States.

Our research results based on CS studies in the market field and on CS studies carried at the national level in the US –notably the ACSI (American Customer Satisfaction Index) study around 1990 and in Europe are presented here, with attention focusing on the need the time-related effects (e.g., public feelings about the economic situation) on the level of customer satisfaction by considering the way CS is related to corporate performance.

2. Relationship between the Pattern of Year on Year Changes in the CS index based on the Level of Quality Improvement Expectation and Market Share

Using the Quality Improvement Expectation level which can serve as an indicator of the monadic CS index measured for the three major consumer durables on the Japanese market (refrigerators, TV sets, and washing machines), data that have been collected over the last 25 years, we raised the topic of the average NIKKEI Share Index as a tell-tale indicator of the public's feelings about the economic situation and found that there is a strong negative correlation between the NIKKEI and the CS index. Eliminating any bias resulting from viewing the effect as an economic status perception bias and allowing for the time delay, we did find, however, that there was a significant positive correlation between the two, contrary to the conventional research approach that interprets this effect as bias in the public's perception of the economic situation and so considers whether there is no or only a low correlation between the customer satisfaction index and market share. On the assumption that the time bias corresponds to the replacement cycle of the above products it was found that these results were in agreement also with the"Expectation – Disconfirmation Paradigm" known as the mechanism underlying the formation of Customer Satisfaction.

3. Customer Satisfaction versus Blaming-the-Economy Attitude

Considering that because the overseas CSI study data and especially the ACSI as the most representative figures, are already 10 years old the data are now being analyzed in the same manner as in 2 above, we carried out an analysis serving an expanded version that takes up the ASCI as a representative cumulative index and 11 economic indicators thought to be related to the DOW average and the public's economic status perception. Although the results indicated that although the ASCI data presented a smaller magnitude of correlation than the Japanese data, they too show a negative correlation the share value mad GDP, attributes related to the public feelings about the economic situation. It was recognized at the same tine that CS had a positive correlation with personal income and consumer expenditure, leading to the conclusion that together with the public's economic status perception this might be described as a complementary factor pulling up the CS level. Analyzing the factor also on a breakdown by industrial sector, the same relationship was discovered and at the same time that there was a clear negative correlation between the average CS per sector and the economic status perception bias, in other words, the economic status perception bias was the greater the more the sector showed a low customer satisfaction index, suggesting that the factor explaining this mechanism is due to the existence of switching costs.

4. Analysis of Effect of CSI using the consumer psychology index and Comparison between Japan and the US

In order to enhance the accuracy of the analyses carried out until the present a comparative analysis was made between the Japanese and US data, using the Consumer Confidence/Expectation index (an indicator believed to more indicative of the economic status perception bias) in addition to the economic and consumer expenditure indices use so far. Since, however, these variables are strongly interrelated analysis was performed by way of applying main component analysis to the explanatory variables. Consequently, it was possible to analyze by breakdown into four main components, expansion in scale of the economy, economic status perception, an expectation of an upward trend of the economy and limit expectation, and so we were successful in extracting a model explaining the consumer satisfaction generation mechanism in fuller detail in the sense that there was a positive correlation between customer satisfaction and economic scale as, factors believed to be indicative of quality recognition, and a significant negative one in terms of economic status perception and limit expectations, factors believed to influence idealized expectations (comparison standards). Identical results were also obtained with the Japanese data.

5. Conclusion

The outlook for the future is that hopefully the results covered in this research that has used only Japanese and US data for verification may be expanded by the same results expected from the GCN, the German Customer Satisfaction Index data. And further research will be undertaken by taking the differences of the institutions in the various countries into consideration. For this it will be necessary to conduct further CSI studies to discover the omnipresence of what is called the time-related "economic states perception bias" and thereby prove its ubiquity. Having shown the presence of this time lapse effect it will be possible not only to consider new findings for clarifying the mechanism underlying the generation of customer satisfaction but also to pave the way towards new directions in customer satisfaction research. These endeavours are also of great practical value in that they shed light on the relationship between customer satisfaction and economic results, taking into account the "economic status perception bias.

How Economic Processes and Institutional Characteristics Co-Evolve with Customer Satisfaction and Loyalty

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1. Introduction

The analysis of institutional influences on co-evolutionary dynamisms between economic growth and innovation is at the heart of the SIMOT framework. I conducted this type of analysis from the perspective of marketing and quality management. My research analyzed the co-evolution between quantitative and customer-perceived qualitative economic indicators and explored how national and industrial institutions affect these relationships. After fundamental research yielded an empirically verified theory of these dynamisms, additional research explored consequences of this theory for management and policy makers. In this process, I developed techniques to refine quality management and international marketing strategies.

2. Co-Evolution between Economic Processes and Customer Satisfaction across Countries

Since consumer appreciation represents both an objective and a source of corporate endeavors, I analyzed whether customer satisfaction and economic development are elements of a co-evolutionary relationship. My analyses of eight countries revealed that economic expansion exerts a positive influence on customer satisfaction, whereas economic expectations exert a negative influence. Conversely, I also analyzed whether customer satisfaction growth has a positive impact on spending growth, but I could only confirm the effect for Sweden.

3. Removing Economic Influences from Customer Satisfaction to Improve Quality Management

The above research project found that customer satisfaction is positively influenced by economic growth and negatively by the national stock index. These results are important to managers using customer satisfaction surveys to benchmark changes in their firm's customer-oriented performance over time. They run the danger of misinterpreting economic-induced variations in customer satisfaction as caused by changing customer-oriented performance. My study on durable goods and hospitals shows that this danger is justified because economic processes explain 49 to 95%, thus the majority, of variations in firm-level customer satisfaction scores. To help firms interpret variations in customer satisfaction, I proposed two methods to correct time series of customer satisfaction by removing economic influences. I verified the corrected scores by their impact on future business performance. In a number of institutional settings, I confirmed that my correction methods can help managers better understand their firm's customer-oriented performance and predict future business performance.

4. The Influences of Gender and Culture on the Determinants of Customer Loyalty

Customer loyalty is one of the most important drivers of business performance. Within the SIMOT framework, my research explored the moderating impacts of market characteristics, gender, culture, and Chinese-Japanese differences on the determinants of customer loyalty in Japan. I found that customer satisfaction is the most important driver of customer loyalty in Japanese product industries, whereas brand image is the most important loyalty driver in service industries. Women care far more than men about brand image and less about customer satisfaction, price, and new product functionalities. Switching costs have stronger effects on men than women. Chinese care more about price and less about brand image than Japanese. Uncertainty avoidance positively relates to customer loyalty. Time-related switching costs and brand image have a stronger influence on the loyalty attitudes of collectivist compared with individualistic consumers.

5. Conclusion

The most important results of my SIMOT research were that customer satisfaction is positively influenced by economic growth and negatively by economic expectations. Conversely, customer only has a very limited to no impact on economic growth measures. Removing economic influences from time series of customer satisfaction may enhance the strategic meaningfulness of customer satisfaction scores and thus improve quality management. New knowledge about differences in consumer behavior between men and women, Japanese and Chinese, individualistic and collectivist consumers enable firms to design cross-cultural customer retention strategies.

International Comparative Research on Cultural Factors of Customer Satisfaction

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1. Introduction

Customer satisfaction has long been a central issue in marketing theory and practice. In recent years, aggregate-level customer satisfaction has gained research attention and a number of studies have investigated its linkage to financial and economic performance. While the extent literature examined the consequences of aggregate customer satisfaction, there has been relatively little study on its antecedents. Moreover, despite concern about internationalisation strategies of companies and organizations, the aspect of cultural difference has been lacking in the literature. The main objective of this research is to explore aggregate-level antecedents to customer satisfaction, and in particular, it focuses on cultural context. Subsequently, individual-level analysis is carried out to confirm the validity of aggregate-level findings. Finally the research scope is extended further to the examination of the relationship between customer satisfaction and life satisfaction.

2. Relationships between Economic Indicators and National Customer satisfaction

First of all, by analysing the relationships between various economic indicators and national customer satisfaction date, antecedents of aggregate customer satisfaction were examined. The results indicated the existence of two significant factors that affect customer satisfaction, both positively and negatively. One of these factors, an “economic growth factor”, has a positive impact on aggregate customer satisfaction, while the other, an “economic condition factor”, has a negative impact on it. The effects of these two antecedents were observed in all countries studied, regardless of differences in measurement methods or country-related institutional factors. These findings suggest that companies should view trends in aggregate customer satisfaction with the realization that factors besides product or service performance may be impacting customer satisfaction.

3. Cross National Comparison of Customer Satisfaction

Second, cross national comparison of customer satisfaction was carried out. Using customer satisfaction date of nine countries, the effect of economic institutions and national culture on customer satisfaction was analysed. The results indicated that there is a systematic difference in customer satisfaction among countries. It was also found that customer satisfaction is higher in economically freer countries. And most important is the finding that customer satisfaction is higher in countries where individualism is higher and uncertainty avoidance is weaker. As an implication for multinational companies, these results suggest that special efforts are necessary in marketing a product / service in countries where uncertainly avoidance is strong because consumers’ expectations and demand levels are higher than other countries.

4. Individual-level Analysis

In contrast to the previous country-level analysis, subsequently individual-level analysis was carried out. A questionnaire survey measured individual-level culture, variety seeking, switching costs, customer satisfaction, and repurchase intent with eight different types of products / services. The results suggested the existence of a moderating effect of switching costs on sulture-satisfaction relationship. In the high-switching-costs group, support was found for the hypothesized positive effect of individualism and negative effect of uncertainly avoidance on customer satisfaction, which corresponds to the preceding aggregate-level results. In addition, the results also suggested the negative influence of variety seeking on repurchase intent particularly in service industries rather than products, in addition to the known effect of customer satisfaction and switching costs. The findings of this research imply the need of caution with prevalent customer retention strategy realized by establishing high switching costs of a product / service. It may not work for high-individualism customer group, and for strong-uncertainty-avoidance customer group an adverse effect – lowering customer satisfaction – could occur.

5. Conclusion

Lastly, the research went further into comparison of customer satisfaction with life satisfaction. Using aggregate-level customer satisfaction and life satisfaction data of various coutries, it was found that on a long term, customer satisfaction is more sensitive to economic change than life satisfaction. Moreover, the results of cross-country comparison indicated the cultural influence on life satisfaction in the same way as customer satisfaction, but its impact is stronger than customer satisfaction. It was also found that customer satisfaction, life satisfaction, financial satisfaction, and job satisfaction are interrelated each other. These findings will contribute to further understanding of the mechanism and linkage of customer satisfaction and life satisfaction.

Cross National Comparative Analysis on Supply Chain Operational Performance and Customized SCM Assessment Model for Thai Industry

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1. Introduction

Supply chain performance measurement was earlier noted as a significant key for improving the efficiency of the entire supply chain. Performance measurement could be used not only for driving continuous improvement of business but also set directions for future strategies in organization. This research focuses on analyzing supply chain operational performance of the Thai industry thoroughly with an extension to international comparison. The study mainly utilized Japanese developed self assessment tool, the Supply Chain Management Logistics scorecard (LSC). This scorecard is centered around four decisive areas, namely, company strategy, planning and execution capability, logistics performance, and IT utilization.

2. Supply Chain Operational Performance of Thailand's Manufacturing Sector

The first interest highlights on investigation supply chain operational performance of Thailand's manufacturing sector. Over 150 companies from five major industries in Thailand participated in the study by providing their LSC self-evaluation data.

This data was subsequently analyzed in order to indentify determinants of supply chain operational performance in terms of industry type and ownership status. The results indicate that different industries have focused on different areas of supply chain operational performance. Furthermore, it was observed that multinational companies in Thailand significantly outperform domestically owned companies in terms of supply chain operational performance level in several industry sectors. Also, dissimilarity between multinational and local companies was found in terms of their managerial philosophy or approach to supply chain management. The findings of this study may be useful as guidelines for investigating and enhancing supply chain operational performance in other newly industrialized or developing countries.

3. Potential Factors Constituting Efficient Supply Chain Operational Performance

The second stream of this research focuses on exploring supply chain operational performance and potential factors that constitute efficient supply chain operational performance in different countries, namely, Japan, Thailand and China. The scores in each assessment area were compared among countries. Subsequently, in this research study, a factor analysis was conducted using the result of the LSC in order to identify significant factors that represent the operational performance of SCM in each country. The result of the factor analysis indicate that the structures for generating successful SCM in Japanese, Thai and Chinese industries are not the same due to different operating environments.

Another aspect of interest concentrates on the institutional differences between nations and its influences on supply chain operational performance. Since the development of supply chain operational performance in global context is often limited by some of the institutional constrains, it is essential for the focal company to understand the institutional environments of the supply chain members to enhance related abilities. The proper institutional arrangement should be, furthermore, positioned to include cooperation and motivate all chain members to participate activities which produce reciprocal benefits. The research on supply chain operational performance was again carried out in Japan, Thailand and China. The findings indicate that the institutional environment would play important roles in the current performance level and could be one of the main obstacles in improving the supply chain operational performance. In addition, the companies with similar institutional environment have been observed to have common way of thinking with respect to supply chain management perception.

4. Relationship between IT in Supply Chain Management Systems and its Productivity

The final attention for this research has been drawn on the relationship between information technology (IT) in supply chain management systems and its productivity at national, industry, and company levels. Previous literatures suggested that in order to implement IT into an enterprise efficiently, it is required not only to introduce IT into existing process, but also adopt intangible approaches such as organizational reformation. In this research work, organizational strategy is identified as a vital ingredient. Our findings highlight the adoption of organizational strategy to supplement IT usage in an enterprise and their remarkable impact on the financial performance. IT implementation and SCM organizational data collected from participated companies in Japan using SCM Logistics Scorecard are utilized for hypothesis verification. This work also covers two other countries, Finland and Thailand, for cross national comparison. The interaction between IT utilization and organizational strategy shows positive contribution on some selected financial indicators of IT is accompanied by proper SCM organizational strategy, favorable improvement in the management performance can be ascertained.

5. Conclusion

This research also proposes the modification of the SCM logistics scorecard (LSC) to be suitable for Thai industry. The context of changes was achieved from data collection process together with the intensive review by specialists from various industry backgrounds. The diagnosis system was subsequently developed according to the accumulated data from Thai manufacturing and logistics service provider. This research further provides the fundamental idea in generating a country's before. The useful of database may possibly be adopted to assist in initiating related supply chain and logistics research to support better supply chain operational performance.

NPD of Japanese Manufacturing Firms: Institutional Views of R&D Intensity and Technology Trajectories

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1. Introduction

Firms have to heavily rely on New Product Development (NPD), to survive in the intensive competition and dynamic business environment. According to the empirical research on 396 Japanese manufacturing firms by using New Product Development Scorecard (NPDSC), three influential factors of *"Development strategy and organization", "Utilization capability of tools and IT"* and, "*Development production technology",* which affect NPD operational performance and financial performance, are explored. In general, NPD is the outcome of R&D process. Firms with different institutional level of R&D intensity (R&D expense per sales) may have different ways of implementations of these factors to contribute firm's financial performance.

In addition to the factor level that mentioned above, analysis through the NPDSC can provide the guidance of NPD operations which can also constitute NPD operational performance. Among several NPD performances, it has been known that NPD efficiency is mainly constituted by the technology of firms. Therefore, firms might require different critical NPD operations to improve development efficiency in each institutional trajectory of technology.

2. Relationships between NPD Influential Factors and Institutional Level of R&D Intensity

Regardless the effect of R&D intensity, in general, firms need to implement tools and IT incorporated with development strategy and organization factor or development production technology factor in order to constitute firms' financial performance (herein, revenue growth average 5 years). When considering the effect of institutional level of R&D intensity, the ways of implementations of these three factors are different. Firms with high R&D intensity need to integrate the implementation of development strategy and organization factor and development production technology factor to constitute firm's financial performance. In this case, using tools and IT might be considered as the facilitating factor which could not directly contribute to financial performance but still necessary to support those factors integration. On the other hands, for low R&D intensity group, firms require the combination of all three factors in order to bring competitive advantage and later directly enhance financial performance.

3. Critical NPD Operations for Each Institutional Technology Trajectory

Regarding Pavitt's industries classifications of technology trajectories, firms in each institutional trajectory should focus on different critical operations in order to improve NPD efficiency. Firms in the groups which technology come from external related parties (supplier-dominated and specialized suppliers group) need the NPD operations that concern to external sources of technology in order to improve development efficiency. Since technologies for supplier-dominated group are provided by suppliers, firms in this group should specifically emphasize on the exchange of technical standardized data with their suppliers as well as the design rationale system. Meanwhile, because technology for specialized suppliers group are generated from customer requirements, thus firms in this group should put the importance on grasping needs of customers and markets and try to make the relationship with them to. On the other hand, to enhance NPD efficiency in the groups which mainly rely on internal development of technology (scale-intensive and science-based group), firms require the operations that are particularly conducted on their own. For scale-intensive group, firms should focus on product data management that will be able to respond their typical features of in-house technology development as well as their internal learning and experience. Meanwhile, firms in science-based group, which technologies are mostly generated from internal R&D, should especially emphasize on developing their human resources and organizations.

4. Conclusion

The institutional level of R&D intensity and institutional technology trajectories respectively affect the ways of implementations for the NPD influential factors as well as the critical operations. These might be beneficial as the guidance for firms to let them know how and what to be done in order to enhance firms' financial performance and development efficiency in accordance with these institutional perspectives.

Cross-Industry Comparison of Drivers of Customer Satisfaction and Repurchase Intention

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1. Introduction

Customer satisfaction which has became a popular term of the 1990s, generating much interest among academic researchers. Studies have shown beneficial effects of satisfaction on consumer behavior, which result in increased loyalty, positive word-of-mouth advertisement, enhanced firm's reputation, and increased profits and growth. For these reasons customer satisfaction and loyalty have been widely studied as well as their influential factors. National customer satisfaction index/barometer has been developed in some countries to enhancing the performance of firms, industries, economic sectors and national economics. However, in the studies industrial differences of drivers of customer satisfaction and loyalty have been paid little attention.

The purpose of the research is to investigate cross-industry variation in customer satisfaction and repurchase intention which also refers to as loyalty, as well as determinates of them to explore Japanese consumer behavior.

2. Survey Methodology

In order to explore the drivers of customer satisfaction and repurchase intention a corresponded survey was designed with three main parts. The first part contains demographic questions along with economic and quality expectations. The second part contains questions about culture and life satisfaction. The last part includes a series of questions toward four goods (mobile phone, automobile, PC, shampoo), six private services (mobile phone service provider, hospital, supermarket, bank, fast foods, hair salon) and five public services (municipal administration, power supply company, post office, drivers' license renewal, tax authorities). Question items in this part mainly contains purchase experience, time since purchasing, main purpose of usage, overall satisfaction, pre-purchase expectations, perceived quality, perceived value (product quality relative to the price), recommendation intention, repurchase intention, corporate image, relational switching cost and non-relational (time, money, risk) switching cost.

3. Drivers of Customer Satisfaction

The main driver of customer satisfaction in Japan is perceived quality which has positive strong effect in all industries. Other important drivers are perceived value and corporate image. However, the impact of them varies from industry to industry. As to the purchase experience, for the products with high rate of change such as shampoo, hair salon, fast food showed positive effect while products with low rate of change like automobile and mobile phone service provider showed negative impact. Time since purchasing which data is only available for PC, mobile phone, mobile phone service provider and automobile can be considered as products with low rate of change, showed negative impact on customer satisfaction.

4. Drivers of Repurchase Intention

In Japan, the most influential driver of repurchase intention for most of the goods and services is corporate image rather than satisfaction. This indicates the approach to predict loyalty based only on customer satisfaction is not sufficient. Building a good corporate image should be given due consideration. Impact of other drivers such as satisfaction, perceived quality, perceived value, switching cost differs from product to product.

5. Conclusion

Through the analysis of the data, we found that in various Japanese consumer markets determinants of customer satisfaction and repurchase intention are different. To invest in the items which having strong effect on customer satisfaction and repurchase intention would be helpful for marketing managers in decision making. Customer satisfaction and repurchase intention model not only varies from industry to industry but from country to country. Same survey were conducted in China and resulted differently from Japanese consumers. We are also planning to conduct the survey in USA, France and Thailand in near future to investigate the cross-cultural difference of drivers of customer satisfaction and repurchase intention.

Beyond Deliberate Corporate Control - The Roles of Isomorphic Pressures, National Culture and Organization in the Institutionalization of Knowledge Management

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1. Introduction

Knowledge management (KM) has been recognized not only as a source of sustainable competitive advantage, but also as a primary driver for competitiveness. However, the use of knowledge in organizations is largely a discretionary behavior that can be encouraged but not demanded by the firm, and turning employees into knowledge workers may not solely depend on corporate decree. Therefore, the purpose of this research is to identify, through qualitative and quantitative analyses, the prescriptive factors influencing KM beyond the deliberate systems introduced by the firm, in particular intrinsic forces such as company-specific business configuration and national culture, and extrinsic environmental pressures.

2. The Effect of Congruent Knowledge Management Behaviors on Competitive Advantage

Since processes designed at enhancing the productivity of knowledge do not equally contribute to the organization's capabilities, the first part of this research first focuses on how different perceptions and behaviors related to KM affect competitive advantage. Using data collected from the population of a firm's personnel in Japan, results show that the perceived importance of KM activities appears as an important source of competitive advantage related to technical knowledge, and that more time spent on KM activities contributes to a competitive advantage related to affective knowledge. Further analysis involves a taxonomy of employees based on their perceived importance of and the time they spend on KM. There is evidence suggesting that KM strategies should be tailored to fit the discriminate beliefs and actions of each group of workers, identified based on their level of congruence between their espoused theories and theories-in-use related to the management of knowledge.

3. The Effect of Institutional Pressures on KM and the Resulting Innovation: A Case Study

As governments attempt to stimulate the economy, solving the issue of disconnect between institutional systems legitimized in routine on the one hand and innovation striving on change on the other hand, promises to lead to a newfound virtuous cycle of growth. Knowledge management, as enabler of change using its knowledge creation capability, is subject to different forces that shape its processes and eventually the resulting innovation.

A qualitative analysis based on data gathered from the case study of the first major rollout of smartcard technology in France shows how institutional isomorphic pressures affect the KM processes applied in the creation and maintenance of the resulting innovation. The government impetus, legal authorities and cultural expectations in the French society produced coercive isomorphic pressures onto the credit card industry, while existing credit card solutions, systems and standards played the role of mimetic isomorphic pressures, and professional networks and network effects functioned as normative isomorphic pressures. Also, a systems perspective of institutional pressures was found to provide a better understanding of interdependence mechanisms.

4. Organizational Characteristics and National Culture as Prescriptive Factors of KM

Using both a qualitative approach with semi-structured interviews and quantitative data gathered from a questionnaire survey with several international offices of a major Japanese pharmaceutical company, organizational characteristics – specifically structure, membership, relationship, and strategy –and national culture – power distance, individualism-collectivism, masculinity-femininity, and uncertainty avoidance – were found to affect KM, – namely knowledge acquisition, storage, diffusion, and application – respectively. These results suggest that practitioners can increase the yield of KM when integrated upstream into the elementary business processes and adapted to the culture of each local office.

5. Conclusion

These analyses have uncovered some of the institutionalizing forces – responsible for the creation and perpetuation of enduring social features – affecting KM that exist inside and outside the firm's boundaries. These findings are expected to improve the design and efficiency of KM especially in heavily-regulated industries and international operations.

Institutional Congruence of Knowledge Creation Process

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Knowledge creation
Current theories of knowledge creation theories define knowledge creation process as conversion between tacit knowledge and explicit knowledge. Based on such perception, this research has two phases. Firstly it visualized the knowledge creation key process, and constructs a model for knowledge-creation process throughout and out the firm. And based on such model, this research examines the institutional congruence of knowledge creation activities in each model. It has potential to: 1. Help managers to diagnose the project and find specific enablers/barriers in a certain organization. 2. Help researchers find mechanisms and adopt operational approaches to enhance each step in a creating project.

Index Terms—organizational knowledge creation, ontological model, isomorphic pressures, Ba,

1. Overview of the Research

1.1 Methodology of Japanese Mode of Technology Innovation

During the recent half century, knowledge creation theory has tried to contribute in three main fields: discovery of enablers and barriers, improvement of organizational infrastructure, and examination of knowledge creation mechanisms. However, lacking of solid evidence and visible key process, there are always gaps in the theory construction and practical instruction. Therefore, this research has two contents: Visibility of knowledge creation key process by constructing practical model; and examination institutional congruence based on such model.

As the epistemological research of knowledge creation has been well developed, this research focus on the ontological aspects: the dynamic of stakeholders and knowledge creation entities. “Boom-up” and “Slip-down” are the two mechanisms in such ontological shifting. Organizational characteristics (OC), product risk and isomorphic pressures are the influential factors as institutions in knowledge creation projects.

1.2 Surveys and Data Collection

In The model construction project, second data from cases in existing knowledge creation literatures are adopted to create the model (Panasonic bakery and 3M’s post-it note). In addition, interview with Sanyo’s knowledge activist in their invention of detergent free washing machine is implemented to do evaluation and comparison.

In the second project, product development cases in ZTE China (an international communication provider) are examined. 3 cases are selected (according to the ontological taxonomy of knowledge creation) to evaluate the institutional influential factors.

2. Findings in Each Project

2.1 Ontological Model of Knowledge Spiral

A four-layer model of presented as Knowledge creation activities sometimes start from individual inspiration, boom-ups through group, organization and social network towards rent appropriation and have different task to complete in each ontological layer. This model discovered the underlying isomorphism of knowledge creation in all ontological layers, and regards SECI as the epistemological base for model demonstration.

2.2 Institutional Congruence of Knowledge Creation

In this research, we presented a hypothesis that OC and isomorphic pressure have potential to trigger to boom-up mechanisms, while differentiation strategy, product risk and OC accelerate slip-down mechanisms.

Research on the Introduction of Technology in the Japanese Shipbuilding Industry during the 1950's Period

- Focusing on the Hitachi Zosen efforts -

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1. Introduction

The purpose of this study was to investigate the records of technology introduction in the shipbuilding industry as one of the core sectors of the Japanese economy after the Second World War and, based on the findings, to present suggestions about the importance of technology introduction for business management in the future.

2. Technical Trends in the Japanese Shipbuilding Industry of the Post-war Period

The economic needs of the then maritime sector calling for lower transport costs made it impetrate to have larger and faster ship capacity, especially for tanker and mineral cargo vessels. The challenge facing the shipbuilding sector was therefore the quest for the lowest possible costs and the shortest possible time for the construction of large-capacity high-speed vessels. These challenges were met mainly through three types of technology, 1) welding, 2) modular construction, and high-output diesel engines.

3. Efforts of Hitachi Zosen Corporation

Responding to the demands for large-capacity and high-speed ships, Hitachi Zosen vigorously embarked on the development and use of the three technologies above. An example that is particularly worth mentioning is the the introduction of technology from Burmeister & Wain Scandinavian Contractor A/S (B&W). The technology that was introduced was related to large-capacity high-output diesel engines. The background for this technology acquisition was that while the General Headquarters had allocated 20 vessels in the 5,000 – 10,00 ton range for export to Japan in 1948 - 1949 Hitachi Zosen was not eligible for receiving an order for shipbuilding since it was actually not engaged in the manufacture of large-capacity high-output diesel engines.

Based on the technology it had introduced, Hitachi Zosen did build 30 large-capacity high-output diesel engines in the period fro July 1951 to the end of 1955 (total output capacity: 1326.50 HP). It also engaged in advancing technical development at that time, and in November 1953 it completed an exhaust gas turbo supercharger type 7,500HP engine. After this, almost all engines that were manufactured were of this supercharger type.

In April 1956, Hitachi Zosen occupied the No. 1 position I the new shipbuilding sector, and also at this time, Japan was the world's leading shipbuilder in terms of ship production volume. After this, efforts were made to build even larger engines, as witnessed by the completion of the world's largest 12 cylinder 15,000HP diesel engine in May 1957. This marked the beginning of the diesel engine's inroads into the large tanker area which had until then been dominated by the steam turbine engine, a process that followed the prevailing trend toward larger capacity ushering in the transition from the super-tanker to the mammoth-tanker.

4. Conclusion

Hitachi Zosen already established a record in shipbuilding with the prewar construction of merchant vessels and the wartime building of small navy ships. Despite the accumulation of technology it had no prior record of building large-capacity high-speed ships. It may therefore be doubtful that Hitachi Zosen could have reached the first position in the volume of shipbuilding and especially in meeting the posatwar demand for large-capacity high-speed vessels without introducing technology from B&W. This may serve as a tell-tale example showing the importance of introducing technology from abroad in an endeavour toward further development of the companies and the industry.

Research on Optimizing Decision
- Making Regarding the Detailed Descriptions of Patents Using Quantitative Indices

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1. Introduction

The purpose of this research is to present the background and to indicate the question as to whether not the conditions 1 and 2 are met is to a significant extent dependent upon the provisions presented in the detailed description of patents; with the further purport being that the hypothesis assumed in the present research is the fact that when the samples of the detailed patent descriptions are statistically analyzed for a plural number of instances on the assumption that decision-making can be digitalized and quantified by introducing quantitative indices, there is a certain relationship between the posited quantitative indices and the condition 1 and 2.

2. Analysis of Patenting Rate Focusing

Proposed as quantitive indices governing the patenting rate are 1) (number of invented concepts, 2) claim(0)/num (Claim ratio), and ３) cgroup(0)/group (Ratio of claim-forming groups). These are formulated in equation form in terms of their extraction method and the relationship between these quantitative indices 1) – 3) and the patenting rate is analyzed taking the actual patent applications granted and the patent applications rejected as the samples, so that as a result it can be demonstrated that there is a strong relationship between the quantitative indices 1) – 3) and the patenting rate. Using. Furthermore, the quantitative indices 1)-3) a regression model can be proposed for deciding the validity of the decision made regarding the patent details, with the patents granted or rejected taken as the variables. This can furthermore more substantiate the validity of actually using the verification samples.

3. Digitalization Method for Scope of Patent Claims Corresponding to the Extension of the Technical Scope of the Invention of the Patent

The quantitative indices ４) total_LD（total of all factors）that are used for digitalizing the extent to which the component factors of the description of the scope of the patent claims are limited are proposed on a grammatical examination and the respective objective extraction methods are indicated. Furthermore, comparisons made with the results obtained by digitalizing the extension of the technical scope using the quantitative index 4) with regard to precedents of claims, including such claims as have been termination on the ground of patent infringement, and by digitalization based on other minimum extraction units have demonstrated their validity as parameters. This chapter also makes reference to the descriptions given in the detailed explanations of patents and the digitalization method for the technical scope reflected therein.

4. Proposal of a Decision-Making Model for the Scope of Patent Claims Made by Duly Taking into Consideration the Sufficiency of the Component Elements

The quantitative index ５) part (Special Sub-element ratio i.e., Ratio of Special Sub-element total number of descriptive elements stated in the Scope of Patent Claims) is proposed as a quantitative index, which takes into account the sufficiency of the component elements and the process of creating the scope of patent claims. It is also reported that with the quantitative index 5) it is effective to use an approach in which the ratio of special sub-element is increased by reducing the non-special sub-elements or in which the number of elements is reduced so as to prevent to the greatest possible degree a lack of sufficiency of non-special subelement components factors (case C) when carrying out digitalized analysis precedents of patent claims such as actual instances of termination on the ground of patent infringement. I would like to proposes the quantitative ６) mcLD (Degree of change of component elements). Index ６) mcLD gives the extent to which changes have been made by way of correction of the scope of patent claims on receipt of notification with reasons for rejection of application due to criteria such as lack of progress. It is demonstrated that based on actual precedents is can be stated that the greater index ６) mcLD is the lower is the lower is the degree of insufficiency of component elements. I also would like to proposes a regression model using the appurtenance or non-appurtenance of the technical scope as the target variable and the quantitative indices ４) ～６) as explanatory variables and this substantiates the validity of the index.

5. Conclusion

A method of displaying the entries of the detailed description of patents in an objective manner with quantitative indices governing the patenting rate and the effective patentability of paten applications has been present and it has also been possible to statistically verify the validity of these quantitative indices through actual sample analysis.

The dynamics of Knowledge Spillover for Functionality Development in Japanese Acoustic Equipment Industry

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1. Introduction

A plethora of researchs has been published discussing the usefulness of Knowledge Spillover as one of the foremost factors in encouraging the development of technological innovation. We find three main points of view in previous papers in relation to Knowledge Spillover, technological affinity, geographical distance, and cultural difference. Many previous papers have mainly discussed the Knowledge Spillover at the level of countries, industries, or companies. From the viewpoint of an institution, we discuss the Knowledge Spillover by taking the difference of characteristics in industries and also in technologies into consideration. The purpose of this study is to propose a new scope of Knowledge Spillover between technologies in a product.

2. Technological development in a speaker industry

The IPC (International Patent Classification) is used to group the technologies used to produce a product into "Basic Technology" and "Complementary Technology". We define "Basic Technology" as a technology which uses the fundamental physical laws as the core technology of a product and "Complementary Technology" as a technology which supports Basic Technology to produce an efficient product.

We select a speaker as the product, a main product in the electro-acoustic industry. Japanese companies occupy a large share of the market, and also contribute nearly 70% to the number of patent applications in the world. By a historical analysis of a technological development process of a speaker, the functionalities of a speaker are found to be developed in two stages. In the first stage, Basic Technology is developed in order to have products working by focusing on structural technologies. After the structural technologies have already been developed to a certain level, at the next stage, the functionality of a product is developed. In this process, Knowledge Spillover occurs in the transition from Basic Technology to functional technologies indicated as Complementary Technology.

3. Analyzing model of Knowledge Spillover between technologies

The number of patent applications is used as an indicator of innovation. It is demonstrated that the number of patent applications began to increase rapidly in the late 1990s. Obviously, innovations in speaker technologies occurred at that period. We use the number of patent applications given the specific IPC or FI (File Index) as Basic Technology or Complementary Technology as an indicator of Technological Knowledge of Basic Technology or Complementary Technology, respectively. Electro-acoustic equipments are classified by IPC as [H04R]. As Basic Technology, we chose two types of transducers: Transducers of moving-coil type (H04R9) and Piezo-electric transducers (H04R17) in the main groups of IPC. As Complementary Technology, there are three main devices; namely the Component (H04R1; mechanics), Circuit (H04R3; electronics), and Diaphragm (H04R7; materials).We use patent data to analyze the relation between innovation and Technological Knowledge of Basic Technology and each Complementary Technology before and after the late 1990s.

4. Conclusion

It is shown that there are two stages in the functional development of speaker technologies. It is also shown that the Knowledge Spillover could account for the development and there is Knowledge Spillover from Basic Technology to Complementary Technology; especially, Knowledge Spillover from Basic Technology to Materials, and between Complementary Technologies; especially, Knowledge Spillover between Mechanics and Materials. On the basis of intensive empirical observation on patent statistics, it can be said that Material technologies have an important role in leading the flow of Knowledge Spillover, and thus improving the functionality of speakers in the acoustic industry

Modeling and Solving Periodic Inventory Routing Problems

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1. Introduction

With a growing focus on supply chain integration, several initiatives have been created to reduce costs and drive inefficiencies out of the supply chain while satisfying service level requirements. One of the initiatives is to build strategic alliances within the supply chain players. Retailer Supplier Partnership (RSP) is a model of strategic alliances between retailers and suppliers in product distribution systems. Vendor Managed Inventory (VMI) system is a type of RSP in which suppliers are assumed to be fully responsible for all decisions regarding inventory management at their retailers. Traditionally, the VMI system has been applied in gases and heating oil industries while, currently, it has been also adopted in grocery, food and beverage industries.

2. Decision Tool for Coordinating Inventory Replenishments and Delivery Schedules

An important task that has to be addressed in the VMI system is to build a tactical-level decision tool for coordinating inventory replenishments and delivery schedules. Such a tool is known as Inventory Routing Problem (IRP). The IRP is required to design a strategy that realizes the potential savings in inventory and transportation costs brought about by the VMI system. The IRP models have been discussed extensively in the literature, unfortunately, most of them focus on situations faced by gases and heating oil distribution industries. The IRP models for grocery, food and beverage industries are very scant. This research is an attempt to cope with this issue. We propose several IRP models which would be suitable for these industries.

We build the new IRP models based on the Periodic Vehicle Routing Problem (PVRP) and other models within the periodic vehicle routing class, which are available in the literature. We have chosen the existing models since they have been used as vehicle routing models in these industries. The new models will be referred to as Periodic Inventory Routing Problems (PIRPs).

3. PIRPs Model Apprication

Some modifications have been made. First, the problem scope has been changed from a vehicle routing problem, which deals only with vehicle routing decisions, to an inventory routing problem, which considers not only vehicle routing decision but also inventory decision. The objective is now to minimize system-wide costs, which consists of traveling cost and inventory holding cost, over a given m-day period. Second, in the PIRPs, we treat the visit frequency as a decision variable to make a trade-off between both cost in order to minimize the objective function.

In this research, we propose four variants within the PIRPS: Periodic Inventory Traveling Salesman Problem (PITSP), Periodic Inventory Routing Problem (PIRP), Periodic Inventory Routing Problem with Time Windows (PIRPTW) and Priodic Inventory Routing Problem with Simultaneous Deliveries and Pickups (PIRPSDP). Mathematical formulations for each model have been investigated. We develop heuristic algorithms capable of solving all problems with minor changes.

4. Conclusion

Several numerical experiments for each problem are conducted. One of the main purposes is to evaluate the effectiveness of treating the visit frequency as a decision variable to make a trafe-off between the traveling cost and the inventory holding cost in order to minimize system-wide costs. The experiment results showed that the proposed models could be a good tool for a VMI supplier to coordinate inventory replenishments and delivery schedules for its suppliers.

Innovations in Manufacturing System and Planning Manufacturing Strategy under Dynamic Environment

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1. Introduction

With the characteristics of competitive environment become changing and uncertain, the theme of manufacturing management also changes greatly. This research proposes that the capability of dealing with change can determine the core competence of a firm in the turbulent environment. The purpose of this research is to analyze the innovations in manufacturing system for dealing with change, and re-examine the planning process of manufacturing strategy under the turbulent environment.

2. Innovations in Manufacturing Systems

Based on the literature review on 83 innovative manufacturing systems with the capability of dealing with change, the common characteristics for dealing with change in manufacturing has been analyzed with text mining. Four common paradigms were identified: autonomy, distribution, modularity, and integration. The identification was supported by a factor analysis, and the modularity paradigm could be divided into two paradigms: modularity through fabrication and modularity through standardization. The supporting relationships among different paradigms were examined through structural equation modeling analysis.

3. Consistency between Manufacturing System and Competitive Environment

Based on a cluster analysis on 14 factors, some close relationships among different types of competitive environment, business strategy, and production system were found: (1) the mass production environment-cost down strategy-make to stock system; (2) the development environment-quality improvement strategy-assemble to order system; (3) the dynamic stability environment-sever improvement strategy-make to order system; (4) the invention environment-differentiation strategy-design to order system. The results were supported by a canonical analysis.

4. Consistency between Manufacturing Systems and Business Strategy

There are two approaches for planning manufacturing strategy: the strategic approach and the paradigmatic approach. The key decisions of these two approaches are respectively located in the choices of competitive priorities and manufacturing paradigms. The relationships between these two approaches in a turbulent environment are empirically studied. Three hypothesis models on the relationships are founded with the help of Structural Equation Modeling and tested with 107 samples from the Chinese manufacturing industry. The results show that in a turbulent environment, business strategy has a direct influence on the key decisions of each approach. The results suggest that when established the relationships between manufacturing strategy and business strategy, the mediate function of competitive priorities is not suitable for manufacturing paradigms, and it is more appropriate to make the key decisions in each approach based on business strategy directly.

5. Conclusion

In our results, we found the matching relationships among the turbulent environment, business strategy, and manufacturing system; identified four important manufacturing paradigms for dealing with change: Autonomy, Distribution, Modularity, and Integration; explored the relationships among these paradigms and their relationships with different competitive capabilities, such as quality, cost, delivery, and flexibility; and found that both strategic approach and paradigmatic approach are necessary when planning manufacturing strategy under the turbulent environment. At last, a framework for planning manufacturing strategy under the turbulent environment has been proposed.

Flexible Supply Contract Strategies in Supply Chains

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1. Introduction

The present study constructs a flexible supply contract model using the real option concept in order to reduce loss due to mismatch between supply and demand in the rapidly innovated product supply chain. It analyzes the characteristics of the innovatively changing supply chain –e.g., long product development/production lead-time and short selling period (life cycle) – and of the high level of uncertainty of demand and also points to the problems of "twin losses" (that is, machine and waste losses) due to supply-demand mismatch and demonstrates the need for establishing a new supply contract model using real options in the innovative product development production cycle that offers only one chance of production.

2. Existing Studies

This study points to the need for construing a supply contract model using the real option concept innovative products that have only one chance for production by distinguishing three categories arrived at by addition to the two existing modalities of the previous studies regarding supply contracts with 2 or more supply contract and production changes employing the fast production mode (that is, the so-called call option and the put option), a third modality of a real option admitting of two-way adjustability.

3. Supply Contract Mode Using the Call Option: A model that maximizes buyer's profitability

A supply contract model using the call option (SCCO) has been established and has been formulized as a two-tier model which determines the order quantity and option quantity for the initial period so as to maximize buyer's profits and which allows updating of the buyer's profit function in line with forecasts of potential market demand scale and thus uses the optimum conditions for the initial order quantity and option quantity. It also determines in an analytical manner the optimum initial order quantity and option quantity in case the scale of potential market demand during the selling period follows a uniform distribution pattern and its validity has been substantiated through numerical tests.

4. Supply Contract Mode Using the Call Option: A model that maximizes supplier's profitability

This model has shown that it is possible to enhance the supplier's profitability in the same was as the buyer's profitability has been increased in the SCCO model described in 3) above. The model that is capable of maximizing the supplier's profits has been devised on the assumption that the order is placed by the buyer based the optimum initial order quantity and option quantity, using the supplier's decision variables which are the option purchase price and option call price (that is, price applicable when option is exercised) and thus this model leads to the optimum conditions for the option purchase price and option call price. It has been demonstrated through numerical tests that this model provides a substantial improvement compared to the problems associated with sales through newspapers albeit the improvement seems small compared with the integrated sales type models that produce ideal total profits for supplier and buyers in the SCCO model.

5. Suppler Contract Model Using Two-way Adjustable Option: Model that maximizes the buyer's profitability

This model has been devised as a two-tier model (SCBO) using the two-way adjustable real option concept and makes it possible to update the buyer's profit function in line with demand forecasts on the basis of the option purchase price and option call price. Based on the model formulation, the optimum initial order quantity and option quantity conditions providing maximum profit to the buyer have been determined and it has also been possible to statistically determine the optimum initial order quantity and option quantity when the potential market demand scale follows a unified distribution pattern. Comparison of SCBO and SCCO has also demonstrated by numerical experiments that the twin loss" risk is substantially reduced in that SCBO provides greater flexibility for the buyer than SCCO

6. Conclusion and Future Prospect

The research results of this study have been summed up with regard to the method of determining the initial order quantity and option quantity that optimizes buyer's profitability, and with regard to the method of determining the option purchase price and option call price that provide optimum supplier benefits on the assumption the previously mentioned initial order quantity and option quantity are applicable; and also with regard to the method of determining the initial order quantity and option quantity that provide optimum buyer profits using the two-way adjustable option mode. An outlook towards future research, including the establishment model that maximizes supplier profits using the two-way adjustable option mode has also been presented. The above study has established a supply contract model using the call option and the two-way adjustable option modes, determined the optimum conditions for the option purchase price and the option call price that maximizes supplier's profits while, at the same time, determining the initial order quantity and option quantity that optimizes buyer's profitability based on the call option and also determined initial order quantity and option quantity that maximizes buyer's profits. The purpose of the study on the above has been to make an academic contribution as well as a contribution to the supply contract practice which offers only one chance for production.

A Study on the Development of Information Systems for Customer-Centric Business Process Based on Backward and Forward-Looking Perspectives

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1. Introduction

The aim of the present study is to consider how to develop information systems that support customer-centric business process based on backward and forward-looking perspectives on IT risk.

The backward-looking perspective examines how misfits between the IT systems and its purpose can be avoided by analyzing IT risk in past projects and controlling the activities of the IT systems. In contrast, the forward-looking perspective considers how the IT system actively contributes to the strategy.

2. Framework and Methodology

Firstly, based on the backward-looking perspective, we proceeded in three steps in order to construct a check-list for failure in IS integration. In the first step, we prepared a 3×3 matrix using, as unit of analysis, components (Users, Supporters, and Project organization) of IS integration model on the horizontal axis, and phases of IS integration (Analysis, Design, and Implementation) on the vertical axis. In the next step, we interviewed several project members so as to collect critical failure factors in IS integration and make an exhaustive list of those factors.

Secondly, based on the forward-looking perspective, we have proposed a seven-step integrated approach that unifies goal modeling, business process modeling, and information systems modeling. Since few existing methodologies have attempted to seamlessly link those together, we addressed that issue by focusing on customers, their perspectives, and their activities.

3. Conclusion

The seven-step integrated approach is as follow. First, identify the primary customer needs using persona. Second, describe a static conceptual data model to identify interactions between objects. Third, define Business Process Unit (BPU) in relation to business goals. Fourth, create the customer action scenario, and the associated business process and relationships. Fifth, design the Customer Busness (C-B) activity diagram showing the business actors' activities based on customers' behaviors. Sixth, clarify the relationship between each business process and resource in the assembly line diagram. Seventh and last, identify use-cases so as to implement IS supporting the business process.

A Hybrid Approach to Dynamic Management of Business Processes

− Verification Based on XPDL and Situation Calculus

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1. Introduction

Business process management (BPM) has advanced from the process centric paradigm and has recently been receiving great attention from academia and industrial societies. As a fundamental component in BPM systems, business process modeling is still important and should adapt to changes and requirements in the new business environment.

2. Framework

Business process verification (BPV) belongs to the field of business process modeling and will be increasingly important to ensure the correctness of business processes. BPV will make it possible to detect design errors in the early stage and thus reduce the development time and cost of business process systems. This research proposes a hybrid approach to integrate formal and informal approaches in business process modeling and concentrates especially on verifying XPDL-defined business process by using the formalism of the situation calculus.

3. XPDL and the Situation Calculus

Formalization of the concepts in XPDL and the situation calculus acts as the theoretical foundation of this research. The mapping from XPDL to the situation calculus is defined by introducing mathematical structures such as process structure and action structure. Moreover, the correctness properties are formally defined so as to verify business processes by using the situation calculus.

The gap between XPDL and the situation calculus is bridged by formalization efforts. Some formal definitions are introduced to guide the implementation of transformation from XPDL to XSSL – a language introduced to make this bridge work convenient, and finally to Prolong – a logical language that interprets the situation calculus and implements automatic verification.

4. Coclusion

A prototype system has been designed and developed to demonstrate the feasibility of this approach. Furthermore, this approach is also conceptually extended to implement dynamic management in the ubiquitous business environment where the situation calculus enables as a higher degree of business intelligence and provide customers with satisfactory service.

A Study on Chinese Organizations' Readiness for The Telework Adoption: A Proposal of Pre-evaluation Model for Telework Adoption

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1. Intrduction

Since the beginning of the economic reform and its opening to outside world, the Chinese economy has been growing at a rate of nearly 10 percent annually while its external trade has been expanded by more than 15 percent a year. The Chinese economy has been attracting world's economists' attention. However, the overall growth of the Chinese economy has been accompanied by some significant problem. China still faces the huge challenge of moving beyond technology transfer and contract manufacturing toward being a technology innovator and global leader in brands and products. China government wants to make China to be a technology powerhouse. All these things are experiences of some developed countries, Chinese government and an increasing number of Chinese organizations have starts to believe that telework-based offshoring will provide opportunities to improve the management skills and promote to be truly global organizations.

2. Develop a Telework Pre-evaluation Model

The global of the research is to develop a telework pre-evaluation model. Its aim is to pre-evaluate the readiness level of telework adoption for the organization which wish to adopt telework. The purpose is the initial assessment of the adoption potential. The result of this assessment serves to the organizations of further training program which should help to introduce or improve the telework adoption readiness level.

3. Result of the Survey in China

According to the two survey carried out in China, the results indicated that the technological environment for Chinese organizations is ready for telework. Some kinds of telework (remote site work) exist in Chinese organizations especially in developed areas and high-technology industries. This trend can be regarded as a strong support for the adoption of telework. However, more attentions should be paid to the management issues because the majority of Chinese organizations use the traditional management style and do not integrate ICT into management of the organization even though their ICT usage level is quite high. ICT alone is not sufficient enough for successful implementation of telework. ICT must be aligned with the organizational strategy and integrated into management of the organization.

In order to investigate the readiness level of telework adoption by a Chinese organization, pre-evaluation model was developed. The model includes a questionnaire, an evaluation and a classification system which can identify telework readiness level. The questionnaire maps the company's preparedness to telework adoption. The result of the questionnaire-based assessment serves to the company to describe the readiness of the telework adoption.

4. Conclusion

By the field test is two Chinese organizations, the pre-evaluation model had resulted in a series of significant an unambiguous results, and a valuable experience, which could be used for the organizations to pre-evaluate their readiness level of telework adoption. Thus the proposed pre-evaluation model can be used by Chinese organizations before they start the telework implementation program. Moreover, with the data from the pre-evaluation, organizations can identify their current culture and management status and enhance their strengths or overcome the weaknesses.

Research on Media Selection Behavior of Grope Work: Towards a Theory of Media Fitness

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1. Introduction

The necessity of the present research has become clear in the light of the research results achieved by outlining the problems concerning the method of selecting communication area in a distributed environment and the state of research carried out until now..

2. Past Research

The results of searching comparative analysis of the media selection theories of the past have made it clear that seeing that there were partial difficulties such as the insufficient ability to explain media selection behaviour with the theories of the past it is clearly necessary to undertake research so as to overcome these problems..

3. Total Research Design

The Media Fitness Framework (MFF) was proposed with a view to establishing a new communication media selection theory. Based on the past theories used for the comparative analysis described in the previous section, and particular the Media Richness theory that was most widely accepted and the Social Influence Perspective, the factors required for media selection have been extracted and have been made the constituent factors of MFF, by adding the factors that were missing in the theories of the past. All of the constituent factors have been divided into a factorial group showing the degree of Media Richness, a factorial group showing the preferences of the group and a factorial group showing the limitations of media use.

4. Media-Compatible Framework

The system for using MFF has been configured. In more specific terms, we have established the method of measuring the constant factors of MFF and the index for each factorial group, as well as the method of calculating the degree of compatibility of the media uniting the three factorial groups. For the MFF, we first defined the values for each factor and or each communication medium and stored the data in a database. The next step was to determine the values for each task factor according as to the group executing the communication task. Finally, the degree of compatibility of each of the media and the tasks with the three indexes was calculated to determine the level of compatibility of each of the media with the respective tasks and the non-compatible factors by comparison.

5. Effectiveness of Media-Compatible Framework

The validity of the MFF was checked based on experiment results. More specifically, for the communication tasks executed by the actual groups at three companies, the procedure was to assume tasks of four stages of complexity from the most simple notification to the most difficult negotiation, and the result was that the experiments for the communication media used by the groups were limited to 8 types of generally media, including e-mail, telephone, fax, and video conferencing system. The results confirmed the possibility of explaining the media selection behaviour by analysis in the MFF.

6. Design of Research Study

Verification test were designed for the purpose of clarifying the role of each communication media selection factor and of each factorial group in the group work using MFF. By defining the communication tasks with four-step degrees of complexity performing actual services in an 18-company group (total of 72 tasks) and by selection the media used for these tasks, it was possible to achieve a design that made it possible to analyze the factors considered important for media selection by the groups.

7. Analysis of random media selection

The results obtained in the verification experiments were analyzed using MFF when the following four points came to light.

1) There was much overlap in the factorial fro up showing the media richness level and in the group showing the Group's preferences.
2) In cases with a high frequency of use of two or more media for one task, the practice is to select one main and one auxiliary medium.
3) In the selection of the main media, the work of the factorial group showing the Group's preference has a strong effect whereas the group showing the degree of media richness has a strong effect in the selection of the auxiliary medium.
4) Almost all of the selection results that cannot be explained in either group it is possible to explain in the factorial group showing the restriction in media use.

Based on the above results it was possible to demonstrate the usefulness of the MFF proposed in this study.

8. Conclusion

This research study permits the proposal of a framework for the establishment of a new theory concerning the communication media selection method, an important issue for groups doing joint work in a distributed environment and the experimental results have vindicated the usefulness of the framework. The study has also made clear that there are two types of behaviour, the main-media selection behaviour as well as the auxiliary-media selection behaviour, a finding not known until the present. We have also proposed effective analysis tools future media selection behaviour research and for communication tool development.

Personal Factors Influence on ICT Engagement and Affective Technology to Promote Productive Love

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1. Introduction

Information and communication technologies (ICT) are becoming more important everyday. In the latter years some studies have concerned about engagement modes (EM), which contribute to a better interaction with technology. Similarly, personal factors have been related to EM with technology. Besides, recent literature shows the importance of the aesthetics as an emotional factor. Although some relationships among among the mentioned factors have been investigated locally by individual studies, a big picture of the relationships or causalities among ICT, Personality traits engagement, and aesthetics has not been explored. The purpose of our first research was to investigate the relationships between new ICT engagement, individual psychological factors and aesthetics.

Furthermore, there are practically no antecedents on devices or applications that aim to improve loving relationships. The objective of our second study was to provide an understanding of the nature of love in a manner that may be usable for designing the most appropriate love-promoting technology. We focused theories that understand love not as an involuntary passion but as a voluntary action, which can be improved, bringing up the possibility to make use of the existent or future technologies to help to improve love.

2. Personal factors influence on ICT engagement

The relationships between new ICT engagement and the individual psychological factors were investigated. A questionnaire-based investigation was conducted. The collected data was analyzed using Structural Equation Modeling to examine hypothetical causality model. The results not only corroborated the previous studies' partial results but also revealed new implications to be used for designing highly pleasurable ICT, which could contribute to build a successful national strategy. Three overall implications derived for ICT design: First, design should be differently directed to those users who tend to engage with technologies in a positive way, it is, intrinsically and extrinsically motivated. And to those who engage in a negative way, it is, amotivated individuals. Secondly, an ICT that provides CA, arousal and flow might be the most successful to provide ICT engagement. Finally, the third implication should be that ICT could also be oriented on its construct to satisfy quantitative and qualitative engagement.

3. Affective Technology to Promote Productive Love

A set of original guidelines for designing technology that aims to improve loving relationships was proposed. The guidelines were based on an extensive review of literature and an exploratory brainstorming about Erich Fromm's, 1956, four central elements of love: care, respect, responsibility and knowledge, resulting the following list of elements of Productive Love: (a) Preservation of personal individuality and freedom, (b) respect. (c) self-growth, (d) care, responsibility and active concern, (e) giving, (f) selflessness, (g) enjoying the other, (h) enjoying the love experience, (i) realism, And (j) knowledge.

Furthermore, we explored principles of engagement with technology, such as technology as a mirror, fun, pleasure and flow, which may be important when designing love-promoting technology. Finally we are currently working on a real system that embraces several of the proposed guidelines.

4. Conclusion

Technology designed in a way that fits people's personalities may succeed on reaching people who has no access to the technology use. Besides, a technology that helps to promote love may attractive and satisfactory. Expertise on design of new applications of technology that reach new users could be a key to establish a new innovative science for the management of the technology. Besides, the use of technology and personal relationships are part of entrepreneurial and other institutional organizations, which improvement should contribute to the dynamic evolution between innovation and institutions. As a further step of this research, institutional management of technology could consider the personal differences and the love differences among cultures, and thus the differences of technological needs.

Unobtrusive Estimation of Psychological States Based on Human Movement Observation

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1. Introduction

Emotions are integral to human life and as such, the recognition and classification of emotions becomes an important venue to understand emotions dynamics and complexity. Within Institutional Societies, effective emotion recognition may enable effective, real world, interaction strategies, which could lead to new group interaction and performance evaluation possibilities. The purpose of this study was to investigate the possibility of estimating users' emotion and other psychological states based only on body movements. No video or audio monitoring mechanisms were used protecting users' privacy. Besides, in order to minimize intrusiveness to users, no devices were attached to users. Methods to estimate users' emotion and other psychological states based on information retrieved from movement and infrared sensors were proposed and validated.

2. Procedure

Two sources were reviewed in order to set up the basis for the hypotheses to be tested in this study. The first source was the results of a pilot study which aimed to derive predictions to estimate human emotions based on observable gross movements. This previous study revealed speed, physical activity, walking directness and arm usage to be emotion movement predictors. The second source was the Emotion Diagram which is a summary of the literature review concerning human emotion recognition by gross movements.

Three subjects performed daily routines in the presence of this experiment's motion-sensor-based recognition system called "*Just Feel It!*". It recorded the subjects' body movements converting body motion into six basic emotion labels proposed by the sources aforementioned. The subjects wrote their emotions once every thirty minutes during three weeks, choosing from a list of psychological states: anger, disgust, fear, happy, sad, surprise, neutral, tired, energetic and thinking. After collecting the subjects' written responses, these were compared with the emotion recognition system output.

3. Results

Paper responses described the emotion responses for each subject. Overall results revealed that fear state received no marks from any of the subjects. Anger, sadness, and surprise states marks do not reach the 5% of the emotion distribution along the three subjects. It was found a greatly unbalanced mark distribution along the studied emotions.

Results of hypotheses accuracy for subject A revealed that velocity and motion load were good psychological states descriptors for subject A. Results of hypotheses hit rates for subject B showed that velocity and motion load were again effective emotion estimating descriptors for subject B. Subject C differed from subject A and B, in that his emotion mark distribution is the most unbalanced one with 0% marks distribution for anger, fear, sad and surprise states; no more than 10% of the total emotion marks for disgust (4%), happy (8%), and thinking (5%) states. Neutral state with more than 80% of subjective response invalided every hypothesis which did not relate neutral state.

4. Conclusion

Results in the validation experiment showed that psychological states could be estimated by predictors such as walking speed, motion load and walking directness, after being analyzed for individual subject users. Within the institutional point of view, in order to acknowledge the entrepreneurial organization and its structure, it is also necessary to understand the condition of its human capital. Comprehensive human state appreciation assures a better fit for the evolutionary fusion of operating techniques within a home setting, the workplace, a work group, a working process, or the mind itself. Therefore, studying human behavior within institutions gives evidence of the dynamic evolution between innovation and institution itself. This study showed how technological innovation may serve to supply the identification of gaps within organizations to achieve better performance levels and working atmosphere.

A Study of Initial Public Offering in Japan:
The Impact of Information Asymmetry and Corporate Control on Offer Price

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1. Introduction

Existing research on initial public offering (IPOs) mainly focus on three areas: issuing activity, share pricing and allocation, and long-run performance. Although several studies have been made on Japanese IPOs, there are no systematic and convincible explanations to the decisions related to Japanese IPOs. What seems to be lacking in these studies is a link between the IPO-related decisions and the characteristic of both Japanese firms and Japanese stock market.

The purpose of this reserach is to develop an understanding of the factors that may influence the decisions related to Japanese IPOs. In particular, I hope to gain insight into the impact of information asymmetry and corporate control on the decisions on IPO pricing and allocation by the investigation of IPO initial returns, directors' motivation to retain control, and the pre-IPO earnings management.

2. Framework and Methodology

The first part of research focus on the factors leading to the IPOs initial return. In consideration of characteristics of IPOs on the Japan Securities Dealers Association Automated Quotation (JASDAQ) market, I expand and test several existing theories under information asymmetry, where IPO underpricing is used to avoid winner's curse or to signal the firm's intrinsic value. Furthermore, I innovatively investigate how regulatory changes in the primary market and investor's concern for the governance problem during the IPO affect the IPO initial return. Most of those factors studies above are found to be important determinants of the IPO initial return.

The second part of the research offers a new perspective to consider the serial decisions around the IPO. These decisions are examined in light of the pre-IPO director's motivation to retain control. I argue that the pre-IPO directors are motivated to avoid the possibility of losing control over their firms during the IPO. After studying the possible methods to retain control during the IPO, I find that director's activities to retain control during the IPO have significant impact on the IPO offer price, changes in ownership structure, and the magnitude of the offer for sale.

The third part of this research reveals the relationship between the dilution effect at the time of the IPO, and the pre-IPO earnings management that carries weight in the decision of offer price. An important finding is that the motivation to reduce wealth transfer from pre-IPO shareholders to new investors, taking effect through IPO underpricing, has a significant impact on pre-IPO earnings management. In particular, the IPO issuers are inclined to utilized positive abnormal accruals in order to reduce the wealth loss suffered by stable shareholder during the IPO process. Moreover, I find that the negative abnormal accruals could be employed to retain managerial control at the time of the IPO.

3. Conclusion

In summary, this research provides a systematic and comprehensive study on how information asymmetry and corporate control influence the decisions related to Japanese IPOs. This study contributes to the IPO literature by exploring new factors affecting the IPO pricing and distribution.

A Study on Intangible Assets and Corporate performance:
Assessing the Influence of Organizational Capital

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1. Introduction

In recent years the concept of RBV has tackled two of the most important questions of strategic management, by focusing on how firms achieve and sustain their advantages (what makes firms earn and sustain above-average returns over time). This theory suggested that the search for sustained competitive advantages has shifted from firms' choice of industry positions or market strategies towards its ability to accumulate and sustain resources.

This work contributes to the literature on resource based view (RBV), strategic management, industrial organization and market signaling by examining the relationship between intangible assets and firm performance in various aspects. We first empirically test the association between organizational capital and corporate performance. Second we test the impact of sort of intangible assets and corporate performance predicted by RBV in a sample of public Japanese firms. This work has important implications for managers in that we intend to shed light on whether intangibles help firms achieve a competitive advantage or sustain it over time.

2. Intangible Assets

Either profits or value differentials may be specific to industries where forces restricting competition are present (infrastructural barriers of entry, government regulations and so forth), or specific to firms that may have access to a specific resources. Assuming that firms within industries benefit from similar barries of entry or government regulations, outperformers may have access to specific strategic resources (intangible assets) that allow them to produce more innovative-premium-priced products or benefit from top notch production processes by cutting costs (the mentioned benefits could be the result of investments in technology (R&D), brand, human capital, organizational capital and so forth).

3. Organizational Capital

According to the literature nowadays, most of productions' factors are commodities (as they are equally available for all competitors). Therefore the major source of differences on firm performance should be explained through internal developed resources (more specifically organizational capital or organizational innovations). Solow observed that organizational innovations (which he believes either minimized or ignored by traditional economists) are the major source of high-impact innovations to drive productivity growth.

In this work it was our intention to link the concept of organizational capital to corporate performance. Following previous literature, we measured the impact of organizational capital by isolating its productive contribution.

4. Empirical Results

Our results suggests that regardless the type of firm (high-low tech firms) the impact of organizational capital is significant when compared with traditional assets. This was consistent with the idea of organizational capital as a source to explain firm's differences on total sales/market value. However, our results also indicate that organizational capital could be a damaging factor (instead of helping firms increase their outcome, lessen it).

Besides, the results suggested not only the importance of organizational capital but also the benefits derived from its combinations with other intangibles (especially human capital).

5. Implications

Extending previous works, our results highlighted the importance of intangibles; however, managers should be cautious regarding to whether these strategic resources overlap the nature of their business. Besides, it is important to remark that while some intangibles are more likely to impact productivity, others may impact the market value of the firm.

Finally, our results also suggest that managers have to consider build up and enhance higher levels of organizational capital first, and then reconsider all other intangible investments.

Stock Repurchase as a Leverage Adjustment Device

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1. Introduction

Previous studies have successfully discussed the financial behavior of stock repurchase and document the potential motivations of it, like signaling of undervaluation, takeover defense, dividend substitution, stock options and capital structure adjustment. Less attention has been given to motivation of leverage adjustment. Managers may weigh emergent motivations against capital structure adjustment when they make decision of repurchasing shares. The theory of capital structure adjustment may be not always consistent. It is expect to examine the motivation of capital structure adjustment predicted by trade-off theory and to find out the evidences that firms are likely to neglect capital structure when they have emergent motivations.

2. Motivations of Stock Repurchases

Corporate management always has better information about their firms than outside investors and attempt to tell their private information to outsiders and expect positive reaction from markets. Undervalued firms may subject to the risk of being acquired and might undertake stock repurchases to increase the acquisition price and lower the threat of becoming takeover targets. Firms retiring a large number of shares by stock repurchases increase their debt to equity ratio and achieve their target. Since income tax rate is higher than capital gain tax rate, management may prefer repurchase over dividends. Stock options encourage managers to substitute stock repurchases for dividends because repurchases decrease the shares outstanding.

3. Univariate Analysis

It is investigated whether firms use stock repurchases to adjust capital structure and mitigate deviation between actual leverage and target leverage predicted by trade-off theory by univariate tests. Five portfolios are formed based on deviation and compute the mean of stock repurchase in each portfolio. t-statistic for the difference between small portfolio and large portfolio is reported, which shows that hypotheses are partly supported. Since the results are mixed, multivariate regressions are employed to make them clearer and test the relation between stock repurchase and deviation in next section.

4. Multivariate Regression Tests

Stock repurchase may be used as a device of leverage adjustment if their debt ratio is lower than target leverage. This relation between stock repurchase and capital structure in Japan is directly checked by a basic model in which stock repurchase is depended on a set of potential motivations. After that, emergent motivations of stock repurchase, undervaluation and takeover threat, are taken into account, and other models are used to test hypotheses that undervalued firms and firms with the threat of becoming takeover targets do not pay attention to capital structure and neglect the impact of repurchase on leverage.

5. Conclusion

This research focuses on the notion of capital structure adjustment and also controls other motivations of stock repurchases. By testing the trade-off theory of capital structure, this research confirms that Japanese firms with leverage ratio that is below their targets have a tendency to undertake stock repurchases and to mitigate deviation. This research investigates motiavations of 2163 stock repurchase announcement and finds that the theory of capital structure adjustment is not always consistent, and comparing to emergent motivations of stock repurchases, capital structure adjustment is a secondary motivation. Firms neglect the impact of stock repurchase on capital structure if they are undervalued or have the threat of becoming takeover targets.

On the Development of the High Pressure Steam Engine in the 19th Century

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1, Introduction

This research studies the development of the steam engine in the 19th century, especially focusing on the connection of "means of labor" with the steam engine and the theories of steam and heat.

Studies of the steam engine often presuppose that there was a linear development from low pressure system to high pressure system. But this assumption is simplistic, as the story was more complicated. I argue that relationship between means of labor and form of power, knowledge of steam and heat engineers used, and strength of boilers.

2, A Comparative Analysis of Steam Engines with Respect to Their workings

In terms of work they perform, there are four types of steam engines: pumping engines, rotative engines for mills, locomotive engines, and marine engines. The first high pressure steam engine was a pumping engine. The marine engine which used high pressure steam emerged in the 1860's.

3, From the Theory of Water Wheel to the Theory of the Steam Engine

The theory of the steam engine in the early part of the 19th century was generally based on the caloric theory. It is possible to consider that the analogy comparing the water engine to the steam engine is likely to have been the origin of the high pressure steam engine. This theory explained the usefulness of the high pressure steam engine.

But caloric theory had a limit. Therefore British engineers, especially marine engineers also adopted what was known as "Watt law." "Watt law" indicated that "saturated steam will remain saturated whenever it is compressed or expanded mechanically in such a way that there is no loss of heat." Even this sophisticated caloric theory could no longer explain the efficiency of the high pressure steam engine.

4, Marine Compound Engine and Applied Thermodynamics

But in fact, saturated steam expanded adiabatically in the cylinder cannot keep saturated, it is condensed into water. Generally, this condensation was called "initial condensation". It became the most important problem for the development of the high pressure steam engine. Scottish engineers John Elder and William John Macquorn Rankine solved this problem by applying the first low of thermodynamics.

They applied thermodynamics to the steam engine and recognized that the high pressure steam engine improved thermal efficiency. The shape of high pressure steam boilers was the most crucial. A change in shape, for instance from box to cylindrical made great difference in boilers' resistance to pressure. Thermal efficiency of high pressure steam engines combined with cylindrical boilers were superior to thermal efficiency of low pressure steam engine combined with box boilers.

5, Some Technological Problems of the Development of the High-pressure Stationary Steam Engine

Early high-pressure steam boilers were made by cast iron. Cast iron could be melted around 1200℃. So this was made in seamless vessels possible. Any joints could be weak points for resistance to internal pressure. Cast iron was brisk material and was not suitable for boilers. Wrought iron, had high tensile strength and was suitable for use of pressure vessel, could also be use. Since it could not be melted at that time, only very small plates could be produced, depending on power of human being. Bessemer steel process was invented in 1856 and this process could make stronger and larger steel plates than paddle plates. So I re-evaluate an important Bessemer steel process.

6, Some Technological Problems of the Development of the High Pressure Marine Steam Engine

With the knowledge of thermodynamics, ship-owners effected the development of the high pressure steam engine such innovations as water tube boilers and triple expansion engines. However, it is too difficult to make steel tubes for marine water tube boiler at that time. So steel cylindrical boiler became popular type in the end of 19th century. Economical constraints of fuel strongly worked and decided a form of the marine steam engine.

7, Conclusion

Finally, the development of high pressure steam engine in the 19th century was depended on the connection of "means of labor" with the steam engine.

A close relationship between demand for "power" and "efficiency" had a huge impact on the development of the high pressure steam engine.

Impact of the Technological Blockade of Japan during the World War II Period

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1. Introduction

The World War II technological blockade of Japan by America and some other countries started before the war and extended to the control of exports for a wide range of industrial products, patents, and drawings, as well as sending and inviting engineers. Facing this technological blockade, the type of research and development required of research institutes changed in Japan. In the later 1930s, the Imperial Japanese Army had asked the aeronautic research institutes to carry out applied research useful for industrialization. By 1941, in addition to this applied research (under the policy of "cultivating soil for unique technology development"), developing new technology was recommended that would not immediately have practical application.

2. Transformation of the aeronautical research strategy

Changes in aeronautical research for the military were necessary because applied research alone was not satisfactory, due to the technological blockade by America. In the 1930s, though Japan started later than others as an industrial nation, apparently it was becoming the equal of any nation in aircraft manufacturing. However, research and development, in the broadest sense, that could support product development was poor. Since overseas information was not being obtained due to the technological blockade, there was only one way to promote a wide range of scientific engineering. Preliminary study indicate that there was a double structure of mobilization and promotion of scientific engineering being used as the main features when the government set up a central office for technology that was the keystone institution of scientific technology mobilization. Given this background, this study shows that there was a period when intensively seeking only applied research, as well as the technological blockade, were the direct causes of the strategic change.

3. Features of the research and development policy in Japan during the war period

Using these features of the research and development policy in Japan during the war indicates that research was coordinated by the central office for technology. Research carried out under instructions from the central office included practical aircraft development as a basic principle, and, of course, this was not academic research for just intellectual interest. On the other hand, neither was it "object-based research" based on requests for development by the Japanese aircraft manufacturing companies. In Japan at that time, there was not much communication between research and development institutes. This kind of research, which included "object-based research" from requests for development, was never carried out. Under these circumstances, some subjects for research, including stratospheric medical science introduced from Germany, were actually carried out on a small scale and were dispersed to domestic research institutes under the instruction of the technology central office. Japan, then had a specific approach at this point for carrying out research introduced from overseas, aside from the domestic aircraft industry. This was a characteristic of Japan.

4. Research and development capability for new technologies in Japan

In this study, the technological blockade of Japan was fully in place around 1940. This was an indication of the respect for Japanese new technology research and development capabilities. At that time, in the background was the priority placed on the development of products dependant on new overseas technical developments.

It can be said that this situation continued, though to a different degree, in the postwar period. Around the 1980s, when there was trade friction from the large-scale export of automobiles and color televisions, etc., from Japan, a kind of "technological blockade" was again established. While criticizing Japan, European countries and America developed the so-called "free ride for basic research theory," and promoted reinforcing intellectual property protection. In America, a policy for protecting patent rights (pro-patent) was started in the 1980s. It was intended to not only reinforce the protection of rights for inventions but also to powerfully protect basic patent rights. Since then, the pro-patent policy has been growing worldwide. To counteract and change the policies of European countries and America, "respect for basic research" was established in Japan in the latter part of the 1980s. The situation since the 1980s is something similar to the situation around the 1940s.

5. Conclusion

For Japan, now a front-running technology nation, extremely strict intellectual property protection will be required from now on. Under the present severe economic conditions, instead of putting emphasis on applied research which can harvest new applications, this study shows the importance of maintaining original research.

Historical Study on the Reorganization of Research and Development Structures in the United States of America after World War II

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1. Introduction

During World War II, the science mobilization system was established to promote cooperation in arms development between civilian scientists and the military. The organizations that led this science mobilization system were the Office of Scientific Research and Development (OSRD) and the Manhattan Engineering District of the Army (MED). The OSRD established a system for the army and civilian scientists to collaborate on the research and development of radar, proximity fuses, and so on. The MED took over the results of basic studies conducted by the OSRD. At the MED, civilian scientists and the military cooperated on the development of atomic bombs. Based on the experience of science mobilization during the war, the military authorities decided that it would be important to continue arms development in collaboration with civilian scientists even after the war.

Because the OSRD and the MED were temporary organizations set up just for the war, they were to be dissolved when the war ended. That meant the end of the system where the military and civilian scientists would cooperate in arms development. At the time when a sense of crisis was heightening due to the Cold War, the military thought that it was essential to continue the research and development of new arms and was compelled to establish a new system to carry out research and development activities in cooperation with civilian scientists.

2. The National Science Foundation (NSF) and Military Research

In July 1945, Vannevar Bush, who was serving the Director-General at OSRD as a scientific administrator from civilian science, published "Science: The Endless Frontier," a call for the continual support of scientific studies by the government even after the war. He stressed that the National Science Foundation (NSF) should be established as the governmental organization that would supervise these activities.

According to Bush's initial plan, the NSF would support basic scientific studies as well as military-related studies. The army also expected that the NSF would be the organization that would liaise between civilian scientists and military-related studies. However, a department that would support military-related studies was not included in the NSF when it was established in 1950. The NSF was set up to only support basic scientific studies. One of the reasons for this was the protest movement and criticism by many scientists who feared control over the sciences by the military, if the NSF had a department of military-related studies.

3. The Atomic Energy Commission (AEC) and the Military

In October 1945, immediately after the end of the war, a bill on atomic energy that would establish the Atomic Energy Commission was submitted to Congress. Although, initially, this bill would allow military representatives to become AEC members who would be in charge of AEC operations, the protest movement by scientists who strongly criticized military control over atomic energy grew. As a result, it was resolved that no military representative would be appointed as an AEC member.

Since military representatives could not be AEC members, the military influence over atomic energy, including nuclear weapons, would be weakened. The military, however, initiated the Armed Forces Special Weapons Project (AFSWP) in January 1947 to develop human resources for maintaining and assembling atomic bombs, as well as conducting research and development on weapons for nuclear wars. In this way, the military intended to expand its role in the area of atomic energy.

4. Research and Development Activities by the Joint Research and Development Board and the Army

The military established the Joint Research and Development Board (RDB) in 1946, and appointed Bush, who had advocated that the RDB be set up by the military, to be its chairman. Bush wanted to build a system where civilian scientists would collaborate with the military on arms development after the war, just as they had done during the war.

The RDB was established as a board directly under the Secretary of War (Secretary of Defense in and after 1947) and was responsible for suggestions and coordination of research and development activities in all military organizations. The RDB consisted of civilian scientists and military representatives, and, under the RDB, expert subcommittees, such as those on basic sciences and atomic energy, were formed. These consisted of civilian scientists and military representatives. The military, thus, built a system where civilian scientists and the military would cooperate on research and development through the RDB.

5. Conclusion

Although the NSF, which did not have a department of military studies, and the AEC, in which a military representative was not allowed to be a member, were both established, the RDB kept the previously strong ties between civilian scientists and the military. The military used the Committee on Fundamental Physics in the RDB to conduct military-related basic research together with civilian scientists. The military also used the Atomic Energy Commission and the AFSWP within RDB to study atomic energy together with civilian scientists.

History of the Exploration of Natural Gas in Bangladesh

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1. Introduction

This study surveys the history of the exploration of natural gas in Bangladesh, studies its marketing and export potential. It probes the politically charged public debate on its export through a pipeline. Transporting natural gas through pipelines is a current central issue. It shows the lack of a co-evolutionary process among local political rivalries between government and opposition, foreign companies, and institutions hamper the project.

2. Natural Gas Pipeline from Bangladesh to India

This year I expanded my work by including, the idea and plans for a natural gas pipeline from Bangladesh to India. The SIMOT program helped me to theorize my work and to assess these concepts in different historical and social contexts. I worked on one article, which I have submitted for publication. Besides in the main time, I made several contacts with some scholars who are from US, Europe, Australia and India. There I received many useful suggestions, which have helped me especially with the direction of my present research. The case of Bangladesh-India pipeline project provides a specific example of political difficulties that might appear in natural resource rich developing countries. If political parties set aside their differences they may be able to find a common ground. When the Bangladesh government chooses a sound export policy, it will also be easy to set up a neutral agency to study the future of the pipeline program. This solution may be a way-out from the difficulties that are peculiar to natural resource rich developing countries.

3. Bangladesh's natural gas prospect

Bangladesh's natural gas prospect has become increasingly more promising. The exploration began when "Bangladesh" was still a part of India under the British colonial rule in the late nineteenth century, and continued when Bangladesh became part of Pakistan after World War II. When Bangladesh finally became independent in 1971, Petrobangla, a state company, was formed to administer all exploration policies and activities. Under production sharing contracts, Petrobangla engaged international companies, mostly from the US. The effort led to several successful discoveries of natural gas reserves. But by the mid 1980s, this state corporation ran into problems and became less productive. In response, in the 1990s the Bangladeshi government took steps to liberalize its natural gas sector and exploration policies.

4. Some Problems Concerning Natural Gas in Bangladesh

A developing country with limited resources, Bangladesh lacked financial and technological resources to meet the challenges of high-risk exploration and production of natural gas. Therefore, the surveys and exploration of gas and oil, in fact, of other raw materials were conducted in cooperation with foreign companies. Major international oil companies came to Bangladesh. Their multi-million dollar investment resulted in the discovery of new natural gas reserves. However, this created a problem. The gas production soon came to surpass the limited local demand. To increase their profits, foreign companies together with the Bangladeshi government, sought ways to market it elsewhere. Among the options is the building of a pipeline to India to sell some of Bangladeshi natural gas.The pipeline was proposed by Unocal, a US based company, which also discovered in 1999 the Bibiyana, the biggest gas field in South Asia. But the issue of exporting natural gas has generated a fierce debate. The debate which is highly politicized has divided the country deeply.

5. Conclusion

The issue of natural gas in Bangladesh illustrates a complex relationship between institutions, government, local and international companies and civil institutions. It shows that there is a dynamic relationship between local and international institutions. The interaction among institutional players has effected innovations in terms of gas exploration and the pipeline development. Natural gas export, the revenues it generates, gas industry and transportation seem to co-evolve. Finally, when a reasonable co-evolutionary process matures and common ground will establish among its components, the gas export though a pipeline will advanced.

Co-Evolutions of Logics/Tense Logic and Science/Technology

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1. Introduction

Tense Logic is an improvement of Mathematical Logic. Mathematical Logic is a study of Logics, which has been studied since ancient times, with mathematical way. Mathematical Logic was born in the beginning of 20th Century. And it is a modern style of study while Logics has been studied for very long time. The contexts such that mathematical way was introduced into Logics, can be explained with the histories from 17th Century. Social conditions required technological innovations. Then these requests demanded scientific and mathematical improvements. Next, scientific improvements created logical problems, and logical solution was required. Finally, Mathematical Logic was born. Recent studies of Mathematical Logics are contributing to improvements of sciences, especially computer science. This research introduces one of the process of Co-Evolution, and attempts to insist that Logics, which is seemed it has no relations to Social problems, is developing together with other fields.

This research is a survey of many other works of histories, but it covers across many fields. There are few works such that explain clearly about a relation between the establishment of Mathematical Logic and Society. Because many works write about each history of developments in their own fields respectively. This research avoids following the detail processes, and gives an importance to following the total process of Co-Evolution.

2. Intention of studying Logics

Logics have been studied since ancient times by a lot of logicians and philosophers standing on various stances. In this chapter, I am going to explain my intention of studying Logics.

3. The history of establishment of Mathematical Logic

This chapter introduces the history from 17th Century's development of capitalism and globalization of Markets, to birth of Mathematical Logic. From this history, it is intended to explain about dynamic Co-Evolution; Society-Technology-Science-Mathematics-Logics.

4. Tense Logic and author's present study

The Mathematical Logical systems are called `***Classical Logic***'. Classical Logic is suitable for analyzing logic of mathematics, but it has limitations for analyzing other logical problems, especially philosophical logical problems. For this reasons, many attempts for improving Classical Logic, with philosophical insights, have been studied. Tense Logic is one of these attempts. In the 1960s, Arthur N. Prior succeeded in constructing some systems which formalized the use of tenses of ancient arguments, but there still remain some philosophical problems. On the other hands, Prior's results contributed to development of computer science, and now, this contribution of study is lasting. The author of this research tried to solve the remained philosophical problems, and found some results. The author is studying to improve these results, and thinking about applying his results to other fields.

5. Conclusion

Although the study of Logics seemed to have no relation to Scientific and Technological problems, and Social problems, it has many relations with those problems and has Co-Evolution with other fields. The study of Logics does not contribute to Social problems, but it is necessary as a part of Co-Evolution and also necessary to solve those social problems. I conclude that Logics is included in Institution.

Influence of Computer Science on the Development of Electronic Computers

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1. Introduction

Computer science, which provides basic theories on computing, and practical electronic computers were both first developed mostly in the 1930s and 1940s. The origin of computer science was earlier than that of practical electronic computers. Regarding the influence of computer science on the development of electronic computers, John von Neumann, who is said to be the father of electronic computers, stated that the basic concepts of electronic computers were based on the theories of Alan Turing, said to be the father of computer science. As a result, Turing was highly esteemed. In this study, I evaluated this view from historical and theoretical perspectives, and reached the conclusion that computer science did not have a significant influence on the birth of practical electronic computers.

Because current computer science is quite practical in terms of computational complexity theory and compiler implementation, and has greatly affected software development, this study suggested that computer science did not have a deep influence on computing in the beginning, but that gradually the applications became more practical and were then used. Therefore, in the conclusion section, I also discussed the general relationship between basic research and applied research.

2. Background on the Beginnings of Computer Science and Electronic Computers

I compared the backgrounds of the beginnings of computer science and those of electronic computers. I explained that although the concepts that each are dealing with were quite similar, each came into existence from a completely different awareness of the issues, and I demonstrated that the actual historical influence of computer science on the development of electronic computers was very small.

3. Influence of Computer Science on Built-in Programs

I also explained that the architecture of built-in programs (von Neumann-type architecture) adopted by von Neumann and Eckert – and currently used in almost all electronic computers – were adopted simply due to technical reasons and that the architecture is considerably different from the virtual computing model advanced by Turning et al.

4. Conclusion

While computer science developed by setting up logical questions, such as the decision question by Hilbert, practical electronic computers mainly developed from real demands, such as the demand for trajectory computations during World War II. I concluded that the relationship of computer science and electronic computers became closer as basic research accepted the various demands from applied research, and using this process, I showed the relationship between basic research and applied research.

Historical Analysis of Transportation Technology Development by National Project

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1. Introduction

National projects in Japan have often been successful on technical grounds. But on the grounds of their commercial use, they have often been failures. Because, most of them could not be put in practical use as they had intended. To illustrate this situation, this research takes the cases of STOL or "the Short Take Off and Landing" experimental aircraft, nicknamed *ASUKA*, and a new type high-speed ship, called "Techno Super Liner" (TSL). The research also analyzes the cases of a jet engine "FJR 710", Tokaido Superexpress Train and electric automobiles as comparisons.

2. ASUKA Project

The National Aerospace Laboratory (NAL) of the Science and Technology Agency began to develop *ASUKA* in 1975. By the time it made its first successful trail flight in 1985, it has become practically useless as there was no longer any demand for it. The Ministry of Transport (MT) pursued a long term program for lengthening runways or building new airports, beginning in 1967. However, in the meantime, the Ministry of International Trade and Industry (MITI) changed the national policies for developing aircrafts. But, regardless of these new policies, the NAL continued to pursue the project.

3. The MT's TSL Project

The MT's TSL project began in 1989. It was managed by a research consortium appointed by the MT. The TSL proved to be a technically successful project. Its first trial voyage in 1994 was a success. But it was a failure commercially. Even though its high production and operation costs had been known from the start and came to light again after it was completed, the MT decided to go commercial with TSL. But it resulted in utter failure.

4. Conclusion

This research identifies three factors for the failure of these national projects. Firstly there was no mechanism for effective coordination and communication among the concerned ministries and their research consortium. Secondly there was no mechanism for evaluating the value of these projects. Thirdly there were mismatches between the goals of the projects and the capabilities of laboratories and research consortium responsible for developing them.

This research has also proposed a method of evaluation of national projects, based on the finding above.

A History of Thought in the Japanese System of Engineering Education in Early Meiji

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1. Introduction

The dramatic industrialization since the Meiji period in Japan has been a significant theme in the fields of the history of technology and economics as a case study how a developing country attains industrialization. This theme is a practical issue on the way to industrialize a developing country at the present day. However, Japan's case involves peculiar factors in the process of industrialization with technology innovation, such as ideological and educational background since Tokugawa Shogunate, end of the feudalistic system, and impact of Western imperialism. A model of technology innovation that can be presented to other countries to obtain general implication will need a historical analysis. This research focuses on engineering departments at imperial universities founded in the Meiji period, specifically the Imperial College of Engineering (ICE) in Tokyo which is admitted at the forefront of Westernization, and attempts to uncover historical materials on its educational feature.

2. Method—Prosopography

The ICE, or *Kobu-Daigakko*, was a higher educational institution in engineering which was founded in the fourth year of Meiji (1871) under the administration of the Ministry of Public Works, and closed in 1886. In this research, I used a method of prosopography, or group biography, to analyze statistical features of the students at the ICE. A fundamental material, *Kobusho Enkaku Hokoku*, or *Report of the History of the Ministry of Public Works*, (1889) reports the names of 211 graduates from the college. However, there are not any basic information of all 493 students who entered the ICE. Then, I made a list of names of all the students, as a basic data-base, by checking *Imperial College of Engineering, Tokei, Calendar* (1873-1880), and *the Calendar of the Imperial College of Engineering* (1883-1885).

3. Analysis of Students

In addition to the list, I collected data regarding the year of birth of students, and motives of entering the ICE. As a result of analyzing students' ages at admission to the college in its beginning, it became clear that there were some students who were under and over the regulations, but they were allowed to enter the college.

On top of that, motives of the students to enter the ICE and their previous institutions before the college reported in *Kobu Daigakko Mukashi Banashi*, or *Essays on the Imperial College of Engineering*, (1927) and *Kyu Kobu Daigakko Shiro, Furoku*, or *Historical Materials on the Old Imperial College of Engineering*, (1931) show that they were not necessarily willing to change schools to the ICE because of the lack of information for prospective students.

4. Conclusion

This research focused on engineering education in early Meiji in the process of formation of Japanese institution. Currently, the ICE is recognized, among historians, as a leading and one of the most authoritative educational institutions in Japan, but it became clear in historical materials that this notion is not true among students at that time, at least at the beginning of the college. Because educational situation was less systematic in early Meiji than in current day, comparison of both educational systems is not simple. For that purpose, real contents of education at the college, such as entrance examinations and syllabi of classes, are needed to evaluate the ICE properly.

Moreover, this research showed both possibility and limit of prosopography as a method of analysis to use college students. Educational level and real situation of the ICE can be revealed by thorough investigation of the students including ones who left college before graduation with prosopographic analysis. At the same time, there are some students who do not leave any trace other than their names probably because they are still young and not in a stable social position. This issue implies an essential feature of the methodology of prosopography.

History of the Upgrading, Maintenance, and Provision of Measurement Standards in Post-War Japan

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1. Introduction

T. Hiroshige, a historian of science, asserted in 1973 that Japan was never so much behind the West when it institutionalized and incorporated science. Since then, a multitude of studies have pointed out the advanced state of Japanese science and technology. However, backward part of science and technology did exist. For example, in the 1980s, Japan fell far behind the US and the European countries with regard to the acquisition, accumulation and provision of the fundamental numerical values, such as measurement standards, chemical constants, material testing results, and characteristics of harmful chemical substances.

This research describes the history of upgrading, maintenance and provision of measurement standards in the post-war period of Japan. It offers a good occasion to illustrate the backward aspect of Japanese science and technology. The main objective of the research is to elucidate how and in what sense the science and technology of measurement standards were backward in post-war Japan.

2. Technological Backwardness and Institutional Backwardness

In order to elaborate the argument, I introduce two types of backwardness: *technological backwardness* and *institutional backwardness*. The former means the backwardness of precision technology, such as accurate measurement and precision processing. The latter means the backwardness of the provision system of measurement standards and the backwardness of the government's policy on measurement standards. I also make a distinction between "high accuracy" and "low accuracy" of measured values and product characteristics. In addition, I pay attention to the use of measurement standards in industry, especially in the electric and electronic industry and the machine tool industry.

I divide the post-war period of Japan into four periods to enable us to identify the backwardness or the advanced state. Then, I study the feature of each period from both the technological and the institutional points of view. In addition, I compare the post-war history of measurement standards in Japan with those in the US, Germany, UK and France to confirm Japan's relative backwardness in the establishment of measurement standards.

3. Conclusion

I conclude that Japan's backwardness with regard to measurement standards was mainly the institutional backwardness. It didn't cause a backwardness at the technological level, thanks to the industry's effort. However, it could have posed an obstacle to the Japanese industrial and technological development.

3. International Joint Research Collaboration

4. Dissemination of Research Information

3. International Joint Research Collaboration

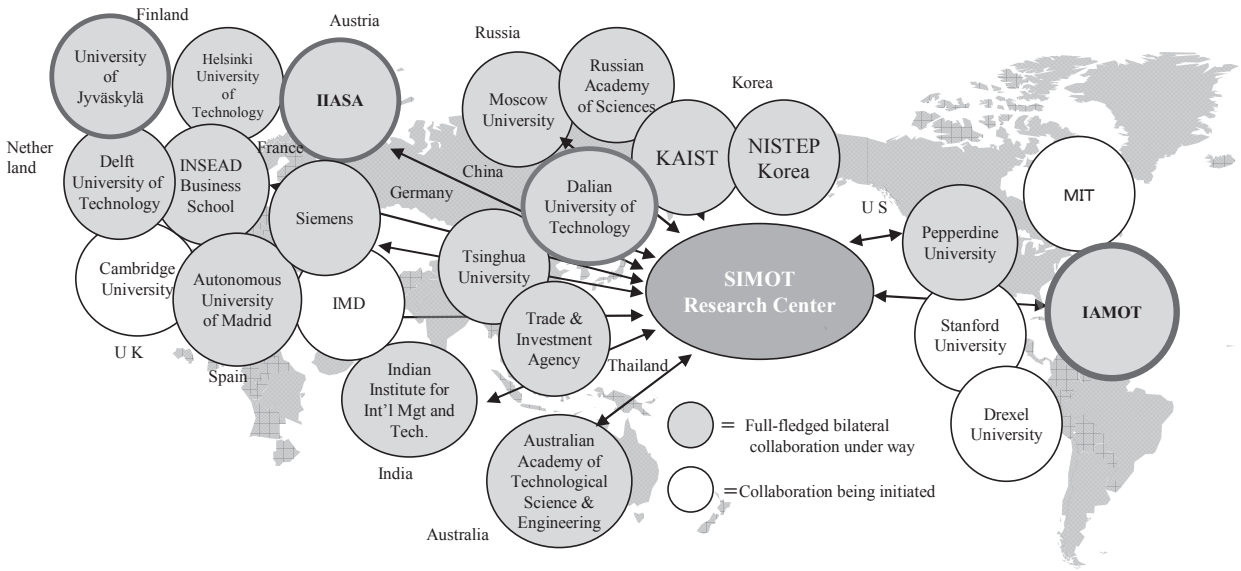
(1) Initial Ideas

1) Build a structure where leading-edge scholars and young researchers are invited to the COE for at least one year from leading research institutes worldwide and at least one visiting scholar collaborates with SIMOT members.
2) Build a research base exposed to information from every region of the world by accepting doctoral candidates not only from Japan but all over the world to cover every region in the five continents.
3) Doctoral candidates are put under the supervision of both visiting scholars and SIMOT members described in 1) to the extent possible. And also, domestic doctoral candidates, in particular, are seconded to overseas research institututes at least one year and expose themselves to the local information and leading-edge researches in such institutes and learn internationalism.

(2) Execution Plan

1) Build and extend spirally an international collaboration network with the US, Europe (UK, Germany, France, Austria, Netherlands, Spain, Switzland, Finland and Rossia), Asia (China, Korea, Tailand and India) and Australia.
   a) The US Pepperdine University, Drexel University and International Association of MOT
   b) UK Cambridge University
   c) Germany Siemens
   d) France INSEAD
   e) Austria International Institute for Applied System Analysis (IIASA)
   f) Netherlands Helsinki Institute of Technology
   g) Spain Autonomous University of Madrid
   h) Switzland IMD
   i) Finland University of Jyvaskyla
   j) Russia Russian Science Academy, Moscow University and Stecrof Mathematics University
   k) China Tsinhwa University and Dalian University of Technology
   l) Korea KAIST, NISTEP
   m) Thailand Trade & Investment Agency
   n) India Indian University of International Management and Technology
   o) Australia Australian Science and Technology Academy
2) Based on 1), promote co-researches aggressively. In addition to the regular exchanges of researchers, pursue researchers further as follows:
   a) Co-sponsored symposia: Tokyo Tech (Feb.), Engineering Academy (Nov.), Dalian Science and Technology University (Nov.)
   b) Co-workshops: IIASA (May and Sep.), Dalian Science and Technology University (May and Sep.) and KAIST (Aug.)
   c) Inviting scholars: SIMOT professors: Siemens, Drexel University and University of Jyvaskyla
      Researchers: University of Jyvaskyla, Russian Engineering Academy, and etc.
   d) Seconding selected students: IIASA (YSSP from Jun. to Aug., etc.), KAIST (07-08)
      IAMOT (Apr. and May)
   e) Related events and journals with special features: IIASA, AAAS, IEEE

(3) Outcomes



■ Examples of researches collaborated with overseas universities and research institutes

1) International Institute for Applied System Analysis (IIASA)

Exchanges of researchers. Co-sponsored symposia and workshops (Twice a year at Vienna, SIMOT member professors, post doctoral fellows, together with selected researchers from many countries, participate and exchange views and ideas.

2) University of Jyvaskyla

Accepted researchers (one SIMOT professor and one assistant professor), co-sponsor a symposium (Rector of the university invited)

3) Dalian University of Technology

Exchanges of researchers (co-researchers with SIMOT members), placement of a young researcher (employed by the university as lecturer), co-sponsored symposia / workshops in both Dalian and Tokyo.

4) Autonomous University of Madrid

Collaboration between researchers (SIMOT members co-research with the researchers of the University., Invitation to workshops (held in Japan. SIMOT members and SIMOT professors joined.)

■ Effectiveness of International Collaboration

1) By means of collaborations including exchanges of scholars and students and co-sponcership of symposia, leading-edge, interdisciplinary researches have developed.

2) Comparative empirical researches have advanced and increased in depth, with the result that the number of co-research papers has more than doubled from 16 to 30.

3) Among top-notch international conferences, SIMOT has held a distinct session in an AAAS conference and co-held a conference with IEEE, leading to special issues for international academic journals.

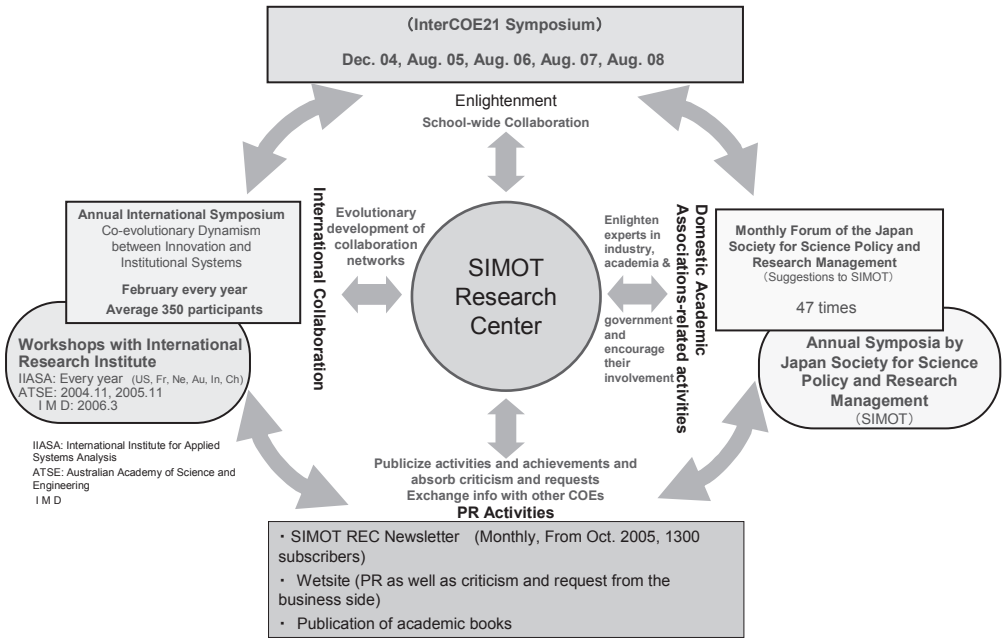
4. Dissemination of Research Information

(1) Initial Ideas

1) With the SIMOT Research Center as the core of the activities, SIMOT has built effective collaborative networks, encompassing Tokyo Tech and both domestic and overseas bodies in order to enlarge and further activate SIMOT activities. SIMOT has pursued co-evolution between such activities and the effective networks
2) Public relations activities have been conducted in order to further dig into the above collaboration and to convey the integrated achievements of the COE as a whole.

(2) Execution Plan

1) Renovated and opened our website to upload information on our research reports, related academic associations and symposium, as well as the critical comments and requests from business media.
2) Started to issue monthly "SIMOT Research Center Newsletter" from Octover , 2005 with as many as 1,300 subscribers, in which research results and related information have been publicized broadly both inside and outside Tokyo Tech.
3) Held international symposia taking advantage of the said international collaboration network.
4) Discussed various SIMOT-related issues and made our activities public, taking opportunities of the montly Evening Forum held by the International Issue Section of the Japan Society for Science Policy and Research Management.
5) Related events and issuance of special issues of journals
6) Presentaions at international academic conferences and papers for international journals



■ International Symposium, Workshop

1. International Symposium

(1) 1st Symposium

- Date: Feb. 28 – Mar. 1, 2005, Tokyo Institute of Technology
- Guest Speakers: Prof. Leen Hordijk (Director of IIASA), Prof. Tarek Khalil (IAMOT), Prof. Michiyuki Uenohara (Professor Emeritus, University of Tama, Former Vice President of NEC), Prof. Keizo Nagatani (President of University of Marketing Distribution and Sciences)

(2) 2nd Symposium

- Date: Feb. 27-28, 2006, Tokyo Institute of Technology
- Guest Speakers: Prof. Nathan Rosenberg (Professor Emeritus, Stanford University), Prof. Lewis M. Branscomb (Professor Emeritus, Harvard University), James C. Abegglen (Honorary Dean and Prof.., Graduate School of Management, Globis University)

(3) 3rd Symposium

- Date: Feb. 27-28, 2007, Tokyo Institute of Technology
- Guest Speakers: Dr. Norio Murakami (President & CEO, Google Japan and Vice President, Google Inc.), Prof. Robert A. Burgelman (Edmund W. Littlefield Professor of Management and Director of the Stanford Executive Program, Stanford University), Dr. Norio Murakami (President & CEO, Google Japan and Vice President, Google Inc.)

(4) 4th Symposium

- Date: Feb. 27-28, 2008, Tokyo Institutte of Technology
- Guest Speakers: Prof. Aino Sallinen (Rector, University of Jyväskylä), Mr. David Blakely (Director, Technology Strategy, IDEO), Dr. John Knights (Vice President, Business Development, Palo Alto Research Center)

2. Technical Meeting on An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories

(1) 2005 Spring

- Date: May 1-2, 2005, IIASA (Vienna)
- Guest: Robert Ayres (INSEAD), Nikolai Grigorenko (Moscow State University) etc

(2) 2005 Fall

- Date: Sept. 18-19, 2005, IIASA (Vienna)
- Guest: Robert Ayres (INSEAD), Marina van Geenhuizen (Delft University of Technology) etc

(3) 2006 Fall

- Date: Sept. 17-18, 2006, IIASA (Vienna)
- Guest: Alexander Tarasiev (Russian Academy of Sciences), Vinnie Jauhari (Indian Institute for Int'l Mgt and Tech.) etc

(4) 2007 Fall

- Date: Sept. 8-9, 2007, IIASA (Vienna)
- Guest: Alexander Tarasiev (Russian Academy of Sciences), Arkadii Kryazhimski (IIASA Project leader) etc

(5) 2008 Spring

- Date: May 1-2, 2008, IIASA (Vienna)
- Guest: Tapio Palokangas (University of Helsinki), Marina van Geenhuizen (Delft University of Technology) etc

(6) 2008 Fall

- Date: Sept. 6-7, 2008, IIASA (Vienna)
- Guest: Charla Griffy-Brown (Pepperdine University), Pradeep Agrawal (Institute of Economic Growth, Delhi) etc

3. Joint Collaboration with Dailian Univ. of Tech & Tokyo Tech

(1) 2007 Summer

- Date: Jun. 3, 2007, Dalian University of Technology
- Guest: Zhongtuo Wang (Director, Knowledge Science and Technology Research Center)

(2) 2007Fall

- Date: Nov. 7, 2007, Tokyo Institute of Technology
- Guest: Zhongtuo Wang (Director, Knowledge Science and Technology Research Center)

etc

■ Monthly forum – *The Japan Society for Science Policy and Research Management-The Section Meeting of National Problem*

1. Common Topic： A suggestion to the Science of Institutional Management of Technology
2. Date

1) 2004: Octorber. ～ December (3)	2) 2005: Janualy ～ December (12)
3) 2006: Janualy ～ December (12)	4) 2007: Janualy ～ December (12)
5) 2008: Janualy ～ December (12)	6) 2009: Janualy ～ March (3)

3. Background of Guest Speakers

1) Business: Seimens (Germany), Canon, Mitsubishi Research Institute, Boston Consulting Group, etc

2) Government: Ministry of Economy, Trade and Industry (METI), Japan Science and Technology Angency (JST), Advanced Industrial Science and Technology (AIST), etc

3) Academia: Emeritus Swiss Federal Institute of Technology, University of Jyvaskyla, Dalian University of Technology, University of Tokyo, Tokyo Institute of Technology etc

Part III List of Publications

1. Journal Publications (Peer-reviewed)
2. Books & Book Chapters
3. Technical Papers and Reports
4. Presentation

1. Journal Publications (Peer-reviewed)

(International Journal)

[1] M.K. Ahsan and D. Tsao, "Adaptive Multi-Criteria Search Technique for Resource-Constrained Project Scheduling Problems," *International Journal of Industrial Engineering 12*, No. 3 (2006) 286-295.

[2] K. Ahsan and D. Tsao, "An Optimal Project Price Negotiation Model for Fixed Price Incentive Contract," *Proceedings of the 5th ANZAM Operations Management Symposium*, *New Zealand* (2007).

[3] T. Anantana, T. Enkawa and S. Suzuki, "Empirical Research on The Influential Factors for Successful New Product Development and their Differences among Industries," *Journal of Japan Industrial Management Association 59*, No. 6 (2009).

[4] B.K. Ane and C. Watanabe, "Structural Change in Techno-production of Japan's Automobile Industry," *Journal of Advances in Management Research 2*, No. 1 (2005) 21-31.

[5] B.K. Ane, A. Tarasyev and C. Watanabe, "Impact of Technology Assimilation on Investment Policy," Dynamic Optimization and Econometric Identification," *Journal of Optimization Theory and Applications 134*, No. 3 (2007) 321-338.

[6] B.K. Ane, A. Tarasyev and C. Watanabe, "Construction of a Nonlinear Stabilizer for Trajectories of Economic Growth," *Journal of Optimization Theory and Applications 134*, No. 3 (2007) 303- 320.

[7] H. Aoki, J.P. Hansen and K. Itoh, "Learning to Interact with a Computer by Gaze," *Behaviour and Information Technology 27*, No. 1 (2008) 339-344.

[8] H. Aoki, J.P. Hansen and K. Itoh, "Learning Gaze Typing: What Are the Obstacles and What Progress to Expect?" *Universal Access in the Information Society 6*, No. 4 (2009) in print.

[9] Z. Cai, M. Miyakawa and M. Kuroki, "On Estimable Effects and Aliasing Patterns in Shainin's Variable Search" *Journal of Japanese Society for Quality Control 34*, No. 4 (2004) 407-418.

[10] C. Carvajal and C. Watanabe, "Clustering Patterns in the Manufacturing Sectors of Japan," *Journal of Technology Innovation 12*, No. 2 (2004) 99-126.

[11] C. Carvajal, C. Watanabe and N. Osada, "Managing Technological and Geographical Distance: Empirical Analysis of Its Correlation in Spillover of Economic Growth and R&D: A Case of Japanl," *Development Engineering 10* (2004) 27-51.

[12] G.G. Castillo, S. Suzuki and T. Enkawa, "Introduction of Equalized Lot Size Concept in TOC Scheduling," *Journal of Japan Industrial Management Association 56*, No. 4 (2005) 237-245.

[13] G.G. Catillo, S. Suzuki and T. Enkawa, "A Proposal for the Scheduling of Cell Manufacturing through TOC," *Journal of Japan Industrial Management 57*, No. 6 (2007) 503-510.

[14] C. Chen and C. Watanabe, "Diffusion, Substitution and Competition Dynamism Inside the ICT Market: A Case of Japan," *Technological Forecasting and Social Change 73*, No. 6 (2006) 731-759.

[15] C. Chen and C. Watanabe, "Competitiveness through Co-evolution between Innovation and Institutional Systems: New Dimensions of Competitiveness in a Service-oriented Economy," *Journal of Services Research 7*, No. 2 (2007) 27-55.

[16] C. Chen, C. Watanabe and C. Griffy-Brown, "The Co-evolution Process of Technological Innovation: An Empirical Study of Mobile Phone Vendors and Telecommunication Service Operators in Japan," *Technology in Society 29*, No. 1 (2007) 1-22.

[17] S.L. Chung, "Retailing in Taiwan: Competition in International and Domestic Retailing," *Ritsumeikan Business Journal 2*, (2008) 49-66.

[18] X. Ding, J. Iijima and S. Ho, "Unique Features of Mobile Commerce" *Journal of Electronic Science and Techonology of China 2004 3*, No. 2 (2004) 205-210.

[19] X. Ding and J. Iijima, "A Study on Implementing Situation Dependent Services based on Logical Approach," *Japan Society of Management Information Journal 16* (2007) 49-62.

[20] P. Fan and C. Watanabe, "Comparative Analysis of Japan's and China's Technology Policies and Industrial Development: Lessons for Developing Countries," *Technology in Society 28*, No. 3 (2006) 303-320.

[21] B. Frank and T. Enkawa, "How Switching Costs Affect Consumer Attitudes: A Cross-Industrial Study from Germany," *Proceedings of the 5th ANQ Congress*, Incheon (2007) CD-ROM.

[22] B. Frank and T. Enkawa, "How Economic Growth Affects Customer Satisfaction," *Asian Pacific Management Review 13*, No. 2 (2008) 512-526.

[23] B. Frank and T. Enkawa, "Does Aggregate Income Influence Satisfaction with the Standard of Living?" *International Journal of Society Systems Science 1*, No. 2 (2008) 113-131.

[24] B. Frank and T. Enkawa, "Economic Influences on Perceived Value, Quality Expectations, and Customer Satisfaction," *International Journal of Consumer Studies 33*, No. 1 (2009) 72-82.

[25] B. Frank and T. Enkawa, "Economic Influences on Customer Satisfaction: An International Comparison," *International Journal of Business Environment 2*, No. 3 (2009) 336-355.

[26] B. Frank and T. Enkawa, "Economic Drivers of Dwelling Satisfaction: Evidence from Germany," *International Journal of Housing Markets and Analysis 2*, No.1 (2009) in print.

[27] B. Frank, S. Sudo and T. Enkawa, "Interpreting Time Series of Patient Satisfaction: Macro vs. Micro Components," *International Journal of Hospital Marketing and Public Relations 19*, No. 1 (2009) 15-19.

[28] B. Frank and T. Enkawa, "Does Economic Growth Enhance Life Satisfaction? The Case of Germany," *International Journal of Sociology and Social Policy* (2009) in print.

[29] W.E. Grunden, Y. Kawamura, E. Kolchinsky, H. Maier and M. Yamazaki, "Laying the Foundation for Wartime Research: A Comparative Overview of Science Mobilization in National Socialist Germany, Japan, and the Soviet Union," *OSIRIS 20* (2005) 79-106.

[30] W.E. Grunden, M. Walker and M. Yamazaki, "Wartime Nuclear Weapons Research in Germany and Japan," *OSIRIS 20* (2005) 107-130.

[31] R. Gu and K. Higa, "A Study on Communication Media Selection in IT and Service Work Groups," *The Internatiional Journal of Services Sciences* (2009) in print.

[32] T. Hachiya and X. Zheng, "Director's Motivation to Keep Control of their Firms in the IPO Process," *Japan Finance Association 23*, No. 2 (2004) 2-17.

[33] S. Hayashi and K. Higa, "Analysis of Differentiating Factors among Trust and Value Stages in e-Commerce Growth Process," *Journal of Japan Industrial Management Association 60*, No.3 (2009) in print.

[34] K. Higa and R. Gu, "Communication Media Selection for Remote Work: Towards a Theory of Media Fitness," *Journal of E-working 1*, No. 1 (2007) 45-68.

[35] S. Ho and J. Iijima, "Growth Model of Local Government Web Sites," *Journal of Electronic Science and Techonology of China 2004*, No. 2 (2004) 156-161.

[36] M. Hobo, C. Watanabe and C. Chen, "Double Spiral Trajectory between Retail, Manufacturing and Customers Leads a Way to Service-oriented Manufacturing," *Technovation 26*, No. 7 (2006) 873-890.

[37] H. Horio and C. Watanabe, "The Paradox of a Service-oriented Economy for Sustainability: Co-evolution between Innovation and Resources Effectuation by a Global Complement," *Journal*

of Services Research 8, No. 1 (2008) 155-175.

[38] H. Horio and C. Watanabe, "The Paradox of a Service-oriented Economy for Energy Efficiency: The Vicious Impact of Network Externality Contrasted by Japan and China," *Journal of Services Research* (2009) in print.

[39] J. Iijima, "Common Structure and Properties of Filtering Systems," *Electronic Commerce Research and Applications* (2009) in print.

[40] N. Indrianti, S. Matsuoka and M. Muraki, "A Management Framework for the implementation of Policies for Industrial Ecology," *Industrial Ecology* 3 No. 3 (2006) 176-191.

[41] N. Indrianti, S. Matsuoka and M. Muraki, "Competitive Bidding Process for Converter Selection to Support Industrial Ecology," *Industrial Ecology* 3 No. 3 (2006) 192-208.

[42] N. Indrianti, S. Matsuoka and M. Muraki, "A Strategic Policy Model for Promoting Secondary Material Use," *Eco-Efficiency Indust. Sce. 22* (2006) 285-305.

[43] N. Islam, K. Miyazaki, "Nanotechnology Innovation System – Strategic Perspective," *International Journal of Knowledge and Systems Sciences 3*, No. 1 (2006) 34-42.

[44] N. Islam and K. Miyazaki, "Nanotechnology Research and Development Policy: An Analysis of R&D Strategy and Some Policy Implications for Promoting Nanotechnology R&D in Japan," *Journal of Science and Technology Studies* (2009) in print.

[45] N. Islam and K. Miyazaki, "Innovation in Nanotechnology – Trend of Nanotech Fusion with Scientific Disciplines and Nanotech Roadmapping," *International Journal of Technology Intelligence and Planning* (2009) in print.

[46] K. Itoh, H.B. Andersen and M. Seki, "Track Maintenance Train Operators' Attitudes to Job, Organisation and Management and their Correlation with Accident/Incident Rate," *Cognition, Technology & Work 6*, No. 2 (2004) 63-78.

[47] K. Itoh, H.B. Andersen, M.D. Madsen, D. Oestergaard and M. Ikeno, "Patient Views of Adverse Events: Comparisons of Self-reported Healthcare Staff Attitudes with Disclosure of Accident Information," *Applied Ergonomics 37* (2006) 513-523.

[48] K. Jonsson and K. Miyazaki, "3G Mobile Diffusion in Japan – Technology Strategies of KDDI and NTT DoCoMo and Technology Adoption by Users," *Japan Society of Management Information Journal 13*, No. 3 (2004) 57-78.

[49] A. Kamurul and D. Tsao, "A Composite Multi-Criteria Search Strategy of Heuristic Learning Algorithm for Resource–Constrained Project Scheduling Problems," *International Journal of Industrial Engineering* (2009) in print.

[50] N. Karami and J. Iijima, "Modeling Dynamic Business Rules Using A Dynamic Knowledge Approach," *Industrial Engineering & Management Systems 6* (2007) 72-78.

[51] R. Kato, C. Watanabe and Y. Tou, "Intra-firm Technology Spillovers Leveraging Co-evolution between Digital Technologies and their Application to Global Warming Mitigation: Towards Eco-friendly Business in a Service-oriented Economy," *Journal of Services Research 7*, No. 1 (2007) 193-213.

[52] M. Katsumoto and C. Watanabe, "External Stimulation Accelerating a Structural Shift to Service-oriented Industry: A Cross Country Comparison," *Journal of Services Research 4*, No. 2 (2004) 91-111.

[53] H. Kim, J. Iijima and S. Ho, "An Integrated Approach of Information Systems Development to Supporting Customer-Centric Business Process," *Industrial Engineering & Management Systems 6* (2007) 28-39.

[54] T. Kitahara, S. Mizuno and K. Nakata, "An Extension of a Minimax Approach to Multiple Classification," *Journal of the Operations Research Society of Japan 50*, No. 2 (2007) 123-136.

[55] T. Kitahara, S. Mizuno, and K. Nakata, "Quadratic and Convex Minimax Classification Problems," *Journal of the Operations Research Society of Japan 51*, No. 2 (2008) 191-201.

[56] R. Kondo, C. Watanabe and K. Moriyama, "A Resonant Development Trajectory for IT Development: Lessons from Japan's i-mode," *International Journal of Advances in Management Research 4*, No. 2 (2007) 7-27.

[57] M. Kotani and J. Iijima, "IT Applications Portfolio Management under Business and Implementation Uncertainty," *Journal of Systems Science and Systems Engineering 17*, No. 1 (2008) 109-124.

[58] Y. Kumakiri and D. Tsao, "An Optimization Model for Apparel Supply Contract with Option," *The 3rd World Conference on Production and Operations Management* – POM TOKYO 2008, (2008) 236-243.

[59] M. Kuroki and M. Miyakawa, "Graphical Identifiability Criteria for Total Effects in Studies with An Observed Response Variable," *Behaviormetrika 31*, No. 1 (2004) 13-28.

[60] H. Lee, B. Shin and K. Higa, "Telework vs. Central Work: A Comparative View of Media Usage for Knowledge Access," *Decision Support Systems 43*, No. 3 (2007) 687-700.

[61] H. Lee, Kunihiko Higa, and Takayuki Fujikawa, "A Study on the Effective Database Integration Methodology – The Identification of Name Conflict," *Journal of Korean Navigation and Port Research 29*, No. 5 (2005) 457-464 (*in Korean*).

[62] C.P. Leguizamo, D. Wang, K. Mori, "Autonomous Mobile-Agent-Based Data Allocation Technology in Distributed Database Systems for Assuarance," *IEICE Transactions on Communications E87-B*, No. 7 (2004) 1818-1825.

[63] C.P. Leguizamo, D. Wang and K. Mori: Autonomous Reconfiguration Technology for High Response Time in Decentralized Database Systems, *Journal of Information Processing* 46, No. 9 (2005) 2361-2368.

[64] B. Li and J. Iijima, "A Situation Calculus based Approach to Dynamic Management of e-business Services," *Journal of Systems Science and Systems Engineering 16* (2007) 336-355.

[65] Z. Lin and De-bi Tsao, "On the Evaluation to the Downstream Information Sharing," *Journal of Japan Industrial Management Association 56*, No. 6 (2006) 413-420.

[66] X. Lu, H. Arfaoui and K. Mori, "Autonomous Information Fading and Provision to Achieve High Response Time in Distributed Information Systems," *IEEJ 125C*, No. 4 (2005) 645-652.

[67] X. Lu, K. Mori et al., "Timeliness and Reliability Oriented Autonomous Network-Based Information Services Integration in Multi-Agent Systems," *IEICE Transactions on Information and Systems E88-D*, No. 9 (2005) 2089-2097.

[68] X.D. Lu and K. Mori, "Autonomous Correlated Services Access for High Response in Multi-Agent Systems," *IEICE Trans. COMMUN E90-B*, No.10 (2007) 2712-2719.

[69] Q. Luo and T. Hachiya, "Investment-Cash Flow Sensitivity and Ownership Structure in Japan," *Japan Finance Association 24*, No. 1 (2005) 49-67.

[70] Q. Luo and T. Hachiya, "Bank Relationship, Cash Holdings, and Firm Value: Evidence from Japan," *Management Research News 28*, No. 4 (2005) 61-73.

[71] Q. Luo and T. Hachiya, "Corporate Governance, Cash Holdings, and Firm Value: Evidence from Japan," *Review of Pacific Basin Financial Markets and Policies 8*, No. 4 (2005) 1-24.

[72] R. Magnier-Watanabe, D. Senoo and M.P. Salmador, "Workplace Reformation, Active BA and Knowledge Creation: From a Conceptual to a Practical Framework," *European Journal of Innovation Management 10*, No. 3 (2007) 296-315.

[73] R. Magnier-Watanabe and D. Senoo, "Organizational Characteristics as Prescriptive Factors of Knowledge Management Initiatives," *Journal of Knowledge Management 12*, No. 1 (2007) 21-36.

[74] R. Magnier-Watanabe and D. Senoo, "Institutional Impetus and Knowledge Management for Successful Innovation: The Case of the Smartcard in France," *International Journal of Intelligent Enterprise* (2009) in print.

[75] R. Magnier-Watanabe, and D. Senoo, "Congruent Knowledge Management Behaviors as Discriminate Sources of Competitive Advantage," *Journal of Workplace Learning 21*, No. 2 (2009) 109-124.

[76] Missing Number.

[77] S. Matsuoka, M. Muraki, "Short-term Maintenance Scheduling for Utility Systems," *Journal of Quality in Maintenance Engineering 13*, No. 3 (2007) 228-240.

[78] S. Min, S. Matsuoka and M. Muraki, "Priority Assignment Procedure in Multi-product Disassembly," *Industrial Engineering & Management Systems 3*, No. 1 (2004) 12-21.

[79] M. Mitsuda and C. Watanabe, "Initial Trajectory of the Start-up of New Ventures: Suggestion from the Milk Crown Model to Services Management," *Journal of Services Research 5*, No. 2 (2005) 169-191.

[80] M. Mitsuda and C. Watanabe, "The Role of the Venture Leader Initiative in IPO Accomplishment: The Impact of Leader Characteristics on IPO Performance," *Journal of Services Research 8*, No. 2 (2008) 141-174.

[81] M. Mitsuda and C. Watanabe, "Accerelated Interaction between Firms and Markets at ICT-based Venture Business: The Case of Mobile Phone Business in Japan," *Journal of Services Research 8*, No. 2 (2008) 101-119.

[82] M. Miyakawa, "Discussion to "Failure Amplification Method: An Information Maximization Approach to Categorical Response Optimization," *Technometrics 46*, No. 1 (2004) 16-19.

[83] K. Miyazaki and E. Wiggers, "Innovation in Telecom Services - Framework and Analysis based on the Case of Pre-paid Calling Cards in Japan," *Asian Journal of Technology Innovation 13*, No. 2 (2005) 45-70.

[84] K. Miyazaki, "Institutional Change Affecting Engineering Education in Japan: A Model of Empirical Analysis of Competence Building," *Information Knowledge Systems Management 4*, No. 3 (2004) 155-166.

[85] K. Miyazaki and N. Islam, "Nanotechnology Systems of Innovation: An Analysis of Industry and Academia Research Activities," *Technovation 27*, (2007) 661-675.

[86] K. Mori, "Assurance in Autonomous Decentralized Embedded System," NATO Security through Science Series D: Information and Communication Security - *Security and Embedded Systems 2*, (2006) 121-128.

[87] K. Moriyama and C. Watanabe, "New Cluster of Industrial Sectors toward a Service-oriented Economy: R&D Profitability Criteria Substitutes for Labor Productivity Criteria," *Journal of Services Research* (2009) in print.

[88] A. Nagamatsu, C. Watanabe and K.L. Shum, "Diffusion Trajectory of Self-propagating Innovations Interacting with Institutions: Incorporation of Multi-factor Learning Function to Model PV Diffusion in Japan," *Energy Policy 34*, No. 4 (2006) 411-421.

[89] K. Nagata and T. Hachiya, "Earnings Management and the Pricing of Initial Public Offerings," *Review of Pacific Basin Financial Markets and Policies 10*, No. 4 (2007) 541-559.

[90] K. Nagase-Reimer, W. Grunden and M. Yamazaki, "Nuclear Weapons Research in Japan during the Second World War," *Historia Scientiarum* (2005) 201-240.

[91] M. Nakagawa and C. Watanabe, "Moving beyond Organizational Inertia as a Survival Strategy for Resource-based Industry in a Service-oriented Economy: Lessons from Cross-sector Technology Spillover in the Nonferrous Metal Industry," *Journal of Services Research 7*, No. 1 (2007) 7-35.

[92] M. Nakagawa, C. Watanabe and C. Griffy-Brown, "Changes in the Technology Spillover Structure due to Economic Paradigm Shifts: A Driver of the Economic Revival in Japan's Material Industry beyond the Year 2000," *Technovation 29*, No. 1 (2009) 5-22.

[93] M. Nakagawa and C. Watanabe, "A Revival of Material Innovation: Strategic Technology Spillovers in Japan's Material Industry in the 2000s," *Journal of Services Research* (2009) in print.

[94] A. Nakatsuka and D. Tsao, "Tasit Knowledge Aggregation for Demand Forecasting in Prediction Market," *The 3rd World Conference on Production and Operations Management* – POM TOKYO 2008 (2008) 311-322.

[95] Y. Namba and J. Iijima, "City Planning Approach for Enterprise Information System," *Proceeding of the Eight Pacific Asia Conference on Information Systems 2004* (2004).

[96] M. Ogikubo and T. Enkawa, "The Cultural Factors of Customer Satisfaction," *the 13th Asia Pacific Quality Organisation (APQO) International Conference 2007*, Shanghai (2007).

[97] M. Ogikubo and T. Enkawa: "Cross National Analysis of Customer Satisfaction, Economic Institutions and Cultural Factors, Journal of Japan Industrial Management 58, No. 3 (2007) 167-172.

[98] M. Ogikubo, S.J. Schvaneveldt and T. Enkawa, "An Empirical Study on Antecedents of Aggregate Customer Satisfaction: Cross-country Findings," *Total Quality Management and Business Excellence 20*, No.1 (2009) 23-37.

[99] A. Ohmura and C. Watanabe, "Inside the Black Box of Cross-functional Spillover: A Lesson from the Functionality Development of Fine Ceramics," *Journal of Advances in Management Research 2*, No. 2 (2005) 7-23.

[100] A. Ohmura and C. Watanabe, "Cross-products Technology Spillover in Inducing a Self-propagating Dynamism for the Shift to a Service-oriented Economy: Lessons from High-performance Fine Ceramics," *Journal of Services Research 6*, No. 2 (2006) 145-179.

[101] N. Osada and C. Watanabe, "Structural Impediments for Smaller Ventures in Creating New Emerging Industries in a Service-oriented Economy," *Journal of Services Research 5*, No. 2 (2005) 7-35.

[102] Y. Osawa and K. Miyazaki, "An Empirical Analysis of the Valley of Death: Large Scale R&D Project Performance in a Japanese Diversified Company," *Asian Journal of Technology Innovation 14*, No. 2 (2006) 93-116.

[103] N. Ouchi and C. Watanabe, "An Analysis of High Profitability Mechanism by means of Dynamism between Technological Diversification, Learning and Functionality Development," in M.H. Sherif and T. Khalil (eds.), *Management of Technology Innovation and Value Creation* 55-87 (World Scientific Publishing, New Jersey, 2008).

[104] N. Ouchi, T. Takahashi, T. Saiki, C. Watanabe and Y. Tou, "Timing of the Initial Functionality Development as a Key to Sustainable Functionality: Comparative Analysis of Copying Machine Development in Canon and Ricoh," *Journal of Advances in Management Research* (2009) in print.

[105] N. Ouchi and C. Watanabe, "Co-evolutionary Domestication for Self-Propagating Functionality Development: Lessons from Mobile Phone Business Ventures," *Journal of Services Research* (2009) in print.

[106] W. Qiong, K. Klincewicz and K. Miyazaki, "An Analysis of Open Source Software," *Asian Journal of Technology Innovation 14*, No. 2 (2006) 117-142.

[107] K. Ragab, N. Kaji, Y. Horikoshi, H. Kuriyama, and K. Mori, "Autonomous Decentralized Community Communication for Information Dissemination," IEEE Internet Computing, *IEEE Computer Society* (2004) 29-36.

[108] K. Ragab, K. Mori, et al., "Enhancing Community Communication Delay for Large-Scale Information Systems," *IEICE Transactions on Communications E87-B*, No. 7 (2004) 1797-1805.

[109] K. Ragab, N. Kaji and K. Mori, "Scalable Multilateral Autonomous Decentralized Community Communication Technique for Large-Scale Information Systems," *IEICE Transactions on Communications E87-B*, No. 3 (2004) 660-670.

[110] K. Ragab, N. Kaji, Y. Horikoshi, H. Kuriyama and K. Mori, "Autonomous Decentralized Community Communication for Information Dissemination," IEEE Computer Society, *IEEE Internet Computing*, *May/June '04* (2004) 29-36.

[111] P.G. Ramirez and T. Hachiya, "Integrated Management Control System for Small and Medium Sized Enterprises," *International Journal of Accounting and Management*, Supplement No. 1 (2006) 27-38.

[112] P.G. Ramirez and T. Hachiya, "Measuring Firm-Specific Organizational Capital and Its Impact on Value and Productivity," Evidence from Japan, *Review of Pacific Basin Financial Markets and Policies 9*, No. 4 (2006) 549-575.

[113] P.G. Ramirez and T. Hachiya, "How do Firm-specific Organizational Capital and Other Intangible Assets Affects Sales, Value and Productivity? Evidence from Japanese Firm-level Data," *International Journal of Innovation and Technology Management 3*, No. 3 (2006) 1-18.

[114] P.G. Ramirez and T. Hachiya, "Measuring the Contribution of Intangibles to Productivity Growth: A Disaggregate Analysis of Japanese Firms," *Review of Pacific Basin Financial Markets and Policies 11*, No. 2 (2008) 151-186.

[115] P.G. Ramirez and T. Hachiya, "Assessing the Value of Intangible Assets: Evidence from Japanese Firms," *International Journal of Applied Management Science 1*, No. 1 (2008) 55-74.

[116] P.G. Ramirez and T. Hachiya, "A Comprehensive Study on Profits and Sustainable Competitive Advantage," *Management Research News 31*, No.9 (2008) 670-682.

[117] C.G. Riera A., D. Senoo and J. Iijima, "A Study of the Effect of Knowledge Creating Capabilities on Corporate Performance," *International Journal of Knowledge Management Studies 3*, Nos. 1/2 (2009) 116 - 133.

[118] A. Rusdiansyah and D. Tsao, "An Integrated Model of the Periodic Delivery Problems for Vending-machine Supply Chains," *Journal of Food Engineering 70*, No. 3 (2005) 421-434.

[119] A. Rusdiansyah and D. Tsao, "Coordinating Deliveries and Inventories for a Supply Chain under Vendor Managed Inventory System," *Journal of Japan Society of Mechanical Engineering Series A 48*, No. 2 (2005) 85-90.

[120] A. Rusdiansyah and D. Tsao, "Coordinating Deliveries and Inventories for a Supply Chain under Vendor Managed Inventory System," *Journal of Japan Society of Mechanical Engineering Series C 48*, No. 2 (2005) 85-90.

[121] T. Saiki, Y. Akano, C. Watanabe and Y. Tou, "A New Dimension of Potential Resources in Innovation: A Wider Scope of Patent Claims Can Lead to New Functionality Development," *Technovation 26*, No. 7 (2006) 796-806.

[122] D. Senoo, "Knowledge Creation Systems in Seven-Eleven Japan," *Journal of Electronic Science and Technology of China 2*, No. 3 (2004) 92-97.

[123] D. Senoo, M. Fukushima, S. Yoneyama and T. Watanabe, "Strategic Diversity in Japanese University Technology Licensing offices," *International Journal of Knowledge Management* Studies 3, Nos. 1/2 (2009) 60 - 78.

[124] A. Shibashi and K. Mori, "Autonomous Decentralized Data Consistency for High-Assurance Embedded System," *Intl. Scientific Journal of "Computing" 4*, No. 2 (2005) 105-112.

[125] A. Shiibashi and K. Mori, "High-speed Processing in Wired-and-wireless Integrated Autonomous Decentralized System and its Application to IC Card Ticket System," *Journal of Innovations in Systems and Software Engineering 3*, No. 1 (2007) 53-60.

[126] B. Shin and K. Higa, "Meeting Scheduling: Face-to-Face, Automatic Scheduling, and E-mail Based Coordination," *Journal of Organizational Computing & Electronic Commerce 15*, No. 2 (2005) 137-159.

[127] H. Shinno, H. Hashizume, H. Yoshioka and K. Itoh, "Product Development Methodology for Machine Tools: Usability Analysis of Man-Machine Interface," *JSME International Journal, Series C 45*, No. 3 (2004) 815-820.

[128] K.L. Shum and C. Watanabe, "Photovoltaic Deployment Strategy in Japan and the USA: An Institutional Appraisal," *Energy Policy 35* (2007) 1186-1195.

[129] K.L. Shum and C. Watanabe, "The Effects of Technological Trajectory in Product Centric Firms upon the Transition to Service Provision: The Case of Smart Solar Photovoltaic," *Journal of Services Research 7*, No. 2 (2007) 163-182.

[130] K.L. Shum and C. Watanabe, "Towards a Local Learning (Innovation) Model of Solar Photovoltaic Development," *Energy Policy 36* (2008) 508-521.

[131] Sukoyo, S. Matsuoka and M. Muraki, "Production Planning for Multi-site Batch Plants with the MILP Method," *Journal of the Japan Petroleum Institute 47*, No. 5 (2004) 318-325.

[132] S. Suzuki and D. Tsao, "Comparative Studies of the Japanese and Chinese Supply Chain Management,Informs International," (2006).

[133] T. Takahashi, T. Saiki, J.H. Shin, N. Ouchi, C. Watanabe and Y. Tou, "Effective Assimilation of Intra-technology Spillover as a Key to Sustainable Functionality: Comparative Analysis of Copying Machine Development in Canon and Ricoh," *Journal of Advanced Management Research* (2009) in print.

[134] K. Tanabe and C. Watanabe, "Soft Policy Instruments for Inducing Industrial Innovation in a Service-oriented Economy: A Comparative Analysis of the Vision System and University System," *Journal of Services Research 5*, No. 1 (2005) 123-154.

[135] K. Tanabe and C. Watanabe, "Sources of Small and Medium Enterprises Excellent Business Performance in a Service-oriented Economy," *Journal of Services Research 5*, No. 1 (2005) 5-20.

[136] S. Tokumasu and C. Watanabe, "Institutional Structure Leading to the Similarity and Disparity in Innovation Inducement in EU 15 Countries," *Journal of Services Research 8*, No. 1 (2008) 5-42.

[137] D. Tsao and J. Wang, "Managing Complexity in Manufacturing: Relationships among Four Common Approaches," *Journal of Japan Industrial Management Association 48*, No.2 (2005).

[138] D. Tsao and E.A. Silver, "A Dynamic Allocation Heuristic for Centralized Safety Stock," *Naval Research Logistic 52*, No. 6 (2005) 513-526.

[139] D. Tsao, J. Wang and S. Linyan, "Managing Complexity in Manufacturing: Relationships among Four Common Approaches," *Journal of Japan Industrial Management Association 56*, No. 2 (2005) 229-236.

[140] D. Tsao and O. Tang, "An Analysis of Nash Equilibrium in a Competing Flight Leg," *International Working Seminar of Production Economics* (2006).

[141] D. Tsao and S. Suzuki, An "Analysis on Inventory Recovery Process in a Reverse Logistic System," Informs International (2006).

[142] H. Umemuro, "Computer Attitudes, Cognitive Abilities, and Technology Usage among Older Japanese Adults," *Gerontechnology 3*, No. 2 (2004) 64-76.

[143] H. Umemuro, "Lowering Japanese Elderly Users' Resistance towards Computers by Using Touchscreen Technology," *Universal Access in the Information Society 3*, No. 3 (2004) 276-288.

[144] J. Wang and D. Tsao, "Linking Manufacturing Systems to Manufacturing Strategy in a Changing Environment," *International Journal of Innovation and Technology Management 1*, No. 4 (2005) 415-434.

[145] J. Wang and D. Tsao, "A Configuration Study on the Relationships between Production Systems and Business Strategy in the Changing Environment," *International Journal of Manufacturing Technology Management 7*, No. 1 (2005) 20-40.

[146] J. Wang and D. Tsao, "Competitive Priority & Best Practice: Roles in Business Strategy," *Proceeding of 6th Asian e-Business Workshop* (2006) 162-167.

[147] J. Wang and D. Tsao, "Relationship between Two Approaches

for Planning Manufacturing Strategy: A Strategic Approach and a Paradigmatic Approach," *International Journal of Production Economics 115*, No. 2 (2008) 349-361.

[148] J. Wang, D. Tsao and M. Shihua, "Linking Manufacturing Systems to Manufacturing Strategy in a Changing Environment," *International Journal of Innovation and Technology Management 1*, No. 4 (2005) 415-434.

[149] Q. Wang and D. Tsao, "Purchase Contract Management for Fashion Products," *Journal of Electronic Science and Technology 2*, No. 3 (2004) 200-204.

[150] Q. Wang and D. Tsao, "Supply Contract with Bi-directional Option: the Buyer's Perspective," *International Journal of Production Economics 101*, No. 1 (2006) 30-52.

[151] Q. Wang, T. Ou and D. Tsao, "A Flexible Contract Strategy in a Supply Chain with an Inflexible Production Mode," *International Journal of Operational Research 1*, No. 3 (2006) 228-248.

[152] C. Watanabe, R. Kondo, N. Ouchi, H. Wei and C. Griffy-Brown, "Institutional Elasticity as a Significant Driver of IT Functionality Development," *Technological Forecasting and Social Change 71*, No. 7 (2004) 723-750.

[153] C. Watanabe, R. Kondo, N. Ouchi and H. Wei, "A Substitution Orbit of Competitive Innovations," *Technological Forecasting and Social Change 71*, No. 4 (2004) 365-390.

[154] C. Watanabe and B. Asgari, "Impacts of Functionality Development on the Dynamism between Learning and Diffusion of Technology," *Technovation 24*, No. 8 (2004) 651-664.

[155] C. Watanabe and M. Hobo, "Co-evolution between Internal Motivation and External Expectation as a Source of Firm Self-propagating Function Creation," *Technovation 24*, No. 2 (2004) 109-120.

[156] C. Watanabe and M. Hobo, "Creating a Firm Self-propagating Function for Advanced Innovation-oriented Projects: Lessons from ERP," *Technovation 24* No. 6 (2004) 467-481.

[157] C. Watanabe and J.Y. Hur, "Firms Strategy in Shifting to Service-oriented Manufacturing: The Case of Japan's Electrical Machinery Industry," *Journal of Sercices Research 4*, No. 1 (2004) 5-22.

[158] C. Watanabe, M. Kishioka and A. Nagamatsu, "Resilience as a Source of Survival Strategy for High-technology Firms Experiencing Megacompetition," *Technovation 24*, No. 2 (2004) 139-152.

[159] C. Watanabe, M. Kishioka and C. Carvajal, "IT Substitution for Energy Leads to a Resilient Structure for a Survival Strategy of Japan's Electric Power Industry," *Energy Policy 33*, No. 8 (2004) 1069-1084.

[160] C. Watanabe and J.Y. Hur, "Resonant R&D Structure for Effective Technology Development amidst Megacompetition: An Emperical Analysis of Smart Cooperative R&D Structure in Japan's Transport Machinery Industry," *Technovation 24*, No. 11 (2004) 955-969.

[161] C. Watanabe and B.K. Ane: Constructing a Virtuous Cycle of Manufacturing Agility, "Concurrent Roles of Modularity in Improving Agility and Reducing Lead Time," *Technovation 24*, No. 7 (2004) 573-583.

[162] C. Watanabe, K. Matsumoto and J.Y. Hur, "Technological Diversification and Assimilation of Spillover Technology: Cannon's Scenario for Sustainable Growth," *Technological Forecasting and Social Change 71*, No. 9 (2004) 941-959.

[163] C. Watanabe, M. Kishioka and A. Nagamatsu, "Effect and Limit of the Government Role in Spurring Technology Spillover: A Case of R&D Consortia Initiated by the Japanese Government," *Technovation 24*, No. 5 (2004) 403-420.

[164] C. Watanabe and C. Carvajal, "Technological Distance between Manufacturing Sectors and Prefectures in Japan: Innovative Clusters and Patents," *Journal of Advances in Management Research 1*, No. 2 (2004) 9-31.

[165] C. Watanabe, J.Y. Hur and K. Matsumoto, "Technological Diversification and Firm's Techno-economic Structure: An Assessment of Cannon's Sustainable Growth Trajectory," *Technological Forecasting and Social Change 72*, No. 1 (2005) 11-27.

[166] C. Watanabe, H. Takahashi, Y. Tou and K.L. Shum, "Inter-fields Technology Spillovers Leveraging Co-evolution between Core Technologies and their Application to New Fields: Service-oriented Manufacturing toward a Ubiquitous Society," *Journal of Services Research 6*, No. 2, 7-24 (2006).

[167] C. Watanabe and W. Zhao, "Co-evolutionary Dynamism of Innovation and Institution," in N. Yoda, R. Pariser and M.C. Chon (eds.), *Chemical Business and Economics* 106-121 (The Chemical Society of Japan, Tokyo, 2006).

[168] C. Watanabe and K. Fukuda, "National Innovation Ecosystem: The Similarity and Disparity of Japan-US Technology Policy Systems toward a Service-oriented Economy," *Journal of Services Research 6*, No. 1 (2006) 159-186.

[169] C. Watanabe, J.Y. Hur and S. Lei, "Converging Trend of Innovation Efforts in High Technology Firms under Paradigm Shift: A Case of Japan's Electrical Machinery," OMEGA 34, No. 2, 178-188 (2006).

[170] C. Watanabe, "Institutional MOT: Co-evolutionary Dynamism of Innovation and Institution," in M. Horlesberger, M. El-Nawawi and T. Khalil (eds.), Challenges in the Management of New Technologies 355-366 (World Scientific Publishing, New Jersey, 2007).

[171] C. Watanabe, J.H. Shin and J. Heikkinen, "Transition Dynamism in Web 2.0: Emerging Dynamism of New Functionality Impacting on a Service-oriented Economy," *Journal of Services Research* (2009) in print.

[172] C. Watanabe, S. Lei and N. Ouchi, "Fusing Indigenous Technology Development and Market Learning for Higher Functionality Development: An Empirical Analysis of the Growth Trajectory of Canon Printers," *Technovation 29*, No. 2 (2009).

[173] C. Watanabe, S. Akaike and J. Shin, "Adaptitive Efficiency of Japan's National Innovation System toward a Service-oriented Economy," *Journal of Services Research* (2009) in print.

[174] C. Watanabe, S. Akaike and J. Shin, "Hybrid Management of Technology toward a Service-oriented Economy: Co-evolutionary Domestication by Fusing East and West," *Journal of Services Research* (2009) in print.

[175] C. Watanabe, S. Yamauchi, J. Shin and Y. Tou, "Fusing East and West for High-profitable Resilient Structure in Mega-competition: A Lesson from Shin-Etsu Chemical's Global Co-evolution Strategy," *Journal of Services Research* (2009) in print.

[176] C. Watanabe, K. Moriyama and J. Shin, "Functionality Development Dynamism in a Diffusion Trajectory: A Case of Japan's Mobile Phones Development," *Technological Forecasting and Social Change 75* (2009) in print.

[177] C. Watanabe and S. Lei, "The Role of Techno-countervailing Power in Inducing the Development and Dissemination of New Functionality: An Analysis of Canon Printers and Japan's Personal Computers," *International Journal of Technology Management 44*, Nos. 1/2 (2008) 205-233.

[178] C. Watanabe, S. Lei and N. Ouchi, "Fusing Indigenous Technology Development and Market Learning for Higher Functionality Development: An Empirical Analysis of the Growth Trajectory of Canon Printers," *Technovation 29*, No. 2 (2009) 265-283.

[179] K. Yaibuathet, T. Enkawa and S. Suzuki, "Supply Chain Operational Performance and Its Influential Factors: Cross National Analysis," *Journal of Japan Industrial Management 57*, No. 6 (2007) 473-481.

[180] K. Yaibuathet, T. Enkawa and T. Yoshika: "Impact of Information Technology and SCM Organizational Strategy on Corporate Financial Performance and Its Cross National Comparison", International Journal of Information Systems for Logistics and Management 3, No. 1 (2007) 13-24.

[181] K. Yaibuathet, T. Enkawa and S. Suzuki, "Effect of Industrial Type and Ownership Status on Supply Chain Operational Performance in a Developing Country," *International Journal of Integrated Supply Management 4*, Nos. 3/4 (2008) 322-354.

[182] K. Yaibuathet, T. Enkawa and S. Suzuki, "Influences of Institutional Environment Toward the Development of Supply Chain Management", *International Journal of Production Economics 115*, No. 2 (2008) 262-271.

[183] A. Yamada and C. Watanabe, "Firms with Adaptability Lead a Way to Innovative Development," in M. Horlesberger, M. El-Nawawi and T. Khalil (eds.), *Challenges in the Management of New Technologies* 367-379 (World Scientific Publishing, New Jersey, 2007).

[184] S. Yamauchi, S. Morisaki, C. Watanabe and Y. Tou, "A Resilience Structure as a Survival Strategy for Japan's Chemical Industry amidst Megacompetition: Suggestion to Management Research," *Journal of Advances in Management Research 4*, No. 1 (2007) 29-48.

[185] M. Yamazaki, "Masa Takeuchi and his Involvement in the Japanese Nuclear Weapons Research Program," in *Scientific Research during World War II* (Routledge, London) (2009).

[186] X. Yao and C. Watanabe, "Co-evolution between Economic Growth, Educational Development and Urbanization in China: Triggering Role of Informatization," *Asian Journal of Technology Innovation 16*, No. 1 (2008) 23-44.

[187] X. Yao, C. Watanabe and Y. Li, "Institutional Structure of Sustainable Development in BRICs: Focusing on ICT Utilization," *Technology in Society 31*, No. 1 (2009) in print.

[188] H. Yasuda and J. Iijima, "Analytical Framework for Strategic Alliances from the Perspective of Exchange of Management Resources," *Int. J. Business Performance Management 2004 1*, No. 6 (2004) 88-105.

[189] G. Yoshikawa and C. Watanabe, "An Empirical Analysis of Firm Revitalization Innovation: Lessons from Japan's Lost Decade toward a Service-oriented Economy," *Journal of Services Research 6*, No. 1 (2006) 9-29.

[190] G. Yoshikawa and C. Watanabe, "Structural Source Enabling Firm Revitalization Innovation by Sectors - An Empirical Analysis of Japanese 31 Industrial Sectors," *Technovation 28*, No. 1 (2008) 37-51.

[191] G. Yoshikawa and C. Watanabe, "An Empirical Analysis of Firm Revitalization Innovation by Sectors and Revitalization Institutions," *Journal of Services Research* (2009) in print.

[192] W. Zhao and C. Watanabe, "A Comparison of Institutional Systems Affecting Software Advancement in China and India: The Role of Outsourcing from Japan and the United States," *Technology in Society 30*, Nos. 3/4 (2008) 429-436.

[193] W. Zhao and C. Watanabe, "Risk Management in Software Outsourcing: A Portfolio Analysis of India's Case based on Software Export Market Constitution," *Journal of Services Research* (2009) in print.

[194] W. Zhao, C. Watanabe and C. Griffy-Brown, "An Exploration of Competitive Advantage in an Industry Cluster with in Local Institutional Systems: The Case of Dalian Software Park in China," *Technology in Society* (2009) in print.

[195] L. Zhong and D. Tsao, "On the Evaluation to the Downstream Information Sharing," *Journal of Japan Industrial Management Association 56*, No. 6 (2006) 413-420.

（Japanese Journal） In Alphabetic Order

[196] G. Abiko and Y. Tanaka: The Statement Analysis of Patent Claim by Quantitative Element and Statistical Consideration using Tree Model; *Technology and Economy*, No. 490, Japan MOT Society, 68-73（2007）

[197] G. Abiko, Y. Tanaka and H. Nakagawa: Proposal for a Numerical Method of Claims Which Corresponds to the Breadth of their Technical Scope; *Journal of Intellectual Property Association of Japan 5*, No. 1, Japan Intellectual Property Association, 67-80 (2008).

[198] G. Abiko, Y. Tanaka and H. Nakagawa: Proposal on Fluctuating Risk Predicting Scheme of Technical Scope of Patent with Quantitative Index; *The Journal of Science Policy and Research Management 23*, No. 2, 150-162 (2008).

[199] H. Aoki and K. Itoh: Analysis Methods for TV Commercial Viewing Process Based on Viewing Intention; Journal Ergonomics, Vol. 40, No. 1, 21-38 (2004).

[200] H. Aoki, K. Itoh and J.P. Hansen: Analysis of Learning Process of Attentive Interface for Entry of Japanese Characters; *Journal of Ergonomics 41*, No. 6, 345-358 (2005).

[201] H. Aoki, K. Itoh and J.P. Hansen: Learning Easiness Evaluation for Attentive Interface for Entry of Japanese Characters; *Journal of Ergonomics 41*, No. 2, pp.65-76 (2005).

[202] H. Aoki, K. Itoh and M. Kinoshita: Analysis of Influences Exerted by Style Elements on Visual Attention in Case of Viewing Printed Advertisement; *Journal of Ergonomics 44*, No. 1, 22-36 (2008).

[203] K. Arashida, T. Enkawa, A. Hamazaki and S. Suzuki: Development of SCM Logistics Score Card and Analysis on the Relationship with Company Performance; *Journal of Japan Industrial Management Association 55*, No.2, 95-103 (2004).

[204] T. Hachiya and O. Yamamoto: M&A Protection Schemes and Corporate Governance; *Management Accounting 16*, No.2, 69-84 (2008).

[205] A. Hamazaki, K. Arashida and T. Enkawa: A Study on Relationship between Logistics and Business Performance and Roles of Divisions utilizing SCM Logistics Score Card; *Journal of Japan Logistics Society 12*, 89-94 (2004).

[206] S. Hayashi and K. Higa: Verification of Stage-Wise Development Model of e-Commerce by Questionnaire Survey and Analysis; *Journal of Japan Telework Society 7*, No. 1 (2009). (To be published in March, 2009).

[207] T. Higuchi and Y. Tanaka: A Study of the Perception Gaps between Vietnam and Japan in Technology Transfers and International Academic/Industrial Partnerships; *Technology and Economics*, No. 496, Japan MOT Society, 46-51 (2008).

[208] K. Hirano and H. Umemuro: XML-based Information Support for Business System Transformation Model; *Journal of Japan Industrial Management Association 55*, No. 1, 34-50 (2004).

[209] T. Hirano and M. Miyakaya: Robust Parameter Design in Case Error Factors Are Observed as Co-Variables; *Quality 37*, No. 4, 383-391 (2007).

[210] J. Iijima: What is EA Framewrok?; *Journal of Office Automation Society (C) 25*, No. 2 , 20-25 (2004).

[211] J. Iijima: Formal Methods in Information System Development; *Journal of The Japan Society for Management Information 28*, 16-24 (2007).

[212] M. Ikeshoji and T. Enkawa: A Study on Relationship between Customer Satisfaction and Sense of Economic Conditions; *Quality 34*, No.4, 90-99 (2004).

[213] H. Inaba, S. Mizuno and K. Nakata: Minimization of Robust Tracking Error by Quadratic Cone Programming; *CRAFT Preprints Series* 2004-9 (2004).

[214] H. Inaba, S. Mizuno and K. Nakada: Minimization of Robust Tracking Error by Quadratic Cone Programming; *Transactions of the Operations Research Society of Japan 48*, 12-25 (2005).

[215] N. Irikura, S. Ishikawa and T. Enkawa: Search for Core Problems in New Product Development by Practical Manualization of CRT; *Quality 34*, No.1, 97-106 (2004).

[216] N. Irikura and T. Enkawa: Score Card of New Product Development and Proposal on Its Utilization Methods; *Journal of The Japanese Society for Quality Control 35*, No. 4, 73-84 (2005).

[217] A. Kato and D. Tsao: Structural Model Analysis of SCM Logistics Performance; *Proceedings of Spring Conference of Japan Industrial Management Association in 2007*, 10-11 (2007).

[218] T. Kimoto: Modern Science/Technology and Safety; *Economics 8*, No. 131 (2006).

[219] T. Kimoto: History of Science Council of Japan - From Standpoint of Science History Research; *Science History Research*, Spring Edition (2007).

[220] T. Kimoto and Silvina de Maio: Origin of Science Academy; *Academic Trends 3*, 78-84 (2007).

[221] T. Kimoto: Werk Academy Freiberg and Japanese Students - German Science Academy (3); *Academic Trends* (2008).

[222] T. Kimoto: Foundation of Royal Society of London (2); *Academic Trends* (2007).

[223] T. Kimoto: Oldest Medicine Natural Science Academy Existing in Germany "Leopoldina" - German Science Academy (1); *Academic Trends* (2008).

[224] T. Kimoto: Berlin Science Academy - German Science Academy (2); *Academic Trends* (2008).

[225] I. Kinoshita and K. Higa: A Study on Telework as A Solution for Management Problems of Japanese Firms; Journal of Japan Telework Society, Vol. 6, No. 1, 1-15（2008).

[226] I. Kinoshita and K. Higa: A Study on Telework as BPR Strategy of Companies: A Case of a Japanese Company; *Journal of Japan Telework Society 6*, No. 1, 33-45（2008).

[227] T. Kitahara, S. Mizuno and K. Nakada: On Extension of Minimax Probability Machine; *Co-Research Report, Institute of Statistical Mathematics 203*, 346-357 (2007).

[228] T. Kitahara, S. Mizuno and K. Nakada: Quadratic and Convex Minimax Classification Problems; *Co-Research Report of the Institute of Statistical Mathematics 221*, 50-62 (2008).

[229] N. Kitamura and M. Miyakawa: Assignment of Six-Level Factors to L36 Orthogonal Array; *Journal of the Japan Society for Quality Control 36*, No. 4, 461－467 (2006)

[230] Y. Kojima and D. Tsao: Steel Scheduling Optimization Model and Its Solving Method; *Proceedings of Scheduling Symposium 2008*, 95－100 (2008).

[231] M. Kuroki, M. Hirata and M. Miyakawa: Clustering Algorithm through the Common Linearity Trend among Clusters and Its Application; *Computer Statistics 16*, No. 2, 157-166 (2003).

[232] T. Kuroda, M. Miyakawa and K. Tanaka: Formulation of Intervention to Arrows in Causal Diagram and Its Applications; *Journal of Japanese Society of Applied Statistics 35*, No. 2, 79－91 (2006).

[233] T. Masuishi, Y. Oki and K. Mori: Computation Method of Appropriate Owned Resource When Resource Common Community Is Used for Mitigating Resource Peak; *Journal of Institute of Electronics, Information and Communication Engineers J88-D1*, No. 8, 1226-1234 (2005).

[234] Y. Matsuzaki, H. Umemuro and Y. Okimoto: Readablity of Mail-order Insurance Brochures for the Elderly; *Direct Marketing Review 4*, 21-37 (2005).

[235] M. Miyakawa and E. Tanaka: Likelihood Ratio Test for Equality of Odds Ratios between Dependent Contingency Tables and Increased Precision with Dependent Samples; *Journal of Japan Society for Quality Control 35*, No.2, 272－278 (2005).

[236] M. Miyakawa: Causal Inference Using Structural Equation Model with Causal Diagram; *Computer Statistics 17*, No.1, 45-57（2004).

[237] M. Miyakawa, K. Tanaka, T. Iwasawa and H. Nakanishi: The Error Rate in Mahalanobis-Taguchi System; *Journal of Japan Society for Quality Control 37*, No. 1, 101－106 (2007).

[238] M. Miyakawa and T. Kuroda: Intervention Effects on Variable and Arrow in Causal Diagram; *Journal of Japan Statistical Society 37*, No. 1, 71-83 (2007).

[239] M. Miyakawa and K. Tanaka: Testing Homogeneity of SN Ratios from Matched Quantitative Response with Binary Signal; *Quality 37,* No. 2, 49-57 (2007).

[240] M. Miyakawa: The Importance of Returning to the Original Position in Practical Use of SQC; *Standardization and Quality Management 60*, No. 11, 14-17 (2007).

[241] T. Mouri and H. Umemuro: Estimation of Patent Preservation Term Structure and Comparison between Industrial Sectors based on Patent Renewal Data; *Journal of Japan Industrial Management Association 55*, No. 3, 129-137 (2004).

[242] K. Mori: Assurance Technology and Its Development, *Journal of Reliability Engineering Association of Japan 26*, No. 5, 325-335 (2004).

[243] K. Mori: New Application of Autonomous Distributed System in Industries; *Journal of Society of Instrument and Control Engineers 4*, No. 5, 34-34 (2005).

[244] K. Nagata and T. Hachiya: Earnings Management of IPO Firms; *Accounting Progress 5*, 91-106 (2004).

[245] M. Ogikubo, Z. Huang and T. Enkawa: Effects of Cultural Factors of Individuals on Customer Satisfaction and Repurchase Intent; *Quality 38*, No. 2, 63-72 (2008).

[246] K. Omori and D. Senoo: How is the Effect of IT Investment Created? An Analysis of IT Assets and Organizational Characteristics of SMEs; *Journal of Japan Society for Management and Information 16*, No. 3, 63-81 (2007).

[247] T. Otsuka and D. Tsao: LCA Computation Case of Electric Home Appliance; *Proceedings of Autumn Conference of Japan Industrial Management Association in 2008*, 82-83 (2008).

[248] B. Frank and T. Enkawa: Effects of Economic Fluctuation Bias on Customer Satisfaction and Adjusting Method for Reflecting Corporate Efforts; *Quality 39*, No. 1 (2009) 119-128.

[249] D. Sahori and K. Higa: A Study on An Organizational Strategic Model for Network Society - the Symbiotic Organization Model with Telework and Coevolution; *Journal of Japan Telework Society 3*, No. 1, 35-34 (2004).

[250] D. Sahori and K. Higa: A Study on the Factors for Performance of Teleworker; *Journal of Japan Society for Management Information 12*, No.4, 69-87 (2004). (Prize winning paper).

[251] Y. Saito and D. Tsao: A Study on Customer Behavior Analysis Using QG/EP Model; *Proceedings of Autumn Conference of Japan Industrial Management Association in 2007*, 164-165, 2007.

[252] M. Sakakibara and K. Higa: Cellular Phone Access to Media Space without Privacy Violation; *Journal of Information Processing Society of Japan 49*, No. 1, 19-34 (2008).

[253] D. Senoo: Creation of Ba where Knowledge Works - Interaction between Physical and Virtual Environments; *Information Science and Technology 54*, No. 10, 521-529 (2004).

[254] S. L. Chung: Marketing Channel Strategy of Taiwanese Food Manufacturers in China - Cases of Ting Hsin and Uni-President; *Distribution Research 10*, No. 3, 19-36 (2008).

[255] A. Shiibashi and K. Mori: Autonomous Distributed High-Speed Processing in Integrated Wired/Wireless IC Card System and Its Application; *Journal of Society of Instrument and Control Engineers 4*, No. 7, 41-49 (2005).

[256] A. Shiihashi, M. Yamana, K. Ohashi and K. Mori: A Study on Reliability Evaluation Technology for Heterogeneity Integrating Autonomous Distributed IC Card Ticketing System; *Journal of Information Processing Society of Japan 48*, No.2, 791-801 (2007).

[257] D. Tsao and A. Rusdiansyah: A Study on Multi-Period Inventory Distribution Planning with Stable Demand; *Journal of Japan Industrial Management Association 56*, No.1, pp.12-18 (2005).

[258] D. Tsao and Two authors: A Study on Supply Contract Problems Using Option Method; *Journal of Japan Industrial Management Association 58*, No.5, 376-382, 2007.

[259] S. Sdo, T. Enkawa and T. Mochizuki: An Analysis on the Structure of CS and ES in Healthcare Organizations; *Journal of Japan Society for Healthcare Administration 46*, No. 1 (2009) 7-16.

[260] S. Suzuki, D. Tsao and T. Enkawa: Comparison of Japanese and Chinese Organization by SCM Logistics Score Card; *Journal of Japan Logistics Society 13*, (2005) 67-74.

[261] S. Suzuki, A. Ono and T. Enkawa: A Study on Perception Gap in an Organization Which Impedes Enhancement of SCM Efficiency; *Journal of Japan Society of Logistics Systems 7*, No.

2 (2007) 11-19.

[262] S. Suzuki, O. Mishima and T. Enkawa: A Study on Quantification of the Bull Whip Effect in a Supply Chain Using Periodical Ordering Method; *Journal of Japan Industrial Management Association 56*, No.3, 147-154 (2005).

[263] H. Umemuro, Y. Matsuzaki and Y. Ishikawa: Usability of Investment Trusts e-Commerce Web Sites for Older Users; *Direct Marketing Review 5*, 7-23 (2006).

[264] O. Yamamoto and T. Hachiya: Economic Analysis of Financial Crisis Management and Evaluation of Bankruptcy Laws in Japan, *Journal of Japan Finance Association 23*, No. 2, 18-38 (2005).

[265] O. Yamamoto, T. Hachiya and K. Kobayashi: Performance of Companies under Financial Crisis and Roles of Main Banks; *Management Finance Research 24*, No. 1, 2-24 (2005).

[266] M. Yamazaki and K. Okuda: The Rise of Pro-Nuclear Reactor Introduction after the Bikini Incident; *Science History Research 43*, No. 230, 83-93 (2004).

[267] M. Yamazaki: Endogenous Development Principle of Technology and Principle in History; *Science History Research 45*, No. 238, 103-104 (2006).

[268] M. Yamazaki: Development of "Atoms for Peace" Policy in Japan; *Science History Research 47*, No. 249 (2009). (To be published)

[269] H. Yanagimachi and D. Tsao: A Study on Optimal Decomposition Strategy for Re-Production Process over Multi-Period; *Scheduling Symposium 2007*, 245-247(2007).

[270] H. Yashiro, Y. Takahashi and K. Mori: Assurance Ability of Distributed Computing for Space Crafts; *Journal of Reliability Engineering Association of Japan 26*, No. 5, 366-378 (2004).

[271] K. Yoshida and J. Iijima: Proposal of Component Development Method for Application Software and Its Application; *Journal of Japan Society for Management Information 14*, No. 1, 63-84 (2005).

[272] Z. Zhao and K. Higa: Telework Readiness of Chinese Organization: A Survey Study; *Journal of Japan Telework Society 5 (1)*, 1-12 (2007).

2. Books & Book Chapters

(International)

[1] M.V. Grenhuizen and C. Watanabe, Technological Innovation Across Nations: Co-evolutionary Developments, Springer, New York (2008).

[2] K. Itoh, H.B. Andersen and M.D. Madsen: Safety Culture in Healthcare, in P. Carayon, (ed.), Handbook of Human Factors and Ergonomics in Healthcare and Patient Safety, 199-216, Lawrence Erlbaum Associates, Mahwah, NJ (2006).

[3] A. Kryazhimskii and C. Watanabe: Optimization of Technological Growth; Gendaitosho (2004).

[4] M.D. Madsen, H.B. Andersen and K. Itoh: Assessing Safety Culture in Healthcare, in P. Carayon, (ed.), Handbook of Human Factors and Ergonomics in Healthcare and Patient Safety, 693-713, Lawrence Erlbaum Associates, Mahwah, NJ (2006).

[5] R. Magnier-Watanabe and D. Senoo: Knowledge Management under Institutional Pressures: The Case of the Smartcard in France Innovative Knowledge Management: Concepts for Organizational Creativity and Collaborative Design. A Book edited by L. Uden and A. Eardley, (eds.), Staffordshire University, U.K., (2009) in print.

[6] I. Nonaka, V. Peltokorpi and D. Senoo: Knowledge creation in a Japanese convenience store chain: the case of Seven-Eleven Japan, in J. R. Bvyson, P.W. Daniels, (eds.); The Handbook of Service Industries, 355-376 (2007).

[7] C. Watanabe, Managing Innovation in Japan: The Role Institutions Play in Helping or Hindering How Companies Develop Technology, Springer, New York (2008).

[8] Masakatsu Yamazaki, "Masa Takeuchi and His Involvement in the Japanese Nuclear Weapons Research Program," in *Scientific Research during World War II,* Kegan Paul, London (2009).

(Japanese) In Alphabetic Order

[9] T. Enkawa: Production System Development Process; Production System Engineering in Design Chapter β7, *Mechanical Engineering Handbook*, Edited by Japan Society for Mechanical Engineers, Maruzen, 32-36 (2005).

[10] T. Enkawa: Recommendation of Institutional MOT Drawing Strenghts of Our Country; 58 Issues of Japanese "Monozukuri" (Crafting), *JIPM Solution*, 56-61 (2005).

[11] T. Enkawa, N. Irikura and K. Washitani (Editor and Author): Tale of New Product Development; *Japanese Standards Association* (2007).

[12] T. Enkawa: 4.2 Design and Development Project Planning and Management, Design Engineering in Design Chapter β1, *Mechanical Engineering Handbook*, Edited by Japan Society for Mechanical Engineers, 156-168 (2007).

[13] T. Enkawa and N. Irikura: 4.1 Cost Control; Design Engineering in Design Chapter β1, *Mechanical Engineering Handbook*, Edited by Japan Society for Mechanical Engineers, 151-156 (2007).

[14] T. Enkawa: MFCA and TPM - Practical Material Flow Accounting, *Japan Environmental Management Association for Industry*, 67-79 (2008).

[15] T. Hachiya: Relationship between Organizational Capital/Human Capital and Productivity/Company Value; Chapter 13, Issues and Prospects of Intangible Assets Accounting and Reporting (Interim Report), *Special Committee of Japan Society for Accounting Research,* 190-204 (2004).

[16] T. Hachiya: Firm-Specific Organizational Capital and Complimentality; Chapter 13, Issues and Prospects of Intangible Assets Accounting and Reporting (Final Report), *Special Committee of Japan Society for Accounting Research*, 293-309 (2005).

[17] T. Hachiya: Firm-Specific Organizational Capital and Complimentality; Chapter 13, *Intangible Assets Accounting* Edited and Authored by K. Itoh, Chuo Keizaisha, 403-425 (2006).

[18] M. Yamazaki, T. Kurihara and D. Kohase (Translator): Otto Hahn - What are Obligations and Responsibilities of Scientists by K. Hofman, Springer Japan (2006).

[19] H. Ichikawa and M. Yamazaki (Editor): Various Facets of "War and Science"; Maruzen (2006).

[20] J. Iijima: Introduction to Information System Science; Nikka Giren Shuppansha (2005).

[21] J. Iijima: CIO Science (Co-author); University of Tokyo Press (2007).

[22] J. Iijima et al.: Issues in System Integration Leading to Success Edited by *System Integration Special Research Committee of Japan Society for Management Information*, Nikka Giren Shuppansha (2005).

[23] M. Miyakawa: Statistical Causal Analysis - New Framework for Regression Analysis; Asakura Shoten (2004).

[24] M. Miyakawa: Advanced Experimental Planning Method; Nikka Giren Shuppansha

[25] M. Miyakawa: Basics of SQC - Science of Identification and Resolution of Problems; *Japan Standards Association* (2007).

[26] K. Mori: Introduction to Autonomous Distributed System - From System Concept to Applied Technologies, Morikita Shuppan K.K. (2006).

[27] K. Nagata: International Trends of Intangible Assets Accounting - America; *Intangible Assets Accounting*, Chuo Keizaisha, 41-77 (2006).

[28] K. Nagata: International Trends of Intangible Assets Accounting -

International Accounting Standards; *Intangible Assets Accounting*, Chuo Keizaisha, 112-119 (2006).

[29] K. Nagata: International Trends of Intangible Assets Accounting - Japan; *Intangible Assets Accounting*, Chuo Keizaisha, 120-137 (2006).

[30] K. Nagata: Individual Regulatory Issues Regarding Intangible Assets Accounting - Intangible Assets and "Uncertaintly"; *Intangible Assets Accounting*, Chuo Keizaisha, 237-249 (2006).

[31] N. Otsuka and K. Nagata: Trends of Intangible Assets Accounting and Reporting in America; Issues and Prospects of Intangible Assets Accounting and Reporting Edited by *Special Committee of Japan Society for Accounting Research,* 17-44 (2004).

[32] N. Otsuka, S. Okuda and K. Nagata: Intangible Assets in Japanese Accounting Standard; Issues and Prospects of Intangible Assets Accounting and Reporting Edited by *Special Committee of Japan Society for Accounting Research*, 45-57 (2004).

[33] T. Saiki, N. Kyomoto and Y. Tanaka: Basics and Utilization of Intellectual Properties (2nd Edition), Asakura Shoten (2005).

[34] T. Saiki and K. Yoshizumi: Theory and Practice of Chemical Patents, Asakura Shoten, 1-50 (2006).

[35] T. Saiki: Response to the Reasons for Rejection in Patent Application, Revised (3rd Edition), Research Institute of Economy, Trade and Industry (2006)

[36] H. Sakurai, H. Yurikusa and T. Hachiya: Cash Flow Accounting and Corporate Valuation, Chuo Keizasha (2004).

[37] D. Senoo: Creative Routine - Seven-Eleven Japan, 3rd Chapter, MOT Knowledge Creation Management and Innovation, Edited by I. Nonaka and R. Tohyama, Maruzen, 76-104 (2006).

[38] I. Ushioda and D. Senoo: Office Reform Like Magic; Kawade Shobo Shinsha (2007).

[39] D. Tsao, K. Nakajima, K. Takeda and M. Tanaka: Introduction to Supply Chain Management, Asakura Shoten (2008).

[40] Y. Tanaka and S. Kuzuwa: Essence of Patent; Japan Institute of Invention and Innovation (2005).

[41] Y. Tanaka et al.: Building of an IP Division Geared to Corporate Managemen - Towards Cooperation with Other Functional Divisions; Japan Institute of Invention and Innovation (2007).

[42] Y. Tanaka et al.: Integrated IP Management - Guide Book for Utilizing and Protecting Intellectual Properties of an Organization; Japan Institute of Invention and Innovation (2007).

[43] H. Umemuro: Affective Quality: Products and Services Evoking Affective Experiences, Tokyo, Japanese Standards Association (2009).

[44] C. Watanabe, "Techno-Economic Systems" (Sosei-sha Publishers, Tokyo, 2007).

[45] Y. Yoshizumi, K. Nagata and N. Otsuka: International Trends of Intangible Assets Accounting and Reporting; Issues and Prospects of Intangible Assets Accounting and Reporting Edited by *Special Committee of Japan Society for Accounting Research*, 58-80 (2004).

3. Technical Papers & Reports

(International)

[1] H. Aoki, P.J. Hansen, K. Itoh and D. MacKay: Report on Asian-Language Versions of Communication Systems. Communication by Gaze Interaction (COGAIN); IST-2003-511598, Deliverable 4.3 (2007).

[2] H. Bouma, S.J. Czaja, H. Umemuro, W.A. Rogers, R. Schulz, S.H. Kurniawan: Technology: A Means for Enhancing the Independence and Connectivity of Older People. Proceedings of Conference on Human Factors in Computing Systems (CHI 2004), Vienna, Austria (2004).

[3] K. Itoh, H.B. Andersen, M.D. Madsen and T. Abe: Comparative Results of Cross-National Surveys on Hospital Safety Culture: The Views and Attitudes of Healthcare Staff towards Safety-Related Issues and Reporting of Adverse Events and Errors, Technical Report, Department of Industrial Engineering and Management, Tokyo Institute of Technology, No. 2005-1, Tokyo Institute of Technology, Tokyo, Japan, 2005.

[4] K. Itoh, H.B. Andersen and M.D. Madsen: Cross-Cultural Surveys on Healthcare Staff Views of Barriers against Adverse Event Reporting; Technical Report, Department of Industrial Engineering and Management, Tokyo Institute of Technology, No. 2006-1, Tokyo Institute of Technology, Tokyo, Japan (2006).

[5] M. Fukushima, S. Yoneyama, T. Watanabe and D. Senoo: Decision Making Process of Licencees – How to Evaluate the Invisible Value; Musashi University Working Paper, No. 9 (F-6), 1-13 (2004).

[6] F.H. Khan, Y. Tanaka: IP Administration and Enforcement System Towards Modernization of IP Protection in Bangladesh and a Comparison of IP Situation Between Japan and Bangladesh; IP Management Review, Vol. 2-2, 1-11 (2004).

[7] T. Kimoto: Some Problems of Technology Transfer in Meiji Japan; S41. Technology Transfer and European Expansion in East Asia (Beijing, July 23-30, 2005).

[8] K. Miyazaki: Strategic Management of Technology; Remote Lecture for Thai Universities Held by Osaka School of International Public Policy, Osaka University (August, 2004).

[9] D. Senoo, M. Fukushima, S. Yoneyama and T. Watanabe: Technology Transfer as Team Building − An Empirical Analysis of University TLOs in Japan; *Innovation Oriented Company Creation Project, Discussion Paper Series*, #06-09, 1-20 (2006).

[10] B. Suratno, Y. Tanaka: Industrial Design Protection in Indonesia: A Comparative Study of the Law on Industrial Design Protection between Japan and Indonesia; IP Management Review, Vol. 2-2, 12-27 (2004).

[11] T. Watanabe, S. Yoneyama, D. Senoo and M. Fukushima: Visualizing the Invisible – A Marketing Approach of the Technology Licensing Process; Musashi University Working Paper, No. 9 (F-5), 1-13 (2004).

[12] S. Yoneyama, M. Fukushima, D. Senoo and T. Watanabe: Marketing of Technological Knowledge: Empirical Analysis of Licensing Activities from University TLOs to Industrial Sectors in Japan; *Innovation Oriented Company Creation Project, Discussion Paper Series*,s, #06-07, 1-21 (2006).

(Japanese) In Alphabetic Order

[13] T. Enkawa: 2003 International Enhanced Logistics System Development Project Report; GEDIS (2nd Term), *Japan Institute of Logistics Systems/METI* (2003).

[14] T. Enkawa: Possibility of Suica Electronic Money; *JR EAST 11*, No. 2, 4-7 (2004).

[15] T. Enkawa: Breaking Down "Constraints" by Society and Organization is Required for Innovation of "Monozukuri" (Manufacturing); *Weekly Economist*, Feb. 17, 50-53 (2004).

[16] T. Enkawa: TPM and Its Recent Trends; Quality Management, Vol. 55, No. 6, 64-71 (2004).

[17] T. Enkawa: Globalized and Multi-Faceted SCM in the Period of Real Application and Organizational Constraints; *Material Handling Journal*, No. 238, 4-8 (2004).

[18] T. Enkawa: Towards Development of Human Resources for Japan-Style MOT; *Quality Management 55*, No. 7, 27-40 (2004).

[19] T. Enkawa: Principles of SCM and Its New Wave; *Quality Management 55*, No. 10, 69-77 (2004).

[20] T. Enkawa: Chairman's Report, *Committee for International Logistics and Trades, Japan Customs, Ministry of Finance* (2004).

[21] T. Enkawa: Corporate Management and Facility Management in Need; *Plant Engineer 37*, No. 1, 13-16 (2005).

[22] T. Enkawa: MOT and Formation of New Japanese Institution; *PHASE*, No. 135, 14-15 (2005).

[23] T. Enkawa: Current Status and Issues of Electronic Export/Import Procedure; *Engineering*, No. 107, 8-11 (2005).

[24] T. Enkawa and S. Suzuki: SCM Logistics Score Card (LSC); *Logistics Information 7*, No. 6, 55-59 (2005).

[25] T. Enkawa: Theory of Constraints (TOC) and Japanese Culture; *Defense Facilities and Technology*, No.58, 4-17 (2005).

[26] T. Enkawa: Visit Research Laboratory; *Kuramae Journal 986*, 46-47 (2005).

[27] T. Enkawa: On Promoting Safe and Efficient International Logistics; *Logistics Information 8*, No. 2, 4-9 (2006).

[28] T. Enkawa: Towards Enhancement of Quality Control Power Matching with the Era; *Journal of Japan Society for Quality Control 36*, No. 2, 3 (2006).

[29] T. Enkawa: Production Management to Establish Sustainable Competitive Advantage Making the Most of Japan's Strengths; *Journal of Japan Society for Quality Control 36*, No. 3, 6-13 (2006).

[30] T. Enkawa: Senior Managers Do Not Know Actual Strength of a Company; *Monthly Logistics Business 6*, No. 2, 1 (2006).

[31] T. Enkawa: Production Management to Establish Sustainable Competitive Advantage Making the Most of Japan's Strengths; *Journal of Japan Society for Quality Control 36*, No. 3, 147-155 (2006).

[32] T. Enkawa: Domestic Monozukuri Again and New Japanese Model; *Hitachi Hyoron 88*, No. 11, 41 (2006).

[33] T. Enkawa: IC Ticket to Change Life Style; *EAST 13*, No. 11, 4-7 (2006).

[34] T. Enkawa: "Securing Quality" and Our Country's Monozukuri Culture; *Standardization and Quality Control 60*, No. 1, 25-28 (2007).

[35] T. Enkawa: Impact of Standardization of IC Card; *Transport and Economics 67*, No. 1, 2-3 (2007).

[36] T. Enkawa: On Assuming Chairmanship; *Quality 37*, No. 1, 3 (2007).

[37] T. Enkawa: Material Flow Cost Accounting and TPM (Total Productive Maintenance); *Environmental Management 43*, No. 2, 59-66 (2007).

[38] T. Enkawa: How to Dissolute Organizational Hurdle Impeding New Product Development - "Score Card" and "CRT"; *Standardization and Quality Management 60*, No.3, 40-47 (2007).

[39] T. Enkawa: Materialization of Customs Clearance System and Regulations Supporting Global SCM; NTT Data DIGITAL GOVERNMENT, January, 2008 http://e-public.nttdata.co.jp/f/repo/521_j0801/j0801.aspx (2008).

[40] T. Enkawa: Modal Shift through "Right People for Right Place - Key for Its Promotion is Establishment of Infrastructure and Societal Consensus Building; ECO JAPAN (Nikkei BP) (2008). http://www.nikkeibp.co.jp/style/eco/interview/080916_enkawa/

[41] T. Enkawa: IE is Characterized by Top-down Thinking; September 15, 2008, Seisansei Shimbun (2008).

[42] T. Enkawa: Quality and Risk; Quality, Vol.6, No.4, 3(2008).

[43] T. Enkawa: Towards "Securing Quality", "Developing Quality" and "Creating Quality" to Cope with Environmental Changes; Quality, Vol.38、No.1, 3(2008).

[44] T. Enkawa: Demanding Customers and Efforts for Kaizen, and Monozukuri and Quality in the Future; Quality Management, Vol.59, No.1, 34-37(2008).

[45] T. Enkawa and R. Ichikawa: Logisticians Develop into Managers; Management and Logistics, Vol.1, Spring, 10-17(2008).

[46] I. Endo, A. Kinumura, N. Fujii, K. Miyamoto and K. Enkawa: Discussing the Origin of Japanese Monozukuri; *Quality Management 58*, No. 1, 10-21 (2007).

[47] K. Higa: Contribution and Utilization of ICT in Telework; *ICT World Review, Special Fall Edition*, 52-56 (2007).

[48] J. Iijima: System Thinking in Business; 2nd Session of "System Thinking in Business", *Serial Seminar by Information Processing Society of Japan* (2006).

[49] J. Iijima: Capture the Essense - Expression of Static Structure; 2nd Session of "System Thinking in Business", *Serial Seminar by Information Processing Society of Japan* (2006).

[50] J. Iijima: In Order to Succeed in System Integuration; Forum for Supporting Member of Japan Society for Management Information (2006).

[51] K. Itoh and Y. Tomizawa: Clinical Engineering Session – Design Concept of Artificial Organ-related Equipment Placing Importance on Safety and Operationability, Proceedings of the 43th Conference of Japanese Society for Artificial Organs, *Artificial Organ 35*, No. 1, 85-87 (2006).

[52] K. Itoh: Building Safegy Culture in Healthcare; *Therapeutics and Engineering 19*, No. 1, 50-54 (2007).

[53] K. Itoh: Ergonomic Approach to Healthcare Safety Management – Towards Introduction of Patients' Perspectives and Safegy Culture Formation (1), *Journal of Medical Safegy 3*, No. 1, 3-11 (2007).

[54] K. Itoh: Ergonomic Approach to Healthcare Safety Management – Towards Introduction of Patients' Perspectives and Safegy Culture Formation (1), *Journal of Medical Safegy 3*, No. 2, 104-111.

[55] S. Kuo and T. Saiki: Trends of Research and Development of Chinese Pharmaceutical Industry from the Viewpoint of Patent Application and Registration; *Intellectual Property Management Research 4*, 30-38 (2007).

[56] T. Kimoto: Minamata Disease and Development of Japanese Chemical Industry; Tsinghua University (2005).

[57] T. Kimoto: Minamata Disease and Development of Japanese Chemical Industry; Beijing University (2005).

[58] T. Kimoto: Structure of Japanese Technological Development in the Meiji Era - Case of Shipbuilding Technologies; University of Science and Technology Beijing (2005).

[59] T. Kimoto: Structure of Japanese Science and Technology Development in Inter-War Period; Tsinghua University (2005).

[60] K. Kimoto: 2005 52nd Conference of History of Science Society of Japan, Hokkaido, (June 3 – 5, 2005).

[61] T. Kimoto: Science and Technology and War/Cold War in the 20th Century - Prospects for International Collaborative Research; Hiroshima University (2005).

[62] T. Kimoto: Technology Import in the Meiji Era and Rebuilding of Japanese Modern History; "Issues in Frontiers of Humanities, Social Science and Socio Science/Technology and College Education", Symposium of Socio Science/Technology Course in Dual Graduate School Program of Tokyo Institute of Technology and Tsinghua University, Tokyo (2007).

[63] K. Nagata: Earnings Management at IPO and Pricing; *Secruity Analyst Journal 45*, No. 9 (2007) 57-67.

[64] K. Nagata: Objectives of IPO and Incentives for Earnings Management, *Accounting 166*, No. 6 (2004) 86-99.

[65] K. Nagata: Eargnings Management Behavior of IPO Firms; *JICPA Journal 17*, No. 5 (2005) 44-45.

[66] M. Ogikubo, Z. Huang and T. Enkawa: Impact of Culture Factor of Individuals on Customer Satisfaction and Repurchase Intent; *Quality 38*, No.2 , 63-72(2008).

[67] N. Otsuka and K. Nagata: Individual Regulatory Issues Regarding Intangible Assets Accounting; Issues and Prospects of Intangible Assets Accounting and Reporting, *Special Committee of Japan Accounting Research Association*, 169-196 (2005).

[68] N. Otsuka, S. Okuda, Y. Shimuzu, K. Nagata and Y. Yoshizumi: International Trends of Intangible Assets Accounting and Reporting; Issues and Prospects of Intangible Assets Accounting and Reporting, *Special Committee of Japan Accounting Research Association*, 28-105 (2005).

[69] T. Saiki: Singapore Intellectual Property Report; *IP Management Research 2*, 68-70 (2004).

[70] T. Saiki: Invention by Employees toward the Future and Its Incentive; *Funtai To Kogyo 37*, No. 7, 51-60 (2005).

[71] T. Saiki: Acquisition and Management of Intellectual Properties to Benefit Corporate Strategy; *Funtai To Kogyo 37*, No. 7, 61-70 (2005).

[72] T. Saiki: Proposal of Patent Protection Model in Development of Pharmaceuticals; *IP Management Research 3*, 26-40 (2005).

[73] T. Saiki: Role of Internship in Developing Human Resources Versed in Intellectual Properties; *IP Management Research 4*, 98-101 (2007).

[74] T. Saiki: Current Status of IP Management Education at Tokyo Tech; *Journal of Intellectual Property Association of Japan 4*, No. 3 (2008).

[75] D. Senoo: Knowledge Creation Theory and Work Style Reformation; *Organizational Information 72*, 3-13 (2005).

[76] D. Senoo (Member and Chair of Working Group): Research Report on New Office Style to Activate Knowledge Creation; *New Office Promotion Association* (2007).

[77] D. Senoo: Report on Impact of Drastic Review of Organization/Work System on IT Productivity; *Proceedings of the 23rd FMES Symposium*, 5-10 (2007).

[78] D. Senoo: What is Expected of Creative Office? (Discussion); O.E. *Quarterly Office Environment, 2007 Winter 17*, 6-13 (2007).

[79] D. Senoo: Creativity Generated by Relationship between Human and Human, and Human and Goods; *Ud & Eco style 17*, 6-7 (2007).

[80] D. Senoo: Creative Office Report 1.0; *NEWOFFICE, 2008 Winter*, No. 182, 11-17 (2008).

[81] D. Senoo (Member and Leader of Research Task Force): Research Report by Creative Office Promotion Committee (Investigation of the State of Manufacturing Base Technology in 2007); *New Office Promotion Association* (2008).

[82] D. Senoo, R. Matsui and S. Kawashima: Study on Visualization of Knowledge Structure Using Text Mining, Knowledge Society Research Report, Series No. 6, Report on "International Collaborative Research on Innovation Policy and Policy Analysis Method" Entrusted by Economic and Social Research Institute, Cabinet Office (2008).

[83] D. Senoo: "Creative Office Report 2.0"; *NEWOFFICE, 2009 Winter*, No. 186 (2009) 2-7.

[84] T. Takahashi and T. Saiki: Analysis of Carbon Nano Tube-related Patents; *IP Management Research 3*, 57-69 (2005).

[85] N. Tanaka, T. Enkawa, S. Sekine, T. Kikuchi, A. Matsui, H. Takeuchi, Y. Aoyama and M. Hara: Discussion on "New Trends of International Logistics and Response by Customs Administration"; *Finance 42*, No. 5, 2-19 (2006).

[86] Y. Tanaka: Utilization of Intellectual Properties for Strengthening and Growing Business; *IP Management, Japan Intellectual Property Association 54-5*, 555-566 (2004).

[87] Y. Tanaka: Kew Word for Sensing the Times: "Intellectual Property"; *Heat Service, Japan Heat Service Utilities Association 54*, 10-11 (2004).

[88] Y. Tanaka: Industrial Property Rights Seminar "Our Lives and IPR"; Japan Patent Office, Kanto Bureau of Economy, Trade and Industry, Tokyo University of Science, Suwa (2004).

[89] Y. Tanaka: The 3rd Engineering Intellectual Property Seminar "Intellectual Property State of China"; Engineering Intellectual Property Lectures (2004).

[90] Y. Tanaka: Hanoi IPR Seminar in Vietnam; Vietnam National Office of Intellectual Property, Hanoi City, Japan Patent Office (2004).

[91] Y. Tanaka: Ho Chi Minh IPR Seminar in Vietnam; Vietnam National Office of Intellectual Property, Ho Chi Minh City, Japan Patent Office (2004).

[92] Y. Tanaka: Seminar on Industrial Properties for Researchers, "Turning Research Results into Legal Rights and Their Utilizatin"; Japan Patent Office, Kanto Bureau of Economy, Trade and Industry and Muroran Institute of Technology (2004).

[93] Y. Tanaka: Seminar on Industrial Properties for Researchers, "Turning Research Results into Legal Rights and Their Utilizatin"; Japan Patent Office, Kanto Bureau of Economy, Trade and Industry and Shizuoka Institute of Science and Technology (2004).

[94] Y. Tanaka: Seminar on Industrial Properties for Researchers, "Turning Research Results into Legal Rights and Their Utilizatin"; Japan Patent Office, Kanto Bureau of Economy, Trade and Industry and Tokyo Denki University (2004).

[95] Y. Tanaka: Industrial Property Rights Learning Lecture, "Our Lives and Intellectual Properties"; Japan Patent Office, Kanto Bureau of Economy, Trade and Industry, Yoshiwara Technical High School (2004).

[96] Y. Tanaka: Valdes Open Forum, "Basic of Intellectual Properties and Business"; Department of Value System, Tokyo Tech (2004).

[97] Y. Tanaka: 2004 WIPO Japan Fund Training, "Execution Course"; WIPO, JPO and Japan Institute of Invention and Innovation (2004).

[98] Y. Tanaka: 2004 1st JPO/IPR Training, "Corporate Manager Course"; JPO and Japan Institute of Invention and Innovation (2004).

[99] Y. Tanaka: Industrial Property Rights Seminar for SMEs and Venture Companies, "Corporate Intellectual Properties Management and Its Utilization"; JPO, Kanto Bureau of Economy, Trade and Industry, Ibaraki Corporation for Small and Medium Enterprise Promotion (2004).

[100] Y. Tanaka: Industrial Property Rights Seminar for SMEs and Venture Companies, "SMEs and Venture Companies and Patent Strategy"; JPO, Kanto Bureau of Economy, Trade and Industry, Chiba Industry Advancement Center (2004).

[101] Y. Tanaka: Industrial Property Rights Seminar for SMEs and Venture Companies, "SMEs and Venture Compnaies and Patent Strategy"; JPO, Kanto Bureau of Economy, Trade and Industry, Tochigi Prefecture (2004).

[102] Y. Tanaka: Industrial Property Rights Seminor, "Turning Research Results into Patent Acquisition"; JPO, Kanto Bureau of Economy, Trade and Industry, Shizuoka Prefecture (2004).

[103] Y. Tanaka: Intellectual Properties Seminar, "Patent Strategy for SME Management" and "Patent Information for Product Development"; Ota City Industrial Promotion Organization (2004).

[104] Y. Tanaka: "Utilization of Intellectual Property Rights for Environment"; JPO, Kyushu Bureau of Economy, Trade and Industry, Fukuoka Research Center for Recycle Systems (2005).

[105] Y. Tanaka: Industrial Property Rights Seminar for SMEs and Venture Companies, "Corporate Intellectual Property Management and Its Utilization"; JPO, Kanto Bureau of Economy, Trade and Industry (2005).

[106] Y. Tanaka: 2004 JPO/IPR Training, "Intellectual Property Educator Course"; JPO, Japan Institute of Invention and Innovation (2005).

[107] Y. Tanaka, Japan Built on Intellectual Properties; *LANDFALL 56* 、8-12(2006).

[108] Y. Tanaka: "MOT and Industry-Academy Liaison" No.1, Diffusion and Full-Fledged Practice of MOT"; *Journal of Industry-Academy-Government Collaboration*, 23-25（2006).

[109] Y. Tanaka: Not Just Response to WTO, but towards Actual Diffusion Activities of Objectives of IPR System; Sekai Shuho, *JIJI Press 87*, No. 7, 36-37 (2006).

[110] Y. Tanaka: Current State of Intellectual Properties in Japan and China-Japan Viewpoint; Searchina China White Paper, *China Intellectual Property White Paper, Searchina*, 97-113 (2006).

[111] Y. Tanaka: Investigation and Research on Differences in Patent System between Japan and Other Asian Countries in View of International Industry-Academy-Government Collaboration; Office of Industry Liaison, Tokyo Tech, 1-70(2007).

[112] Y. Tanaka: Research on Collaboration between Corporate IP Division and Other Divisions, Proceedings of the 3rd SIMOT International Symposium, 13-21(2007).

[113] Y. Tanaka: Intellectual Property Activities Contributing to Company Management; 2007 Hokkaido Conference on Success Cases of Industry-Academy-Government Collaboration; (2007) WIPO

[114] Y. Tanaka: Current Status and Issues of Technology Transfer Activities in Asian Regions; International Patent Diffusion Seminar (2007)

[115] Y. Tanaka: Investigation and Research on Differences in Patent System between Japan and Other Asian Countries in View of International Industry-Academy-Government Collaboration (2007)

[116] Y. Tanaka: Building of IP Division Geared to Company Management; THE INVENTION, *Japan Institute of Invention and Innovation 104*, No. 11, 22-23 (2007)

[117] Y. Tanaka: Integrated Intellectual Properties Management - Guide Book for Utilizing and Protecting Intellectual Properties of an Organization; THE INVENTION, *Japan Institute of Invention and Innovation 104*, No. 12, 28-29(2007)

[118] Y. Tanaka: Significance, Roles and Issues of Intellectual Property Activities; Seisanssei Shimbun, Japan Productivity Center for Socio-Economic Development (2007).

[119] Y. Tanaka: Turning Japanese More Globalized; Seisansei Shimbun, Japan Productivity Center for Socio-Economic Development (2008).

[120] Y. Tanaka: Report on Indian Intellectual Properties, *THE INVENTION*, Japan Institute of Invention and Innovation, Vol. 105, No. 10, 40 (2008).

[121] Y. Tanaka: Report on Thai Intellectual Properties, *THE INVENTION*, Japan Institute of Invention and Innovation, Vol. 105, No. 8, 70 (2008).

[122] Y. Tanaka: Report on Korean Intellectual Properties, *THE INVENTION*, Japan Institute of Invention and Innovation, Vol. 105, No. 11, 31 (2008).

[123] Y. Tanaka: Report on Indonesian Intellectual Properties, *THE INVENTION*, Japan Institute of Invention and Innovation, Vol. 105, No. 12, 35 (2008).

[124] Y. Tanaka: "Company Management and Intellectual Property Activities", 2008 Intellectual Property Management Consultant Training; *Japan Institute of Invention and Innovation* (2008)

[125] Y. Tanaka: Intellectual Property Seminar in Indonesia "Policy and Current Status on University-Industry Collaboration in Japan"; JICA (2009)

[126] Y. Tanaka: Toward Promotion of International Industry Academy Collaboration; *Proceedings of Symposium on International Industry Academy Collaboration*, 7-10 (2008)

[127] H. Umemuro: Older People and Usability, and beyond. P*roceedings of the AIST Gerontechnology Forum 2005*, 1-6. Tokyo, Japan. (2005)

4. Presentation

(International)

[1] M.K. Ahsan, Z. Lin and D.Tsao, Optimal Fixed Price Incentive for Project Price Negotiation, Informs International (Hong Kong), 2006, 6

[2] K. Ahsan. and D. Tsao, An optimal project price negotiation model for fixed price incentive contract, Proceedings of the 5th ANZAM Operations Management Symposium and 1st Asia Pacific Operations Management Symposium 2007 Operations Management, 2007, 6

[3] C. An and C. Watanabe: The Similarities and Disparities within Australia and Japan's Structure of Institutional Systems and their Effects on the ICT Development and Utilization; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 107-110 (2006).

[4] T. Anantana, T. Enkawa and S. Suzuki: New Product Development Operational Performance and Its Influential Factors of Manufacturing Firms in Japan; the 12th Annual International Conference on Industrial Engineering Theory Applications & Practice (IJIE), November 4-7, Cancun, Mexico. Proceeding, 307-313 (2007).

[5] T. Anantana, T. Enkawa, and S. Suzuki: "New Product Development Efficiency and Firm's Financial Performance: Perspective of Technology Trajectories in Japanese Manufacturing", *The 5th International Conference on Innovation and Management (ICIM),* December 10-11, 2008, Maastricht, the Netherlands, Proceeding, 766-774 (2008).

[6] H. Aoki and K. Itoh: Eye Tracking Analysis for Unconscious Processes of Information Gathering from Television Commercials; Proceedings of the 33rd EMAC Conference, Murcia, Spain, May 2004 (CD ROM).

[7] H. Aoki, K. Itoh and J.P. Hansen: Learning to Type Japanese Text by Gaze Interaction in Six Hours; Proceedings of the 11th International Conference on Human-Computer Interaction, Las Vegas, NV, July 2005 (CD ROM).

[8] H. Aoki, J.P. Hansen and K. Itoh: Leaning Process of Computer Input by Eye Movement with Gaze Interface; Proceedings of the Work with Computing Systems 2007, Stockholm, Sweden, May 2007.

[9] H. Aoki, K. Itoh and J.P. Hansen: Usability Evaluation of a Gaze Interface Based on Scan-Path Analysis; Proceedings of the 16th Triennial Congress of the International Ergonomics Association, IEA 2006, Maastricht, The Netherland, July 2006 (CD-ROM).

[10] H. Aoki, J.P. Hansen and K. Itoh: Towards Remote Evaluation of Gaze Typing Systems; Proceedings of the 2nd Conference on Communication by Gaze Interaction - COGAIN 2006: Gazing into the Future, pp.94-101, Turin, Italy, September 2006.

[11] H. Aoki, J.P. Hansen and K. Itoh: Leaning Process of Computer Input by Eye Movement with Gaze Interface; (*Proceedings of the Work with Computing Systems 2007*, Stockholm, Sweden, May 2007).

[12] H. Aoki and K. Itoh: Eye Tracking Analysis of Effects of Key Styling Factors on Visual Attention during Reading of Printed Advertising, Proceedings of the 2nd International Conference on Applied Human Factors and Ergonomics, Las Vegas, NV, July 2008 (CD-ROM).

[13] H. Bouma, S.J. Czaja, H. Umemuro, W.A. Rogers, R. Schulz and S.H. Kurniawan: Technology: A Means for Enhancing the

Independence and Connectivity of Older People; Extended Abstracts of Conference on Human Factors in Computing Systems (CHI 2004), Vienna, Austria, 1580-1581 (2004).

[14] C. Carvajal and C. Watanabe: Regional Industrial Clusters, Output Productivity Growth Convergence and Technological Distance: The Case of Japan's Manufacturing Sector; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 521-524 (2004).

[15] J. Chen and K. Higa: The Online Reservation Business in Japan; Proceedings of 2005 Conference of Japan Telework Society, 29-33 (2005).

[16] K. Chen and H. Umemuro; Social, Cultural, and Personal Factors Influencing the Usage of Electronic Bulletin Board System by Chinese Elderly People; Proceedings of the 5th Conference on Gerontechnology (Gerontechnology 2005), Nagoya, Japan (CD-ROM; 2005).

[17] K. Chen and H. Umemuro: Older Adults and Computer-Mediated Communication Technology in Shanghai. Proceedings of the International Society for Gerontechnology Japan Chapter annual meeting 2008, 35-38 (2006).

[18] G. Christian, A. Riera and J. Iijima: A Study of the Effect of Organizational IQ on IT Investment and Productivity; 2007 International Conference on Wireless Communications, Networking and Mobile Computing (2007).

[19] S. Ding and J. Iijima: Logical Approach for Dynamic System in Situation Dependent Services; 3rd IEE Mobility Conference 2006 (2006).

[20] X. Ding and J. Iijima: A Framework for Modeling Situation Dependent Service Process; 2007 International Conference on Wireless Communications, Networking and Mobile Computing, (2007).

[21] X. Ding and J. Iijima: Toward a Logical Architecture for Situation Dependent Information Services with Surrounding Awareness; Sixth International Conference on Grid and Cooperative Computing (GCC 2007), (2007).

[22] H. Endo, Y. Sugiyama, K. Hama, Y. Nakahara and K. Mori, "Autonomous Community Area Construction Technology to Achieve High Assurance", The 6th International Workshop on Assurance in Distributed Systems and Networks (2007).

[23] T. Enkawa: Logistics Challenges in Japan (Key note speech), E-business Logistics Technology Seminar 2005, Helsinki, Finland (2005).

[24] T. Enkawa: Logistics Scorecard in Japan, Logistics networks are successfully benchmarked (Key note speech), EGLO 2005, Helsinki, Finland (2005).

[25] T. Enkawa: Strengthening Competitiveness with SCM Logistic Score Card (keynote speech); ASEAN wide Logistics Forum, Bangkok (2006).

[26] T. Enkawa: Customer Satisfaction: Impact of Country Cultural Differences and Economic Fluctuation; keynote speech at the 5th ANQ Congress, October 17-18, Incheon (2007) CD-ROM.

[27] G. Fatih and C. Watanabe: Effects of institutional systems on diffusion of innovation - comparative analysis between Japan and Turkey focusing on geographical dimension; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 409-412 (2004).

[28] B. Frank and T. Enkawa: How Economic Growth Affects Customer Satisfaction: A Study from Germany; Proceedings of the 13th APMC Conference, November 18-20, Melbourne (2007).

[29] B. Frank and T. Enkawa: The Impacts of Economic Long-term Expansion and Consumer Confidence on Perceived Value and Customer Satisfaction; in Laosirihongthong, T., Tsang, A., and Xie, M. (eds.): Proceedings of the 5th ICQR Conference, November 5-7, Chiang Mai, 20-25 (2007).

[30] B. Frank and T. Enkawa: How Switching Costs Affect Consumer Attitudes: A Cross-Industrial Study from Germany; Proceedings of the 5th ANQ Congress, October 17-18, Incheon (2007) CD-ROM.

[31] B. Frank and T. Enkawa : What Should We Do to Keep Our Customers?, *Proceedings of the 38th Conference of Japanese Society for Quality Control*, 45-48 (2008)

[32] B. Frank and T. Enkawa: "Economic Influences on Customer Satisfaction: Variation by Product Function," *Proceedings of the 2008 IEEE International Conference on Industrial Engineering and Engineering Management*, December 8-11, 2008, Singapore .

[33] B. Frank and T. Enkawa: "Improving Interpretations of Customer Satisfaction Survey Results," *Proceedings of the 6th ANQ Congress*, October 28-31, 2008, Bangkok accepted, not yet presented).

[34] A. Gao and C. Watanane: Innovative capability in ICT firms in China and Japan focusing on the effects of the institutional systems; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 481-484 (2004).

[35] A. Gao and C. Watanane: Interaction between ICT Development and Institutional Systems in China - Comparative Analysis on the Development Trajectory; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 483-486 (2005).

[36] R. Gu and K. Higa: A Proposal of the Media Fitness Theory: in proc of the 2nd International Systems Conference, San Diego, U.S., July 2006 (CD-ROM).

[37] L. Guan, D. He, K. Nagata, and G. Rhee: Earnings Management and the Performance of Seasoned Equity Offerings: Evidence from Japanese Issuers; The Asian Financial Association-Nippon Financial Association 2008 International Conference, Yokohama, Japan, July 2008.

[38] J.P. Eguez Guevara, H. Umemuro: Unobtrusive Estimation of Psychological States based on Human Movement Observation; Proceedings of e-Society 2009, Barcelona, Spain (2009).

[39] J.P. Eguez Guevara, H. Umemuro: Unobtrusive Estimation of Psychological States for Humane Home Environments; Proceedings of the International Society for Gerontechnology Japan Chapter Annual Meeting 2008, Tokyo, Japan (2008).

[40] N. Haghi, S. Yoshimura, and K. Higa: An Analysis of SNS Users Trust Behavior; The 3rd International Conference on Collaborative Computing, November 2007 (NY) (CD-ROM).

[41] K. Hama, Y. Horikoshi, Y. Sugiyama, and K. Mori: Autonomous Construction Technology of Community for Achieving High Assurance Service; Embedded Computer Systems: Architectures, Modeling, and Simulation, 349-358 (2006).

[42] J.P. Hansen, K. Toerning, A.S Johansen, K. Itoh and H. Aoki: Gaze Typing Compared with Input by Head and Hand, Proceedings of the Eye Tracking Research & Applications Symposium 2004; 131-138 (San Antonio, TX, March 2004).

[43] J.P. Hansen, H. Lund, H. Aoki and K. Itoh: New usability metrics for the evaluation of eye typing systems. Abstracts of the 14th European Conference on Eye Movements, ECEM2007, JEMR, Vol. 1 (Potsdam, Germany, August 2007).

[44] J.P. Hansen, K. Itoh, H. Aoki and H. Lund: GazeTalk: A communication interface that suits the eye, Abstract Proceedings of the Scandinavian Workshop on Applied Eye-Tracking, pp. 9 (Lund, Sweden, February 2007).

[45] K. Higa and K. Nakamura Jr.: Strategies towards Internet Banking: Products, Services, and User's Behaviour; Proceedings of 2005 Conference of Japan Telework Society, 34-37 (2005)

[46] K. Higa, S. Yoshimura, N.P. Haghi: An Analysis of SNS User's Behavior; Proceedings of 2007 Conference of Japan Telework Society, 12-17 (2007).

[47] S. Hayashi, K. Higa: A Study on Trust and Value Establishing Stages in e-Commerce Growth Process; IADIS International Conference on e-Commerce 2007, December 2007 (Portugal), CD only, no pages allocated.

[48] J. Iijima and H. Sho: Common Structure and Properties of Filtering Systems; PACIS 2005 (Pacific Asia Conference on Information Systems) (2005). OA (2005, Fall) Invited Lecture

[49] J. Iijima: How does Information Systems Investment have Business Value in Japan?; INFORMS Hongkong 2006 (2006).

[50] J. Iijima: How does CIO Contribute to IT ROI ?; Internatioal Academy of CIO（2006）.

[51] J. Iijima: IT Investment and Business Performance in Japan; 6th Workshop for Asian e-Commerce（2006）.

[52] J. Iijina, "Guanxi' beyond walls improves IT utilization," Pre-ICIS JPAIS/JASMIN Session、2008.

[53] J. Iijima, " Symbiotic Relation in IT Utilization – Social Network Analysis on IT Investment and Firm Performance," Proceedings of the 8th Asian eBusiness Workshop NO.14 Aug. 2008

[54] J. Iijima, Y. Kitayama, "How Do They Use Cellular Phones in Business in Japan? – Highly Developed BPM with Cellular Phone in ASAI Group," Proceedings of the 8th Asian eBusiness Workshop NO.16 Aug. 2008

[55] M. Ikesyoji, S.J. Schvanevelt and T. Enkawa: An Empirical Study of Economic Condition Effects on Customer Satisfaction: Japan-US Comparison; International Conference on Quality 2005-Tokyo, Proceedings CD ROM (2005).

[56] N. Indrianti, S. Matsuoka and M. Muraki: A Market-Based Approach to Budgetary Resource Allocation for Promoting Secondary Material; 2004 International Eco-Efficiency Conference, 3-2 Public Sector Applications-5, Leiden, the Netherlands (2004).

[57] N. Indrianti and M. Muraki: An Alternative Tax Administrative System to Support Industrial Ecology; 11th Annual International Sustainable Development Research Conference, Sustainability Networks-8, Helsinki, Finland (2005).

[58] N. Indrianti, and M. Muraki: A Strategic Production Contact to Support Sustainable Manufacturing; International Conference on Operations and Supply Chain Management, Bali, Indonesia (2005).

[59] Y. Inoue, K. Miyazaki: Diffusion Process of Wind Energy in Japan, The 3rd ASIALICS International Conference, Shanghai (2006).

[60] Y. Inoue, K. Miyazaki: Technological Diffusion of Renewable Energy in the case of Photovoltaic (PV) in Japan; The 4th ASIALICS, Kuala Lumpur (2007).

[61] N. Irikura and T. Enkawa: Proposal on New Product Development Scorecard and its Application; Proceedings of the 5th ANQ Congress, October 17-18, Incheon, CD-ROM (2007).

[62] N. Islam, K. Miyaaki, K. Klincewicz: Nanotechnology Innovation System – Empirical Analysis of Scientific Output in Asian Countries, The 3rd ASIALICS International Conference, Shanghai (2006).

[63] N. Islam, K. Miyazaki, Nanotechnology Fusion in Scientific Fields – an Empirical Analysis; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 736-739 (2006).

[64] N. Islam and K. Miyazaki: Nanotechnology Systems of Innovation – Investigation of Scientific Disciplines' Fusion into Nanotech; PICMET, August, Portland, USA (2007).

[65] N. Islam and K. Miyazaki: Nanotechnology Innovation in Asia – An Analysis of Nanotech Fusion Trend in Japan; The 4th ASIALICS, Kuala Lumpur, July 22-24, (2007).

[66] N. Islam and K. Miyazaki: Developing a Model for Nanotechnology Knowledge Co-creation; Japan Society for Science Policy and Research Management, 185-188 (2007).

[67] K. Itoh and H.B. Andersen: Reasons for Not Reporting Adverse Events: The Views of Danish and Japanese Healthcare Staff; Paper presented in the 9th European Forum on Quality Improvement in Health Care (Copenhagen, Denmark, May 2004).

[68] K. Itoh and H.B. Andersen: Analysing Medical Incident Reports by Use of a Human Error Taxonomy Adapted from Air Traffic Management; Proceedings of the 7th International Conference on Probabilistic Safety Assessment and Management - PSAM7-ESREL'04, Vol. 5, 2714-2719 (Berlin, Germany, June 2004).

[69] K. Itoh, T. Abe and H.B. Andersen: A Questionnaire-Based Survey on Healthcare Safety Culture from Six Thousand Japanese Hospital Staff: Organisational, Professional and Specialty/Ward Differences; Proceedings of the International Conference on Healthcare Systems Ergonomics and Patient Safety, Florence, Italy, March-April (2005) to appear.

[70] K. Itoh, T. Abe and H.B. Andersen: A Questionnaire-based Survey on Healthcare Safety Culture from Six Thousand Japanese Hospital Staff: Organisational, Professional and Department/Ward Differences; Proceedings of the International Conference on Healthcare Systems Ergonomics and Patient Safety, HEPS 2005, Florence, Italy, March-April 2005, In R. Tartglia, S. Bagnara, T. Bellandi and S. Albolino (Eds.), Healthcare Systems Ergonomics and Patient Safety: Human Factor, a Bridge between Care and Cure, pp.201-207, Taylor & Francis, London (2005).

[71] K. Itoh, H. Aoki and J.P. Hansen: A Comparative Usability Study of Two Japanese Gaze Typing Systems; Proceedings of Eye Tracking Research & Applications Symposium 2006, San Diego, CA, March (2006).

[72] K. Itoh, H. Aoki and J.P. Hansen: A Comparative Usability Study of Two Japanese Gaze Typing Systems; Proceedings of Eye Tracking Research & Applications Symposium 2006, 59-66, San Diego, CA, March (2006).

[73] K. Itoh: A Customer-centred Approach in Healthcare Risk Management: Patients' Views of Adverse Events in Japan, Plenary speech in the 16th Triennial Congress of the International Ergonomics Association, IEA 2006, Maastricht, The Netherland, July 2006.

[74] K. Itoh and H.B. Andersen: Causes of Medical Errors as Perceived by Patients and Healthcare Staff, *Proceedings of the European Safety and Reliability Conference 2007 -- ESREL 2007*, Stavanger, Norway, June 2007, In T. Aven and J.E. Vinnem (eds.), *Risk, Reliability and Societal Safety*, Vol. 1: Specialisation Topics, pp.179-185 (Taylor & Francis, London, 2007).

[75] K. Itoh, N. Omata and H.B. Andersen: A Human Error Taxonomy for Analysing Healthcare Reporting Culture and Its Effects on Safety Performance, *Proceedings of the European Safety and Reliability Conference 2007 -- ESREL 2007*, Stavanger, Norway, June 2007, In T. Aven and J.E. Vinnem (eds.), *Risk, Reliability and Societal Safety*, Vol. 1: Specialisation Topics, pp.187-194 (Taylor & Francis, London, 2007).

[76] K. Itoh and H.B. Andersen: Has Safety Climate Improved with Patient Safety Efforts in Japanese Healthcare? In the *Patient Safety Research Conference Porto 2007 -- Shaping the European Agenda* (Porto, Portugal, September 2007) .

[77] K. Itoh and H.B. Andersen: A National Survey on Healthcare Safety Culture in Japan: Analysis of 20,000 Staff Responses from 84 Hospitals, Proceedings of the International Conference on Healthcare Systems Ergonomics and Patient Safety, HEPS 2008, Strasbourg, France, June 2008 (CD-ROM).

[78] Y. Jiang, X. Lu, I. Luque, M. Kanda and K. Mori: Access-Based Autonomous Infotmation Allocation for High-Assurance in Dynamic Environment; Proceeding of the 12th Conference of Assurance System Wrokshop, Institute of Electronics, Information and Communication Engineers, 1-6 (2004).

[79] Y. Jiang, X. Lu, M. Kanda and K. Mori: Autonomous Node Reallocation for Achieving Load Balance under Changing Users' Preference, Proceeding of the 15th Conference of Assurance System Wrokshop, Institute of Electronics, Information and Communication Engineers, 23-29 (2005).

[80] K. Kera, M. Shoji, T. Igarashi, A. Ando and K. Mori: Assurance technology for large transport operation control system, IEEE Proc. of International Symposium on Autonomous Decentralized Systems 250-258 (2005).

[81] T. Kimoto: Some Problems of Technology Transfer in Meiji Japan; S41. Technology Transfer and European Expansion in East Asia (Beijing, July 23-30, 2005).

[82] T. Kitahara, S. Mizuno and K. Nakata: Quadratic and Convex Minimax Classification Problems, Workshop on Optimization and Signal Processing, The Chinese University of Hong Kong, Hong Kong, December (2007).

[83] K. Klincewicz and K. Miyazaki: Dilemma in Innovation – the Case of Product Innovations versus Marketing Innovations in the Software Industry; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 107-110 (2004).

[84] K. Klincewicz and K. Miyazaki: Software Systems of Innovation in Asia, Empirical Analysis of Industry and Academia Research Activities; STEPI Annual Symposium, Seoul, Korea (2005).

[85] B.P. Kloester, S. Murakami, K. Mahmood, S. Niki and K. Mori, "Autonomous Decentralized Architecture for Assurance in Sensor Network", Proceeding of the 21st Conference of Assurance System Wrokshop, Institute of Electronics, Information and Communication Engineers, 7-13 (2007).

[86] M. Kotani and J. Iijima: Real Option Values and Timing Decisions: A Portfolio Management Framework for Aligning IT Assets with Business Directions and Strategies; IEEE Equity Conference, Amsterdam (2006).

[87] M. Kotani and J. Iijima: Alignment of IT Investment with Business Strategy: An Empirical Study on Japanese Firm Level Data; IEEE Equity Conference, Amsterdam (2007).

[88] M. Kotani and J. Iijima: Real Option Values and Timing Decisions: A Portfolio Management Framework for Aligning IT Assets with Business Directions and Strategies; IEEE Equity Conference, (2007.3.).

[89] M. Kotani and J. Iijima: Alignment of IT Investment with Business Strategy: An Empirical Study on Japanese Firm Level Data; IEEE Equity Conference, (2007.3.).

[90] K. Kumano and K. Higa: An Experimental Study on The Telework-based Diet Management System; in proc of the 2nd International Systems Conference, San Diego, U.S., July 2006 (CD-ROM)

[91] T. Kumon, J. Iijima, S. Ho, "Recommendation Based on Referrer Information and Association Rule," Proceedings of the 8th Asian eBusiness Workshop, No.18 Aug. 2008.

[92] C.P. Leguizamo and K. Mori: Autonomous Agent-Based System Reconstruction Technology in Distributed Database Systems for Timeliness; Proceedings of the 17th International Conference, Software & Systems Engineering and their Applications (ICSSEA'04), Vol. 2. Session 7 (2004).

[93] C.P. Leguizamo and K. Mori: Autonomous Decentralized Database System Restructuring for Achieving Timeleness; Proceedings of the 3rd ACS/IEEE International Conference on Computer Systems Applications (AICCSA'05) (2005), (CD-ROM).

[94] C.P. Leguizamo, M. Takaishi, S. Kimura and K. Mori: Assurance Reconfiguration Technology in Decentralized Database Systems by an Autonomous Restructure Mobile Agent, IEEE Proc. of International Symposium on Autonomous Decentralized Systems 125-132 (2005).

[95] S. Lei and C. Watanabe: Co-evolutionary Dynamism and the Role of Techno-Countervailing Power between Canon Printers and Japan's Personal Computers; IAMOT 2006 (Beijing), (2006).

[96] S. Lei and C. Watanabe: The Role of Market Learning as a Coordinator of Techno-Countervailing Power: An Empirical Analysis of Canon Printers and Japan's Personal Computers; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 589-592 (2006).

[97] Y. Li, P. Fan, C. Watanabe, L. Rong: Elucidation of the Co-evolutionary Dynamism of Japan's System of management of Technology－Comparative Empirical Analysis of the Institutional Systems between Japan, the US and China; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 254-257 (2004).

[98] D. Li, T. Ou and T. De-bi: Demand uncertainty and return policies with asymmetric information, 17th International Conference on Production Research (2005).

[99] B. Li and J. Iijima: Architecture on a Hybrid Business Process Design and Verification System; 2007 International Conference on Wireless Communications, Networking and Mobile Computing, (2007.9.).

[100] B. Li and J. Iijima: Dynamic Management of e-Business Services: A Situation Calculus Based Approach; 2007 International Conference on Service Systems and Service Management, (2007.6.).

[101] B. Li and J. Iijima: Bridging the Gap between XPDL and Situation Calculus: A Hybrid Approach for Business Process Verification; the 9th International Conference on Enterprise Information Systems (2007).

[102] X. Lu, I. Luque, M. Kanda and K. Mori: Agent-Based Autonomous Information Services Integration and Allocation to Achieve High Response and Low Cost in Distributed Information Service System; Proc. of the 9th IEEE Symposium on Computers Communications (ISCC'04), Vol. 1, 19-24 (2004).

[103] X. Lu, I. Luque, M. Kanda, Y. Jiang, K. Moriyama and K. Mori: Autonomous Network-Based Information Services Integration for High Response in Multi-Agent Information Service Systems, IEEE Proc. of International Symposium on Autonomous Decentralized Systems, 51-58 (2005).

[104] X. Lu, Y. Jiang, M. Kanda and K. Mori: Autonomous Information Service Architecture for High Response in Distributed Information Systems, IEEE Proc. of APSITT2005, 393-398 (2005).

[105] X. Lu and K. Mori: Autonomous Timeliness and Reliability Oriented Information Services Integration and Allocation in Multi-Agent Systems, IEEE Proc. of ICESS2005, 292-299 (2005).

[106] X. Lu and K. Mori: Autonomous Information Services Integration for High-Assurance in Demand-Oriented Information Systems; 11th IEEE Symposium on Computers and Communications (ISCC 2006), 904-909 (2006).

[107] X. Lu, K. Mori, and Y. Tan: Autonomous Correlated Services Access for High Response in Integrated Faded Information Field Systems; the 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 163-170 (2007).

[108] X.D. Lu and K. Mori, "Autonomous Coordination Technology to Achieve Continuous Service in Autonomous Decentralized VoD Systems", IEEE Proc. of the 2nd International Conference on Complex, Intelligent and Software Intensive Systems (CISIS), 417-422 (2008).

[109] X.D. Lu and K. Mori, "Autonomous Coordination Technology for Correlated Services Access to Achieve High-Assurance in Seamless Information Integration System", Proc. of IASTED International Conference on Parallel and Distributed Computing and Networks (PDCN), 1-6 (2008).

[110] X. Lu, K. Mori, and Y. Tan: Autonomous Correlated Services

Access for High Response in Integrated Faded Information Field Systems; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 163-170 (2007).

[111] I. Luque, X. Lu, M. Kanda, K. Moriyama, K. Mori, Y. Kuba and R. Takanuki: Decentralized Resource Management for Assurance According to Heterogeneous Service Levels; ICSSEA 2004 17th International Conference, Software & Systems Engineering and their Applications (ICSSEA'04), Vol. 2. Session 7 (2004).

[112] R. Magnier-Watanabe and D. Senoo: The Effect of Consistent KM Behaviors on Competitive Advantage; The 11th Pacific-ASIA Conference on Information Systems (2007) CD-ROM.

[113] K. Mahmood, S. Niki, Y. Nakahara, X. Lu, I. Luque, and K. Mori: Autonomous Real-Time Navigation for Service Level Agreement in Distributed Information Service System; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 231-238 (2007).

[114] K.M. Malik, M. Shoichi, S. Niki and K. Mori, "Autonomous Load Balanced Topology Construction for Wireless Sensor Network", Proceeding of the 22nd Conference of Assurance System Wrokshop, Institute of Electronics, Information and Communication Engineers, 6-11 (2007).

[115] T. Masuishi, H. Kuriyama, Y. Ooki, K. Mori: Autonomous Decentralized Resource Allocation for Tracking Dynamic Load Change, IEEE Proc. of International Symposium on Autonomous Decentralized Systems, 277-283 (2005).

[116] T. Masuishi, K. Shibata, Y. Ooki, and K. Mori: Measurement Error Analysis for Autonomous Decentralized Load Tracking System; The 32nd Annual Conference of the IEEE Industrial Electronics Society (2006).

[117] T. Masuishi, K. Shibata, Y. Ooki, and K. Mori: Autonomous Decentralized Load Tracking Techniques and Evaluation; The 2nd IEEE International Symposium on Dependable, Autonomic and Secure Computing (DASC 2006), 69-76 (2006).

[118] T. Masuishi, K. Shibata, Y. Ooki, and K. Mori: Techniques to Improve Tracking Ability in Autonomous Decentralized Load Tracking System; The 4th International Conference on Computing, Communications and Control Technologies (2006).

[119] T. Masuishi, K. Shibata, Y. Ooki, and K. Mori: Autonomous Decentralized Load Tracking Systems and Evaluation Criteria for Response and Stability; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 255-262 (2007).

[120] T. Masuishi, K. Shibata, Y. Oki, and K. Mori: Autonomous Decentralized Load Tracking Systems and Evaluation Criteria for Response and Stability; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 255-262 (2007).

[121] K. Mishima, J. Iijima, S. Ho, "Is Firm Valuation Affected by its Position in B-to-B Relation Network?," Proceedings of the 8th Asian eBusiness Workshop NO.19 Aug. 2008

[122] M. Miyakawa: Performance Measure for Two Conflicting Defects; Joint Statistical Meetings 2004 Abstract, 278. Toronto, Ontario, Canada, August 2004.

[123] K. Miyazaki and K. Jonsson: Key Success Factors Affecting 3G Mobile Diffusion in Japan; PICMET (Portland International Conference on Management of Engineering and Technology) Symposium, Seoul, Korea, 1-19 (July 2004) (CD Proceedings).

[124] K. Miyazaki and N. Kumaresan: Agenda for Technology Management Caused by Shifting Innovation Trajectories in Research Innovation Systems; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 602-605 (2004).

[125] K. Miyazaki and N. Kumaresan, Agenda for Technology Policy caused by Shifting Innovation Trajectories in National Innovation Systems; STEPI International Symposium on Science and Technology Policy – Public and Private Partnership, Seoul, D1-5, 1-19 (December 2004).

[126] K. Miyazaki: An Empirical Analysis of Industry-Academia Linkages based on the Knowledge Incentive Model, SPRU 40th Anniversary Conference, University of Sussex (2006).

[127] K. Miyazaki, D. Kusunoki: Industry-Acadmia Collaboration in Japan based on the Structure of Knowledge Transfer, The 3rd ASIALICS International Conference, Shanghai (2006).

[128] K. Miyazaki, K. Klincewicz: Sectoral Systems of Innovation in Asian Countries in Software; PICMET, August, Portland, USA (2007).

[129] K. Miyazaki and N. Islam: Nanotechnology Systems of Innovation; An Analysis of Industry Academia Activities; TJASSST, Tunisia, Sousse, (Nov.2007).

[130] T. Miyawaki, J. Iijima and S. Ho: Measuring Function Points from VDM-SL Specifications; Proceedings of the 5th International Conference on Service Systems and Service Management (ICSSSM'08) NO. 040 Jun. 2008

[131] S. Mizuno: An Interior-Point Algorithm for LP Whose Coefficient Matrices Has a Special Structure; Mathematisches Forschungsinstitut Oberwolfach, Germany, January 9-15 (2005).

[132] S. Mizuno and S. Nishibu: A Logarithmic-Transformation Interior-Point Algorithm for Linear Programming, International Symposium on The Art of Statistical Metaware; The Institute of Statistical Mathematics, Tokyo, Japan, March 14-16 (2005).

[133] S. Mizuno: A Logarithmic-Transformation Interior-Point Algorithm for Linear Programming; The 3rd Sino-Japanese Optimization Meeting, Orchard Hotel, Singapore (2005).

[134] S. Mizuno: Primal-Dual Interior Point Methods for Linear Programming, Workshop on Advances in Optimization, Tokyo Institute of Technology, April (2007).

[135] S.Mizuno: Primal-Dual Interior Point Methods for Linear Programming, The 4th Sino-Japanese Optimization Meeting, National Cheng Kung University, Tainan, Taiwan, August 27-31 (2008).

[136] K. Mori: Trend of Autonomous Decentralized Systems; 10th IEEE International Workshop on Future Trends of Distributed Computing Systems, 213-216 (2004).

[137] K. Mori: Massive Ubiquitous Computing World and Autonomous Decentralized System; The 2nd International symposium on Innovations and Real-Time Applications of Distributed Sensor Networks (2006).

[138] K. Mori: Autonomous Decentralized System and its Applications in Ubiquitous Computing; IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing, 472-447 (2006).

[139] K. Mori, "Autonomous Decentralized System for Service Assurance and its Application", International Service Availability Symposium, 1-8 (2007).

[140] K. Moriyama and C. Watanabe "The Analysis of the Bipolarization of Profitability amongst Japanese High-technology Firms" (*IAMOT (International Association for Management of Technology) - 16th International Conference on Management of Technology*, 2007, Miami, USA) CD-ROM.

[141] S. Murakami, S. Kimura, X.D. Lu and K. Mori, "Autonomous Mobile Agent Coordination Technology for Fungible Multi-services to Achieve High Response Time", IEEE Proc. of the 2nd International Conference on Complex, Intelligent and Software Intensive Systems (CISIS), 429-433 (2008).

[142] K. Nagata and T. Hachiya: Earnings Management and Initial Returns of IPOs; Proceedings of the 13th Conference of Nippon Finance Association, 570-578 (2005).

[143] K. Nagata and T. Hachiya: Earnings Management and Initial Returns of IPOs; Program and proceedings, Seventeenth

Asian-Pacific Conference on International Accounting Issues, Wellington, New Zealand, 114 (2005).

[144] K. Nagata and T. Hachiya: Competing Motives for Earnings Management in Initial Public Offerings; Proceedings of the 7th Annual Conference of the Asian Academic Accounting Association, 2006 (CD-ROM).

[145] K. Nagata and T. Hachiya: Competing Motives for Earnings Management in Initial Public Offerings; Proceedings of the 18th Asian-Pacific Conference on International Accounting Issues, 2006 (CD-ROM).

[146] K. Nagata, "Discussion of Corporate Governance, Growth Opportunities, and Earnings Restatement : Effect of a Corporate Governance Code," the Asia-Pacific Journal of Accounting and Economics Symposium 2008, Hawaii, U.S., December 2008.

[147] K. Nagata, T. Hachiya, and G.Rhee, "Inside Block-holdings and Earnings Management in Initial Public Offerings," the 20th Asian-Pacific Conference on International Accounting Issues, Paris, France, November 2008.

[148] K. Nakashima and D. Tsao: Environmental Legislation on business practices in Japan, The 5th workshop on business aspects of closed-loop supply chain (2005).

[149] K. Nakashima and D. Tsao: Global Impacts of Extended Producer Responsibility Legislation on Electronics Manufactures, Workshop on WEEE and Closed-Loop Supply Chain (2005).

[150] M. Nakata and K. Higa: Exploring Human Resource Network using Text Mining; in proc of the 2nd International Systems Conference, San Diego, U.S., July 2006 (CD-ROM).

[151] Y. Nakatogawa, S. Murakami, M. Kanda, K. Mori, R. Takanuki, and Y. Kuba: Autonomous Fault Recovery Technology for Continuous Service in Distributed VOD System; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 221-228 (2007).

[152] Y. Nakatogawa, Y. Jaiang, M. Kanda, K. Mori, R. Takanuki, and Y. Kuba: Autonomous Fault Recovery Technology for Achiiving Fault-tolerance in Video on Demand System; 8th. IEEE Symposium on Multimedia, 113-120 (2006).

[153] Y. Nakatogawa, S. Murakami, M. Kanda, K. Mori, R. Takanuki, and Y. Kuba: Autonomous Fault Recovery Technology for Continuous Service in Distributed VOD System; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 221-228 (2007).

[154] A. Nakatsuka, and D. Tsao, Tacit Knowledge Aggregation for Demand Forecasting in Prediction Market, Proceeding of POMS Tokyo 2008, 2717-2726, 2008, 8

[155] M. Ogikubo and T. Enkawa: Customer Satisfaction and Cultural Factors: Comparison with Life Satisfaction; The 7th Asian Pacific Industrial Engineering and Management Systems Conference, December 17-20, 2006, Bangkok (2006).

[156] M. Ogikubo and T. Enkawa: Cross-national Investigation on the Nature and Determinants of Aggregate Customer Satisfaction; The 4th Asian Network for Quality Congress, September 27-29, 2006, Singapore (2006).

[157] M. Ogikubo and T. Enkawa: Determinants of Aggregate Customer Satisfaction: Cross-Country Findings; the 12th QUALCON-APQO 2006 Conference, October 17-20, 2006, Sydney (2006).

[158] M. Ogikubo and T. Enkawa: The Cultural Factors of Customer Satisfaction; the 13th Asia Pacific Quality Organisation (APQO) International Conference 2007, October 17-20, 2007, Shanghai (2007).

[159] M. Ohno, K. Higa: Creating A Sustainable Society Based on Telework; 1st San Diego International Systems Conference (July 2005). (CD only, no pages allocated)

[160] T. Ono, N. Kaji, Y. Horikoshi, H. Kuriyama, K. Ragab and K. Mori: Autonomous Decentralized Community Construction Technology to Assure Quality of Services; 10th IEEE International Workshop on Future Trends of Distributed Computing Systems, 299-305 (2004).

[161] Y. Osawa and K. Miyazaki: An Analysis of R&D Project Performance, from Research to Commercialization ~ Evidence from a Japanese Electric Company; Proceedings of the First World Congress of IFSR (2005).

[162] Y. Osawa, K. Miyazaki: An Analysis of Large Scale R&D Project Performance from Research to Commercialization, The 3rd ASIALICS International Conference, Shanghai (2006).

[163] N. Ouchi and C. Watanabe, "Elucidation of the Impacting Dynamism of Internal and Market Learning on Firm's Profit: A System Dynamics Approach" (*International Colloquium on Business & Management (ICBM)*, 2007, Bangkok, Thailand) 19-22.

[164] N. Ouchi and C. Watanabe "The Dynamism between Technological Diversification, Learning, Spillover and Functionality Development - The Case of Canon's Copying Machines and Printers" (*The 2007 ISPIM (International Society for Professional Innovation Management) Conference - Innovation for Growth: The Challenges for East & West*, 2007, Warsaw, Poland).

[165] N. Ouchi and C. Watanabe "An Analysis of High Profitability Mechanism by means of Dynamism between Technological Diversification, Learning and Functionality Development" (*IAMOT (International Association for Management of Technology) 2007 - 16th International Conference on Management of Technology*, 2007, Miami, USA) CD-ROM.

[166] R. Solves Pujol, H. Umemuro: Towards Designing Affective Technology to Promote Productive Love; Proceedings of e-Society 2009, Barcelona, Spain (2009).

[167] W. Qiong, K. Klincewicz, K. Miyazaki: Alliance Networks of US, Chinese, Indian IT Service Companies and the Divergence of Sectoral Systems; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 491-494 (2005).

[168] W. Qiong, K. Klincewica and K. Miyazaki: Software Systems of Innovation in Asia, Partnership Networks of Software Companies in China and India; STEPI Annual Symposium, Seoul, Korea (2005).

[169] W. Qiong, K. Miyazaki, K. Klincewicz: Innovation in Business Models of Chinese Software Companies, 15th International Conference on Management of Technology, 1-8, Beijing (2006).

[170] W. Qiong, K. Miyazaki, K. Klincewicz: Innovation in Business Models in the Open Source Sector of China, The 3rd ASIALICS International Conference, Shanghai (2006).

[171] K. Ragab, Y. Horikoshi, H. Kuriyama and K. Mori: Multi-layer Autonomous Community Overlay Network for Enhancing Communication Delay; Proc. of the 9th IEEE Symposium on Computers Communications (ISCC'04), Vol. 2, 987-992 (2004).

[172] C. Riera, D. Senoo, and J. Iijima: A Study of the Effect of Knowledge Creating Capabilities on Corporate Performance; The 11th Pacific-ASIA Conference on Information Systems, 2007 (CD-ROM).

[173] A. Ruhan, J. Iijima, S. Ho, "A Study on Relationship between Organization Intelligence Quotient and Firm Performance – A comparison study between Japan and China," Proceedings of the 8th Asian eBusiness Workshop, No.17 Aug. 2008.

[174] A. Rusdiansyah and D. Tsao: Routing and Scheduling for Delivery of Products under Vendor Managed Inventory Scheme; International Symposium on Scheduling, 153-158 (Awaji, Japan, May 2004).

[175] T. Saiki, "Intellectual Property Management of Biotechnology Start-ups and Companies in Japan," VIPSI-2008 Belgrade 2008

(CD-ROM).

[176] K. Sakakibara and K. Higa: Application of Video-Mediated Virtual Office to Industry-Academia Alliance; The 4th International Conference on Innovation & Management, December 2007（山口）.

[177] K. Sakakibara and K. Higa: Privacy Violations of Video Communications in a Ubiquitous Environment; Proc. of The 3rd International Conference on Multimedia and Ubiquitous Engineering (MUE 2009), June 4-6, 2009, Qingdao, China (accepted)

[178] S. Sasaki and J. Iijima: Verification of Invariant Properties of Business Process Based on Formal Approach; 2007 International Conference on Wireless Communications, Networking and Mobile Computing, (2007.9.).

[179] J. Sato and H. Umemuro: Cognitive Abilities and Individual Differences in the Visual Searches of the Elderly; Proceedings of the 3rd International Conference on Universal Access in Human-Computer Interaction, Las Vegas, USA, 2005 (CD-ROM).

[180] D. Senoo: Knowledge Creation Systems in Seven-Eleven Japan; Paper presented in the 4th of the 3rd Asian eBusiness Workshop, Chengdu, China, August 2004.

[181] D. Senoo, R. Magnier-Watanabe: How to Design Active BA: The Interaction between Physical and Virtual Environments; PACIS2005 (Pacific Asia Conference on Information Systems) Proceedings, Bangkok, Thailand, July 2005 (CD-ROM).

[182] D. Senoo, M. Fukushima, S. Yoneyama and T. Watanabe: Technology Transfer as Team Building – An Empirical Analysis of University TLOs in Japan; Proceedings of PICMET'06, 1836-1844 (2006).

[183] D. Senoo, Y. Wu,"An Ontological Model of Knowledge Spiral", Proceedings of the 8th Asian eBiz Workshop, No. 13, Aug 2008. Gyeongju, Korea.

[184] Y. Shibata and T. Saiki: The dynamics of Knowledge Spillover for Functionality Development in Japanese Acoustic Equipment Industry; VIPSI-2009 AMALFI (2009).

[185] A. Shiibashi, F. Mashiba, and K. Mori: High Reliability in Autonomous Decentralized IC Card Ticket System; 26th IEEE International Conference on Distributed Computing Systems Workshops (2006).

[186] A. Shiibashi, F. Mashiba, and K. Mori: Autonomous Decentralize Processing and Decentralized Algorithm for High Speed in a Wired-and-Wireless Integrated IC Card Ticket System; 11th IEEE Symposium on Computers and Communications (ISCC 2006), 857-862 (2006).

[187] A. Shiibashi, K. Hama, and K. Mori: High-speed Processing by Autonomous Decentralized Architecture and Decentralized Algorithm in a Wired-and-Wireless Integrated IC Card Ticket System; The 8th IEEE International Conference on E-Commerece Technology, The 3rd IEEE Int'l Conf. on Enterprise Computing, E-Commerece and E-Services (CEC/EEE2006), 32-38 (2006).

[188] A. Shiibashi, T. Yajima, X. Lu, and K. Mori: The Evaluation of High Reliability in an Autonomous Decentralized IC Card Ticket System; The 7th International Symposium on Computer Networks, 209-213 (2006).

[189] A. Shiibashi, T. Kadoya and K. Mori: High Performance in a Wired-and-Wireless Integrated IC Card Ticket System; 5th International Workshop on Wireless Information Systems、56-65 (2006).

[190] A. Shiibashi, X. Lu, and K. Mori: Achievement of High-speed Processing by Autonomous Decentralized Processing and Decentralized Algorithm in a Wired-and-Wireless Integrated IC Card Ticket System; The 4th IEEE Workshop on Software Technologies for Future Embedded and Ubiquitous Systems (SEUS 2006), 163-169 (2006).

[191] A. Shiibashi, D. Usuki, Y. Sugiyama, and K. Mori: An Application of Autonomous Decentralized Architecture to An IC Card Ticket System; Proc. of the IADIS International Conference Applied Computing, 107-114 (2006).

[192] A. Shiibashi, M. Yamana, and K. Mori: High-speed Processing in Wired-and-wireless Integrated Autonomous Decentralized IC Card Ticket System; Proc. of the IASTED International Conference Advances in Computer Science and Technology, 145-150 (2006).

[193] A. Shiibashi, T. Kuroda, M. Yamana, and K. Mori: Research of Reliability Technology in Heterogeneous Aoutonomous Decentralized Assurance Systems; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 207-214 (2007).

[194] A. Shiibashi, Y. Maruyama, M. Yamana and K. Mori, "Multi-layered Data Consistency Technology in Autonomous Decentralized IC Card Ticket System", The 6th International Workshop on Assurance in Distributed Systems and Networks (2007).

[195] A. Shiibashi, T. Kuroda, M. Yamana, and K. Mori: Research of Reliability Technology in Heterogeneous Aoutonomous Decentralized Assurance Systems; The 8th IEEE International Symposium on Autonomous Decentralized Systems (ISADS 2007), 207-214 (2007).

[196] J.H. Shin and C. Watanabe "Comparative Analysis of Diffusion Trajectory of Plazma TV among Japanese, Korea and Taiwanese Companies" (*IAMOT (International Association for Management of Technology) - 16th International Conference on Management of Technology*, 2007, Miami, USA) CD-ROM.

[197] J.H. Shin and C. Watanabe: Assessment of Functionality Development Dynamics, Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management (2008) (CD-ROM).

[198] N. Shiraishi, J. Iijima: Inter-firm Relationships in the Telecommunications Industries: Characteristics and Typology; Proceedings of Business And Information 5 (1), No. 431, Jul. (2008).

[199] N. Shiraishi, Junichi Iijima, "Business Process-Based View of Inter-firm Relationships," Proceedings of the 12th Pacific Asia Conference on Information Systems pp. 188-197 Jul. 2008

[200] K.L. Shum and C. Watanabe: Towards a general model of technological forecasting - the Lotka - Volterra systems; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 413-416 (2004).

[201] K.L Shum, C. Watanabe: Comparing Photovoltaic Deployment in Japan and the USA - Its Implications to the Science of Institutional Management of Technology (SIMOT); Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 593-596 (2005).

[202] M. Sorakubo and H. Umemuro: Two-Nearly: Moderate Communication of Awareness to Connect Families Living Far Apart; Proceedings of the 6th Conference of the International Society for Gerontechnology, Pisa, Italy (2008).

[203] S. Suzuki, T. Enkawa and K. Yaibuathet: Identifying the Factors Which Determine the Operational Performance of SCM and Analyzing their Impacts on Financial Indexes; International Conference on Operations and Supply Chain Management proceedings, 2005.

[204] S. Suzuki and T. Enkawa: The Impact of Supply Chain Competencies on Managerial Performance; Proceedings of 1st International Workshop on Institutional View of SCM (ISCM2006), 2006 (CD-ROM).

[205] S. Suzuki and D. Tsao, Comparative Studies of the Japanese and Chinese Supply Chain Management, Informs International (Hong Kong), 2006, 6.

[206] M. Takaishi, C.P. Leguizamo, S. Kimura and K. Mori:

Autonomous Multi-Agent-Based Data Allocation Technology in Decentralized Databese Systems for Timeliness; Proceeding of the 13th Conference of Assurance System Wrokshop, Institute of Electronics, Information and Communication Engineers,16-23 (2004).

[207] K. Takashima and H. Umemuro: Activating Communications Among Family Members Living Far Apart by Sharing Common Topics Through Television; Proceedings of the 6th Conference of the International Society for Gerontechnology, Pisa, Italy (2008).

[208] Y. Takeda and D. Senoo: How Technology Is Made Visible When Exploring Its Application Fields; Proceedings of PICMET '2007 (CD-ROM).

[209] Y. Tanaka: Research on the Integrated Function between IP Organization and Other Organization in Companies; Third Annual International Symposium: SIMOT (2007).

[210] Y. Tanaka: Research on the Intellectual Property-related Activities Contributing to Management; Forth Annual International Symposium: SIMOT (2008).

[211] A. Tarasyev and C. Watanabe: Optimization of Proportions for Trajectories of Economic Growth and Technology Development; Sources of Economic Growth Workshop at IIASA (Laxenburg, Austria), 2005.

[212] D. Tsao, Theoretical Problems and Approaches of Supply Chain Management, JIMA International Symposium 2008, 21-25.

[213] D. Tsao: A Heuristic Analysis for Integrating Disassembly Planning and Scheduling; International Symposium on Scheduling, 210-213 (Awaji, Japan, May 2004).

[214] D. Tsao: Decoupling Stocks in a Multi-Stage Inventory System; 13th International Symposium on Inventories (Budapest, Hungary, August 2004).

[215] D. Tsao: Estimating Customer Lifetime Value Using Hierarchical Bayesian Method; Decision Sciences Institute Annual Meeting, MK-9 (Boston, U.S.A. November, 2004).

[216] D. Tsao: Optimal Seat Allocation Strategy for Competitive Flight Leg; The 6th International Conference on Optimization – Techniques and Applications (ICOTA), (Bararat, Australia, December 2004).

[217] D. Tsao: A Research on Strategic Outsourcing for Short Lifecycle Products; Proceedings of the 5th Asian-Pacific Conference on Industrial Engineering and Management System (APIEMS) (Brisbane, Australia, December 2004).

[218] D. Tsao: A HN-RFID Model to Support Efficient Logistics, Proceedings of 5th Asian e-Business Workshop, pp.21-24 (2005).

[219] D. Tsao and O. Tang: Modeling a Multi-Period Disassembly Planning Problem with Capacity Constraints, Informs Anuual meeting (2005).

[220] D. Tsao, J. Wang and S. J. Schvaneveldt: Planning Manufacturing Strategy in Turbulent Environments, DSI Annual meeting (2005).

[221] D. Tsao and T. Ou: An Analysis of Nash Equilibrium in a Competing Flight Leg, International Working Seminor of Production Economics (2006).

[222] D. Tsao and O. Tang, An Analysis of Nash Equilibrium in a Competing Flight Leg, International Working Seminor of Production Economics, 2006.

[223] D. Tsao and S. Suzuki: An Analysis on Inventory Recovery Process in a Reverse Logistic System; Informs International (Hong Kong), 2006.

[224] D. Tsao: Home Network and Radio Frequency Identification; China RFID Forum (Beijing), 2006.

[225] H. Umemuro and J. Sato: Age difference in Visual Searches; Proceedings of the 3rd International Conference on Universal Access in Human-Computer Interaction , Las Vegas, USA, (CD-ROM; 2005).

[226] H. Umemuro and T. Suzuki: Web Design Parameters Affecting Visceral, Behavioral, and Reflective Levels of Evaluation. Proceedings of IEA2006 Congress, Maastricht, the Netherlands, (CD-ROM; 2006).

[227] H. Umemuro: Beyond the constraints of QWERTY keyboard: Challenges to provide alternative input methods for Japanese older adults; *Proceedings of the 4th International Conference on Universal Access in Human-Computer Interaction*, Beijing, China (2007) DVD-ROM.

[228] J. Wang and D. Cao (Tsao): A Structural Model of Common Approaches Dealing with Changes and Uncertainty in Manufacturing System; Informs annual meeting (Denver, U.S.A., October 2004).

[229] J. Wang and D. Tsao, Competitive Priority & Best Practice: Roles in Business Strategy , Proceeding of 6th Asian e-Business Workshop (Fukuoka, Japan), 162-167, 2006, 8

[230] C. Watanabe: Expectation of Japan's System of MOT to the Ubiquitous Society; Proceedings of the PISTA International Conference (Orland, USA, 2004).

[231] C. Watanabe: An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories - Elucidation of Japan's Co-evolutionary Dynamism Accruing to Global Assets; Proceedings of the 5th Technical Meeting between IIASA and TITech on An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories; 244-272 (Ekaterinburg, Russia, 2004).

[232] C. Watanabe: Elucidation of Japan's Co-evolutionary Dynamism between Innovation and Institutional Systems Accruing to Global Assets; Proceedings of the ATSE Round Table Meeting (Adelaide, Austria, 2004).

[233] C. Watanabe, M. Hobo and S. Lei: An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories - An Implication of the Service Oriented Manufacturing; Proceedings of the 4th Technical Meeting between IIASA and TITech on An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories (Laxenburg, Austria, 2004).

[234] C. Watanabe, Y. Tou and K.L. Shum: Technological Diversification as a Key Strategy for Firms' Sustainable Development under Mature Economy; Proceedings of the 13th International Conference for the International Association of Management of Technology (IAMOT2004) (Washington, 2004).

[235] C. Watanabe: Technological Diversification as a Key Strategy for Firms' Sustainable Development under Mature Economy; Special Lecture to the Association of Industry Portugal (Lisbon, 2004).

[236] C. Watanabe: Institutional Management of Technology; ATSE Round Table Meeting; ATSE Round Table Meeting (Canbera), (2005).

[237] C. Watanabe: Institutional MOT: Co-evolutionary Dynamism of Innovation and Institution - Japan's Co-evolutionary Dynamism and Its Implications to Fostering Science and Technology Human Resources; Proceedings of Japan-South Africa Science and Technology Policy Forum (Tokyo), (2005).

[238] C. Watanabe: Japan's Co-Evolutionary Dynamism between Innovation and Institutional Systems - New Approach; IIASA Spring Workshop on Methodology (Laxenburg, Austria), (2005).

[239] C. Watanabe: Institutional MOT - Co-evolutionary Dynamism of Innovation and Institutions; Proceedings of the 14th International Conference for the International Association of Management of Technology (IAMOT 2005) (Vienna), (2005).

[240] C. Watanabe, K. Moriyama and K. Fukuda: An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories - Empirical Analysis of the Change in Entrepreneurial Features Corresponding to the Transformation of the Characterization of Technology; Proceedings of the 7th

Technical Meeting between IIASA and TITech on An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories (Laxenburg, Austria), 308-349, (2005).

[241] C. Watanabe: Japan's Co-evolutionary Dynamism between Innovation and Institutional Systems; SIMOT International Symposium, SIMOT International Symposium (Tokyo), (2005).

[242] C. Watanabe, M. Kita, A. Yamada and S. Lei: An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories - Empirical Analysis of the Effects of the Institutional Systems on China's PCs Development focusing on the Unique Institutional Structure; Proceedings of the 6th Technical Meeting between IIASA and TITech on An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories (Laxenburg, Austria), 332-344, (2005).

[243] C. Watanabe: Technopreneurial Trajectory Leading to Bipolarization of Entrepreneurial Contour in Japan's Leading Firms; IAMOT 2006 (Beijing).

[244] C. Watanabe: Empirical Analysis of the Change in Entrepreneurial Features Corresponding to the Transformation of the Characterization of Technology; Proceedings of Internaitonal ProACT Conference (Tampere, Finland), (2006).

[245] C. Watanabe: An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories: Empirical Analysis of the Emerging Hybrid Management Fusing the Transformation of the Characterization of Technology; Proceedings of the 8th Technical Meeting between IIASA and TITech on an Elucidation of the Role of Institutional Trajectories (Laxenburg, Austria), (2006).

[246] C. Watanabe: Innovation and Development: Japan's Co-evolutionary Dynamism between Innovation and Institutional Systems; 10th East Asia Round Table Meeting of Academies of Engineering, 2006, Tokyo, (2006).

[247] C. Watanabe: Japan's Co-evolutionary Dynamism between Innovation and Institutional Systems: New Approach; SIMOT International Symposium, 2006, Tokyo, (2006).

[248] C. Watanabe, "Co-evolutionary Domestication for Knowledge Integration and Innovation" (*Dalian University of Technology Workshop on Knowledge Integration and Innovation*, 2008, Dalian, China).

[249] C. Watanabe, "Japan's Co-evolutionary Dynamism between Innovation and Institutional Systems: Hybrid Management of Technology Fusing "East" and "West" (*SIMOT International Symposium*, 2008, Tokyo).

[250] C. Watanabe, "Science and Technology Policy for Innovation and Competitiveness in Developed Countries" (*APO Expert Round Table Meeting on Innovation Framework*, 2007, Singapore).

[251] C. Watanabe, "Essential Strategy for Substantial Hybrid Management of Technology" (*10th General Annual Conference of the Japanese Association of Administrative Science*, 2007, Tokyo).

[252] C. Watanabe, "Enhancement of Japanese Firms Competitiveness through the Entrepreneurial Reorganization: Hybrid Management of Technology" (*10th Memorial Symposium of the Research Center for the Creation of Entrepreneurial Capacity, Toyo University*, 2007, Tokyo).

[253] C. Watanabe, "Hybrid Management for Sustainable Innovation: Fusing East and West in an Innovation Ecosystem" (*11th East Asia Round Table Meeting of Academies of Engineering*, 2007, Beijing).

[254] C. Watanabe, "Hybrid Management of Technology in the 21st Century - Co-evolutionary Domestication by Fusing Indigenous Strength and Global Best Practice" (*IIASA-Tokyotech Workshop on Hybrid Management of Technology*, 2007, Laxenburg, Austria).

[255] C. Watanabe, "Japan's System of Innovation: Co-evolution between Innovation and Institutional Systems" (*APO Expert Round Table Meeting on Innovation Framework, 2007*, Langkawi, Malaysia).

[256] C. Watanabe, "Co-evolutionary Domestication by Fusing - Optimal Co-evolution between Indigenous Strength and External Learning for Innovation" (*EUROGEN 2007 International Conference,* 2007, Jyvaskyla, Finland).

[257] C. Watanabe, "Hybrid Management for Sustainable Growth by Fusing East and West - Suggestion to Institutional Innovation" (*Special Lecture to the Dalian University of Technology,* 2007, Dalian).

[258] C. Watanabe: Hybrid Management for Sustainable Growth - Fusing East and West (*STEPI International Symposium,* 2007, Seoul).

[259] C. Watanabe, "Japan's Co-evolutionary Dynamism between Innovation and Institutional Systems: Hybrid Management Fusing East and West" (*IAMOT (International Association for Management of Technology) 2007 - 16th International Conference on Management of Technology*, 2007, Miami, USA) CD-ROM.

[260] C. Watanabe, "Optimal Functionality Development in Open Innovation toward a Post-Oil Society" (*The 9th International Symposium on Knowledge and Systems Sciences*, 2008, Guangzhou, China).

[261] C. Watanabe, "Measuring the Trajectory of the Transition of the Place where Innovation Takes Place" (*Memorial Speech at the Annual General Meeting of the Japan Society for Science Policy and Research Management*, 2008, Tokyo).

[262] C. Watanabe, "New Functionality Development through Knowledge Transfer in Open Innovation" (*IADE International Workshop on Commitment with Knowledge Transfer*, 2008, Madrid).

[263] C. Watanabe, "Co-evolutionary Domestication for Knowledge Integration and Innovation" (*Dalian University of Technology Workshop on Knowledge Integration and Innovation*, 2008, Dalian, China).

[264] C. Watanabe, "Science of Institutional Management of Technology: Japanese Co-Evolutionary Dynamism between Innovation and Institutional Systems - Fusing "East" and "West" (*2008 AAAS Annual Meeting*, 2008, Boston).

[265] W. Wihandoko and C. Watanabe: The Technological Activity of Indonesian State-own Enterprise: A Contribution to Its Performance; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 477-480 (2004).

[266] Y. Xuening and C. Watanabe: Increasing Inter-regional Heterogeneity Leads to Sustainable Economic Growth - A Case of China's Unique Institutional System; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management 139-142 (2006).

[267] K. Yaibuathet, T. Enkawa and S. Suzuki: Models in evaluation supply chain performance of the Thai milk industry; 6-th Asia Pacific Industrial Engineering and Management Society Conference proceedings (2005).

[268] K. Yaibuathet, T. Enkawa and S. Suzuki: Supply Chain Operational Performance Analysis: Cross National Comparison; Proceedings of 7th Asia Pacific Industrial Engineering and Management Society Conference, 2006 (CD-ROM).

[269] K. Yaibuathet, T. Enkawa and S. Suzuki: Influence of Industrial System toward the Development of Supply Chain Operational Performance; Proceedings of 1st International Workshop on Institutional View of SCM (ISCM2006), 2006 (CD-ROM).

[270] Y. Yajima: Predicting Purchase Preferences Using Semi-Supervised One-Class SVM with Graph Kernels; Proc. of SCM 2007, 2007 (CD-ROM).

[271] Y. Yajima: Semi-Supervised Kernel Logistic Regression and its Extension to Active Learning based on A-optimality; Proc. of

ICDM 2007 Workshops, 2007 (CD-ROM).

[272] A. Yamada and C. Watanabe: Firms with Adaptability Lead a Way to Innovative Development; Proceedings of the 14th International Conference for the International Association of Management of Technology (IAMOT 2005) (Vienna), (2005).

[273] A. Yamada and C. Watanabe: Co-evolutionary Dynamism between Adaptability and Diversification of R&D: The Case of Japan's High Technology Firms; IAMOT 2006 (Beijing), (2006).

[274] A. Yamada and C. Watanabe "R&D Adaptability Leading to the Dynamism of Technological Diversification" (*IAMOT (International Association for Management of Technology) 2007 - 16th International Conference on Management of Technology - Management of Technology for the Service Economy*, 2007, Miami, USA) CD-ROM.

[275] M. Yamazaki, "History of the Japanese Nuclear Weapons Development during the Second World War," The 12th International Conference on the History of Science in East Asia, Johns Hopkins University, MD, USA, July> 2008.

[276] X. Yao and C. Watanabe: The Role of Informatization in Inducing Co-evolution between Educational Development, Urbanization and Economic Growth: The Case of China; IAMOT 2006 (Beijing), (2006).

[277] X. Yao and C. Watanabe "Sustainable Economic Development with Inter-regional Heterogeneity in China" (*IAMOT (International Association for Management of Technology) 2007 - 16th International Conference on Management of Technology - Management of Technology for the Service Economy*, 2007, Miami, USA) CD-ROM.

[278] X. Yao and C. Watanabe: Co-evolutionary Dynamism between Innovation and Institutional systems in the BRICs, Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, 2007 (CD-ROM).

[279] J. Yashikida, H. Umemuro (2008). Close To You: Unobtrusive Awareness Communication to Bring Family Living Far Apart Closer. Proceedings of the 6th Conference of the International Society for Gerontechnology, Pisa, Italy.

[280] S. Yoneyama, M. Fukushima, D. Senoo and T. Watanabe: Marketing of Technological Knowledge: Empirical Analysis of Licensing Activities from University TLOs to Industrial Sectors in Japan; Proceedings of PICMET'06, 1865-1874 (2006).

[281] H. Yuhashi and J. Iijima, "How can We Manage a Collaboration Network?," Proceedings of the 8th Asian eBusiness Workshop No.15 Aug. 2008.

[282] H. Yuhashi and J. Iijima, " How Can We Manage Collaboration Network via Communication?," Proceedings of the 12th Pacific Asia Conference on Information Systems 347-358 (2008).

[283] Q. Zhang, X. Ding and J. Iijima: A Study on Informatization of Museum using IC Card; 7th Asian eBusiness Workshop, (2007.8.).

[284] W. Zhao and C. Watanabe: Co-evolution between Software Innovation and Institutions: Empirical Analysis of China's Software Development; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 1164-1167 (2006).

[285] W. Zhao and C. Watanabe: Co-evolutionary Dynamism between Japan and China in Software Outsourcing; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 1168-1171 (2006).

[286] W. Zhao and C. Watanabe "Analysis of Institutional Factors Influencing the Service Innovation: A Case of Chinese Software Industry" (*IEEE International Conference on Industrial Engineering and Engineering Management*, 2007, Singapore) CD-ROM.

[287] W. Zhao and C. Watanabe "Co-evolutionary Dynamism of Software Outsourcing between Japan and China Focusing on Institutional Systems" (*IAMOT (International Association for Management of Technology) - 16th International Conference on Management of Technology*, 2007, Miami, USA) CD-ROM.

[288] W. Zhao and C. Watanabe: Risk Management in Outsourcing Service Industry - Suggestions from a portfolio analysis in India, Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM.

[289] W. Zhao and C. Watanabe: Who will be the Frontier in Next Software Outsourcing? - A Comparative Empirical Analysis between India and China focusing on their Institutional Systems, Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM.

[290] W. Zhao and C. Watanabe: An Exploration of Competitive Advantages in An Industry Cluster within Local Institutional Systems: the Case of Dalian Software Park in China, Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management（2008）CD-ROM

[291] Z. Zheng, L. Liang, K. Higa: The Pre-Evaluation Model to the Telework Readiness in China; IADIS International Conference on e-Commerce 2007, December 2007 (Portugal), CD only, no pages allocated.

(Japanese) In Alphabetic Ordder

[292] T. Abe and C. Watanabe: Analysis of Long Tail-Based Innovation towards the Ubiquitous Society; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 103-106 (2006).

[293] S. Akaike and C. Watanabe: Study on Resource Allocation System between Different Research Fields in Government R&D Expenditure; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 1000-1003 (2005).

[294] S. Akaike and C. Watanabe: Economic Impacts of Diversity of Resource Allocation in Government R&D Expenditure; Proceedings of the 22th Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM.

[295] S. Akaike and C. Watanabe: Nobel Prize and Japan - through Interviews with Related People; Proceedings of the 22th Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM

[296] H. Aoki and K. Itoh: Analysis of Learnability of Gaze-Interaction Based on Experimental Data, Proceedings of the 45th Annual Conference of Japan Ergonomics Research Society, Saitama, Japan, 444-445 (June 2004). (in Japanese).

[297] H. Aoki, K. Itoh and J. P. Hansen: Analysis of Gaze Typing Errors Caused by Eye-Movement Properties during Its Learning Process, Proceedings of the 46th Annual Conference of Japan Ergonomics Research Society, Tokyo, Japan, 274-275 (June 2005). (in Japanese).

[298] H. Aoki and K. Itoh: Analysis of Desing Parameters of Gaze Typing Interface on Its Usability, Proceedings of the 2005 Fall Congress of Japan Industrial Management Association, Nagoya, Japan, 16-17 (September 2005). (in Japanese).

[299] H. Aoki, K. Itoh, M. Kinoshita: Visual Attention Transition towards Components Elements of Printed Advertisement, Proceedings of Spring Conference of Japan Ergonomics Society, 54-55 (2007).

[300] H. Aoki, K. Itoh, M. Kinoshita: Impact of Component Elements of Printed Advertisement on Visual Attention, Proceedings of the 48th Conference of Japan Ergonomics Society, 394-395 (2007).

[301] H. Aoki, K. Itoh, M. Kinoshita: Impact of Style Elements on Visual Attention in Reading Printed Advertisement; Ergonomics, Vol. 44, No. 1, 22-36 (2008).

[302] H. Aoki and K. Itoh: Basic Characteristics of Move of Eye Balls in Consecutive Implementation of Cognition Tasks; Proceedings of the 49th Conference of Japan Ergonomics Society, 358-359 (2008).

[303] H. Aoki, Y. Tomizawa and K. Itoh, T. Matayoshi, S. Suzuki: Attempt to Analyze Experience Skill in Outer Body Circulation Using Heart-Lung Machine Based on Eyeballs Move Analysis Approach; Proceedings of the 46th Conference of Japanese Society of Artificial Organs, S-152 (2008).

[304] T. Araki and C. Watanabe: Diffusion and Penetration of Service-Led Innovation; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 644-647 (2005).

[305] C. Chaojung and C. Watanabe: Change of Diffusion Mechanism of Media-Based Products - An Empirical Study of Music CD Market in Japan; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 640-643 (2005).

[306] C. Chaojung and C. Watanabe: The Co-evolutionary Mechanism Between Handset Vendors and Telecommunication Service Operators in Japan; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 280-283 (2006).

[307] B. Chan-orn, T. Saiki and H. Osada: Characteristics of Copy Product Problems in Thailand and Activities of Corporations Operating There; Proceeding of the 4th Conference of Intellectual Property Association of Japan, 308-311 (2006).

[308] H. Enjou and J. Iijima: Consideration to Class Chart Algebra in the Correspondence Judgment between Class Charts; Proceedings of the Annual Autumn Meeting of the Japan Society for Management Information 2008, H4-2 (2008).

[309] K. Enkawa: Core Problems in New Product Development and NPD Score Card; Proceedings of the 100th Conference of Japanese Society for Quality Control 29-34 (2004).

[310] T. Enkawa: Kaizen and Strength/Weakness of Japanese Culture; Special Lecture at the 46th Quality Month, Japanese Standards Association (2005).

[311] T. Enkawa, M. Ogikubo and Z. Huang: Relationship between Individual's Cultural Factors and Customer Satisfaction/Loyalty Structure - Effects of Uncertainty Avoidance and Desire for Diversity, Proceedings of the 83rd Conference of JSQC, 51-54 (2007).

[312] T. Enkawa: Securing Quality, Visualization and Japanese Culture; Lecture at 2007 Quality Month, Fukuoka (2007).

[313] T. Enkawa: "Visualization" of Development Process by Using New Product Development Score Card; 2007 Standardization Conference, Japanese Standards Association (2007).

[314] H. Endo, Y. Sugiyama and K. Mori: A Study on Community Autonomous Composition Technology for Quality Assurance in Information Service System; Proceedings of the 19th Assurance System Committee, 9-16 (2006).

[315] H. Endo, T. Saito and K. Mori: A Study on Autonomous Collaborative Technology for Quality Assurance of Information Service; Proceedings of the 23rd Assurance System Committee, 38-45 (2008).

[316] G. Faith and C. Watanabe: Empirical Analysis of Institutional Forces to Promote Accelerated Diffusion of Mobile Phones in Turk; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 786-789 (2005).

[317] K. Fukuda and C. Watanabe: Japan-US Comparison of National Innovation Ecosystem; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 9-12 (2005).

[318] K. Fukuda and C. Watanabe: Innovation Inducing Dynamism in Japanese Corporations - Changes form Emphasis on Input to Pursuit of Output; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 650-653 (2006).

[319] K. Fukuda and C. Watanabe: International Comparison of Effectiveness of R&D Investment by Government; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[320] K. Fukuda and C. Watanabe: Co-Evolutionary Dynamism in Japan's National Innovation Ecosystem; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management (2008) CD-ROM.

[321] M. Furuya and K. Higa: Current Status and Issues of Offshore Development in Japan - Comparison of Current Status in Japan and the US; Proceedings of 2006 Conference of Japan Telework Society, 70-73 (2006).

[322] R. Gu and K. Higa: Comparison of Media Selection in Japan and China; Proceedings of 2007 Conference of Japan Telework Society, 3-7 (2007) (June, 2007).

[323] G. Ablait, T. Enkawa, S. J. Schvaneveldt and S. Suzuki: Impacts of Cultural Factors on Customer Satisfaction and Loyalty; Proceedings of the 38th Conference of Japanese Society for Quality Control, 49-52 (2008).

[324] K. Hama, Y. Sugiyama and K. Mori: Community Autonomous Composition Technology for Advanced Service Provision; Proceedings of the 16th Assurance System Committee of Institute of Information, Electronics and Communication Engineers, 36-43 (2005).

[325] K. Hama and K. Mori: Autonomous Cooperation Technology for Symbiosis of Heterogeneous Needs in Community System; Proceedings of the 20th Assurance System Committee, 17-25 (2007).

[326] K. Hama and K. More: Autonomous Cooperation Technology for Symbiosis of Heterogeneous Needs in the Cummunity System, Proceeding of the 20th Conference of Assurance System Wrokshop, Institute of Electronics, Information and Communication Engineers, 17-25 (2007).

[327] K. Hamachi and C. Watanabe: Co-Evolutionary Dynamism between Bipolarization of Labor Market and Transformation of Growth Trajectory; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 95-98 (2006).

[328] K. Hamachi and C. Watanabe: Analysis of Changes of Labor Quality under Gap Expansion in the Labor Market; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM.

[329] K. Hamachi and C. Watanabe: Analysis of R&D Investment and Productivity in Semiconductor Industry; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management (2008) CD-ROM

[330] J.P. Hansen, H. Lund and H. Aoki, K. Itoh: Gaze Communication Systems for People with ALS, Proceedings of "Communication Workshop" of Japan Amyotrophic Lateral Sclerosis Association, 35-44 (2006).

[331] Y. Hada, T. Tomita and H. Umemuro: The impact of eye cosmetics use on impression formation based on no make-up facial impression, The Japan Journal of Ergonomics, Vol. 42 (supplement), 116-117 (2006).

[332] T. Hatanaka and C. Watanabe: Elucidation of Dynamism of Japanese System of Management of Technology- Empirical Comparative Analysis of Japanese and the US Institutions; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 266-269 (2004).

[333] S. Hayashi and K. Higa: Stages of Building Trust and Value in e-Commerce Growth; Proceedings of 2007 Conference of Japan Telework Society, 108-113 (2007) (June, 2007).

[334] S. Hayashi and K. Higa: Verification of An e-Commerce Staged Growth Model by a Questionnaire Survey and Analysis; Proceedings of 2008 Conference of Japan Telework Society, 45-50 (2008)

[335] K. Higa and K. Kanegae: Investigation of Public Incubation Facilities Utilizing Telework and Analysis of Success Factors; Proceedings of the 6th Conference of Japan Telework Society, 16-20 (2004).

[336] K. Higa and A. Itoh: Distributed Database Search System Utilizing Multi-Agent Technology; Proceedings of the 6th Conference of Japan Telework Society, 79-84 (2004).

[337] K. Higa, A. Itoh and M. Ohno: Proposal of Sustainable Regional Society by Private Delegation; Proceedings of the 7th Conference of Japan Telework Society, 75-80 (2005) (July, 2005).

[338] K. Higa, D.T. Doan and K. Matsumoto: Research on Explanation Factors for Differences in Buying Behavior of EC Consumers; Proceedings of 2008 Conference of Japan Telework Society, 39-44 (2008).

[339] (壮人)Higuchi and Y. Tanaka: On the Relationship between International Technology Transfer/Industry-Academic Collaboration and Hofstede's Researchers; 9th Conference of Japan Society of Kansei Engineering.

[340] M. Hirakawa and J. Iijima: A Study on Utilization of Electronic Watermarking in Distribution Management; Proceedings of 2008 Fall Conference of Japan Society for Management Information, B1-3 (2008) (November, 2008)

[341] N. Hirabayashi, T. Matayoshi, M. Morita, S. Suzuki, R. Yozu, Y. Tomizawa, H. Aoki and K. Itoh: Comparison of Eyeball Moves during Operation of Heart-Lung Machine and Gaze Transition; The 46th Conference of Japanese Society for Artificial Organs, S-138 (2008).

[342] S. Ho and J. Iijima: Evaluation of Website Contents Based on Operation; Proceedings of 2004 Fall Conference of Japan Society for Management Information, 291-294 (2004).

[343] S. Ho and J. Iijima: A Study on Quantitative Evaluation of Information Space on Website; Proceedings of the 49th Conference of Office Automation Society, 71-74 (2004).

[344] S. Ho and J. Iijima: Development Stages of Information Portal Type WIS - Primarily from the Case of Local Government Website; Proceedings of the 48th Conference of Office Automation Society, 189-192 (2004).

[345] M. Hobo and C. Watanabe: Resonant Double Spiral Trajectory Induced by Self-Propagation Function of ERP; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 763-766 (2004).

[346] Y. Horio, C. Watanabe and R. Tsujimoto: Strategic Standardization in View of Worldwide Bio Auto Fuel Markets; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 819-822 (2006).

[347] Y. Horio and C. Watanabe: Analysis of Factors for Increased Energy Efficiency in Japan and China Utilizing Industrial Input-Output Analysis; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[348] Y. Horio and C. Watanabe: Empirical Analysis of Paradox of Servicized Economy - Pan-Asian Induction of Energy Demand Corresponding to Overseas Transfer of Japanese Manufacturing Bases; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM.

[349] J. Iijima: Characteristics of Companies Where CIOs Are in Position; Fall Conference of Japan Society for Management Information, (2006).

[350] J. Iijima and Y. Kitayama: Sophistication of BPM through Mobile Phone - Case of Asai Group; 2007 Fall Conference of Japan Society for Management Information, (2007) (November 17, 2007).

[351] Y. Shono, W. Ogata and K. Higa: A Discussion of Security Threats for Telework; Proceedings of 2008 Conference of Japan Telework Society, 57-61 (2008).

[352] M. Ikeshoji and T. Enkawa: Analysis of Effects of Psychological Perception of Business Conditions on Customer Satisfaction; Proceedings of the 77th Conference of Japanese Society for Quality Control, 79-82 (2005).

[353] Y. Inoue and K. Miyazaki: Interactions between Technology and Market - Case of Diffusion of Solar Power Generation, Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 57-60 (2006).

[354] Y. Inoue and K. Miyazaki: Innovation of Renewable Energies and Its Diffusion; Proceedings of the 2007 Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM.

[355] Ishii and Muraki: A Study on Human Resources Planning for Requirement Definition Management; Proceedings of 2008 Spring Conference of Japan Industrial Management Association, D03, (2008).

[356] A. Itoh and K. Higa: Searching System for Distributed Databases Based on Multi-Agent Technology; Proceedings of 2004 Conference of Japan Telework Society, 79-84 (2004).

[357] K. Itoh, H.B. Andersen and T. Abe: International Comparison of Safety Culture in Healthcare and Effects by Organizational Attributes of Domestic Hospitals; Proceedings of the 4th Conference of Japan Healthcare Management Association, 23-23 (2004).

[358] K. Itoh, I. Ichikawa and M. Suzuki: Anticipation, on the Part of Patients Who Encountered Medical Errors, about Doctors' Explanations and Apologies; Proceedings of the 43th Conference of Japan Society for Healthcare Association, 63-63 (2005).

[359] K. Itoh: Ergonomic Approach to Healcare Safety; Proceedings of the 22nd Conference of Japan Society for Therapeutics and Engineering, 92-92 (2006).

[360] K. Itoh: Human Erros and Safety of Medical Devices from the Viewpoint of Ergonomics; Proceedings of the 82nd Conference of Japanese Society of Medical Instrumentation, pp.40-41, 2007 (*Medical Instrumentation 77*, No. 4, pp.210-211, 2007).

[361] T. Kaneko and C. Watanabe: Analysis of Conditions for Maintaining Competitiveness in Changes of Inter-Company Relationship Due to Open Information; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 169-172 (2006).

[362] K. Kanegae and K. Higa: Investigation on Incubation Facilities for Teleworking Organizations; Proceedings of 2004 Conference of Japan Telework Society, 16-20 (2004).

[363] K. Kanagae and K. Higa: Current Status and Prospects of Japanese Electronic National and Local Governments Viewed from Cases in Developed Countries; Proceedings of the 7th Conference of Japan Telework Society, 81-84 (2005) (July, 2005).

[364] Y. Kanamaru, Y. Nakahara, H. Endo, X. Lu, K. Mori: Analysis of Autonomous Community Composition Technology for Enhancing Quality of Information Services; Proceedings of the 21st Workshop of Assurance System Committee, 40-45 (2007).

[365] M. Kanno and C. Watanabe: Analysis of Co-Evolutionary Dynamism between Mobile Phone Industry and Other Electronics Industries; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM.

[366] A. Kato and D.B. Tsao: Model Analysis of SCM Logistics Performance - Analysis of Data on Chinese Manufacturing and Logistics Industries; 2007 Spring Conference, 10-11 (2007).

[367] K. Kato and M. Miyakawa: K. Kato and M. Miyakawa: Mantel-Haenszel Test in Dependent Multiple 2×2 Cross Tables, Proceedings of 2006 Conference of Statistics-Related Academic Associations (2006).

[368] R. Kato and C. Watanabe: Spillover Effect of New Energy Technologies; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 672-675 (2005).

[369] J. Kawasaki, M. Muraki and H. Habaki: Ingredient Condensation Plant and Condensation Method, Patent Application 2007-107421 (April 15, 2007).

[370] T. Kimoto: History of Japan Science Council – From the Standpoint of History of Science Research, 2006 53rd Council of

History of Science Society of Japan, Tokyo (2006).

[371] T. Kimoto: Taisho Democracy and RIKEN: SIMOT International Symposium, Tokyo, (February 27 and 28, 2006).

[372] T. Kimoto: Development of Computer in Japan and the Related Patents; China-Japan Intellectual Property Symposium, Tokyo (February 19, 2007).

[373] T. Kimoto: Technology Development of Chisso and Structure of Social Institution; SIMOT International Symposium, Tokyo Institute of Technology (2008) (February, 2008).

[374] T. Kimoto: For Methodologies of History Technology in Japan; History of Technology Sub-Committee, History of Science Society of Japan, Osaka City University (2008) (March 15, 2008).

[375] T. Kimoto: Methodology of History of Technology; Search for Frontiers in Education and Research, Humanities and Social Science Symposium by Tsinghua Univ. - Tokyo Tech Alliance, China (2008) (February 25, 2008).

[376] T. Kimoto: For Methodology of History of Technology, History of Technology Sub-Committee, History of Science Society of Japan (2008) (March, 2008).

[377] T. Kimoto: Required is Building a Perspective of History along Timeline, Annual Conference of History of Science Society of Japan (2008) (May, 2008).

[378] S. Kimura, C.P. Leguizamo and K. Mori: Mobile Agent Recovering Technology for Enhancing Fault Tolerance in Autonomous Distributed Database; the 15th Assurance System Committee, Institute of Electronics, Information and Communication Engineers, 30-37 (2005).

[379] I. Kinoshita and K. Higa: A Study on Introduction of Telework for Solving Management Problems of Japanese Companies; Proceedings of 2006 Conference of Japan Telewrok Society, 9-14 (2006).

[380] K. Kisa and D. Senoo: A Study on Existing Companies' Responses to Innovation - Consideration on Value Network in Music Industry; Institute of Electronics, Information and Communication Engineers, (SWIM2004-6), Vol. 104, No. 131, 39-44 (2004).

[381] M. Kita and C. Watanabe: Reform/Development and New Phase of Diffusion of Technology Innovation - Case of Product Line Strategy of Local Chinese PC Manufacturers; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 473-476 (2004).

[382] M. Kita and C. Watanabe: Analysis of Sophistication Dynamism of Innovation Functions in Development and Diffusion Trajectories of Chinese PCs; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 495-498 (2005).

[383] T. Kitahana, S. Mizuno and K. Nakada: A New Method of Classification Problems via Symmetric Cone Programming; 2006 Spring Conference of Operations Research Society of Japan (2006).

[384] T. Kitahana, S. Mizuno and K. Nakata: A New Method for Multiple Classification Problems; Conference on RIMS Research "Modeling and Theory of Optimization," Research Institute for Mathematical Sciences (2006).

[385] T. Kitahana, S. Mizuno and K. Nakata: An Analysis of Minimax Methods Using Convex Set for Classification Rules; Grant-in-Aid for Scientific Research Symposium on "Research and Development of New IT Model for Financial Risk Management, Tokyo Institute of Technology (2006).

[386] T. Kitahana, S. Mizuno and K. Nakata: A Classification Rules Using Minimax Models; Special Session "New Solution of Linear Programming Problems, Research Workshop "Optimization: Modeling and Algorithm," Research Institute for Mathematical Sciences (2007).

[387] T. Kitahana, S. Mizuno and K. Nakata: An Analysis of Minimax Classification Rules; 2007 Spring Conference of Operations Research Society of Japan (2007).

[388] N. Kitamura and M. Miyakawa: Assignment of Six-Level Factors to L36 Orthogonal Array; Proceedings of 2006 Conference of Statistics-Related Academic Associations (2006).

[389] H. Kim and C. Watanabe, Financial Crisis as a Springboard for Korean ICT Advancement; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 797-800 (2005).

[390] K. Kera and K. Mori: Step-Wise System Building Technology Based on Evaluation of Assurance Ability; Proceedings of the 12th Assurance System Committee, 12-21 (2004).

[391] T. Kozaki, S. Mizuno and K. Nakata: Primal-Dual Interior-Point Method for Piecewise-Linear Convex Programming; 2006 Fall Conference of Operations Research Society of Japan (2006).

[392] Y. Kojima and D.B. Tsao: Steel Scheduling Optimization Model and Its Solution Method; Proceedings of Scheduling Symposium, 95-100 (2008).

[393] S. Kotake and H. Umemuro: Development of E-learning Environment Inducing Flow; The Japan Journal of Ergonomics, Vol. 41 (supplement), 302-303 (2005).

[394] M. Kotani and J. Iijima: Portfolio Management Framework to Align Enterprise Application Software Assets to Business Strategy; Proceedings of 2004 Fall Conference of Japan Society for Management Information, 442-445 (2004).

[395] M. Kotani and J. Iijima: Alignment Mechanism for IT Investment to Generate Higher Company Performance; Proceedings of 2005 Fall Conference of Japan Society for Management Information, S31-S34 (2005).

[396] M. Kotani and J. Iijima: IT Portfolio Management Framework to Select Projects by Real Option; Proceedings of 2007 Spring Conference of Japan Society for Management Information (2007) (June, 2007).

[397] H. Koterazawa and H. Umemuro: Relationships between Changes in Computer Attitudes, Cognitive Abilities, and Technology Usage among Elderly; The Japan Journal of Ergonomics, Vol. 41 (supplement), 112-113 (2005).

[398] T. Kumano and K. Higa: Use of Telework for Nutrition Management System Utilizing Mobile Phones with Camera Function; Proceedings of 2006 Conference of Japan Telework Society, 15-20 (2006).

[399] T. Kumano and K. Higa: A Study on Corporate Strategy Where Telerwork Works and Its Societal Effects; Proceedings of 2007 Conference of Japan Telework Society, 22-27 (2007) (June, 2007).

[400] K. Kumano and K. Higa: Lessons Learnt about Telework Management from the Case of Apollo 13; Proceedings of 2008 Conference of Japan Telework Society, 14-19 (2008).

[401] K. Kumano and K. Higa: Creating the Diet Management System Based on Telework; Proceedings of the 3rd Global Conference of the Alliance for Healthy Cities, 159-162 (2008).

[402] T. Kuroda, M. Miyakawa and K. Tanaka: Formulation of Intervention to Arrows in Causal Diagram and Its Applications, Proceedings of 2006 Conference of Statistics-Related Academic Associations (2006).

[403] T. Kuroda, M. Miyakawa and K. Tanaka: Formulation of Intervention to Arrows in Causal Diagram and Its Applications, Proceedings of 2007 Conference of Statistics-Related Academic Associations (2007).

[404] T. Kyuwa and C. Watanabe: Externaization of Innovation and Enterprises as Integrator; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management (2007) CD-ROM.

[405] S. Machitani and T. Saiki: Analysis of Patent Application Regarding Food for Specified Health Uses; Proceedings-I of the 20th Conference of Japan Society for Science Policy and Research Management, 435-438 (2005).

[406] K. Mainichi and Y. Tanaka: A Study on Patent Law Clause 104-3 in Patent Infringement Lawsuit and Corrective Judgment; 10th Conference of Japan Society of Kansei Engineering.

[407] M. Mamoto, T. Noguchi and D. Senoo: Effects of Visualizatin of Work Processes on Knowledge and Organizational Behavior Management; Proceedings of 2004 Fall Conference of Japan Society for Management Information, 254-257 (2004).

[408] T. Masuishi, K. Shibata, Y. Oki and K. Mori: Technology to Evaluate Assurance Ability for Autonomous Load Following System; Proceedings of the 18th Conference of Assurance System Committee, 28-34 (2006).

[409] K. Masuda and C. Watanabe: Elucidation of Dynamism of Japanese System of Management of Technology - Comparative Empirical Analysis of Institutions in Japan and China; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 278-281 (2004).

[410] K. Masuda and C. Watanabe: International Comparative Analysis of Effects of Institutional Structure on Environment for Creating Venture Businesses; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 69-72 (2005).

[411] K. Masuda and C. Watanabe: Elucidation of New Functionality Development System in the Second Phase of Internet; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 646-649 (2006)

[412] R. Matsui and D. Senoo; Visualization of Knowledge Structure of Large Scale Document Group by Text Mining and Network Analysis; 2008 Fall Conference of Japan Society for Management Information.

[413] K. Matsumoto and Y. Tanaka: HIV/AIDS Problems and System to bestow Incentives for New Pharmaceutical R&D; 10th Conference of Japan Society of Kansei Engineering.

[414] K. Matsumoto and K. Higa: Model for Establishing Trust and Value in e-Commerce; Proceedings of 2007 Spring Conference of Japan Society for Management Information, 310-313 (2007).

[415] Y. Matsuzaki, H. Umemuro and Y. Ishikawa: Usability Study of Investment Fund E-commerce Sitts for Older Users; Proceedings of the 4th Annual Meeting of Japan Academic Society of Direct Marketing, 10-12 (2005).

[416] M. Mitsuda and C. Watanabe: Investors and Investees in Servicized Economy - Co-Evolutionary Effects of Business Support Regarding Recognition and Market Occupancy; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 421-424 (2004).

[417] M. Mitsuda and C. Watanabe: Potential Technological Element Base in Servicezed Economy - Comparison with Structural Model Leading to Business Success; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 787-790 (2004).

[418] M. Mitsuda and C. Watanabe: Analysis of Leadership as Internal Factors for Venture Business Management - Investigation of R&D Industry-Academy Collaborative Work Cluster Members; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 188-191 (2005).

[419] M. Mitsuda and C. Watanabe: A Study on Conditions for Continuity of Business - Co-Evolution between Corporations and Market Embedded in Mobile Terminal; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 585-588 (2006).

[420] M. Mitsuda and C. Watanabe: Analysis of Diffusion and Penetration of Scientific Experience to Connect Science Literacy and Innovation; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[421] M. Miyakawa: Likelihood Ratio Test For Equality of Odds Ratios between Dependent Contingency Tables and Increased Precision with Dependent Samples: Equality of Odds Ratio Test of 2 x 2 x K Cross Tables and It's Application; Proceedings of the 27th Symposium of Japanese Society of Applied Statistics, 33－42 82005).

[422] M. Miyakawa and T. Kuroda: Intervention Effects on Variable and Arrow in Causal Diagram; Proceedings of the 75th Anniversary Conference of Japan Statistical Society (2006).

[423] M. Miyakawa and K. Tanaka: Testing Homogeneity of SN Ratios from Matched Quantitative Response with Binary Signal, Proceedings of the 28th Symposium of Japanese Society of Applied Statistics (2006).

[424] M. Miyakawa, K. Tanaka and T. Miura: Detection of Point of Change by Using Independent Component Analysis; Proceedings of the 36th Conference of Japanese Society for Quality Control (2006).

[425] K. Miyazaki: Globalization and Networking of R&D and Industry-Academy Collaboration, Conference of Kansai Chapter of Japan Society for Science Policy and Research Management (June, 2004).

[426] K. Miyazaki and Wiggers: Analysis of Innovation in Communication Services; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 296-299 (2005).

[427] K. Miyazaki and D. Kusunoki: Industry-Academia Linkages Based on the Knowledge Incentive Model; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 692-695 (2006).

[428] S. Mizuno: Optimization Problems and Internal Point Method; 3rd SIMOT Annual Symposium "Elucidation of Co-Evolutionary Dynamism between Innovation and Institution", Tokyo Institute of Technology (2007).

[429] S. Mizuno: Primal-Dual Interior-Point Mehtod for Linear Programming; Special Session "New Methods for Solving Linear Programming Problems, Research Workshop "Optimization: Modeling and Algorithm", Institute of Statistical Mathematics (2007).

[430] K. Mori: Significance of Education of Management of Technology and Its Development at Tokyo Institute of Technology; Proceedings of Engineers Forum of Institution of Professional Engineers, Japan, 1-2 (2004).

[431] K. Mori: Assurance Technology and Its Development; Special Lecture, Fall 17th Reliability Symposium of Reliability Engineering Association of Japan (2004).

[432] K. Moriyama and C. Watanabe: Elucidation of Japanese System of Management of Technology - Comparative Empirical Analysis of Institutions in Japan and New Zealand; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 262-265 (2004).

[433] K. Moriyama and C. Watanabe: Analysis of Relationship between Entrepreneurship and Institution; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 65-68 (2005).

[434] K. Moriyama and C. Watanabe: Analysis of Bipolarization of Profitability of Japanese Companies - Substitution and Complimentary Relationship between R&D Input and Output; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 276-279 (2006).

[435] K. Moriyama and C. Watanabe: R&D and Profitability - R&D As Disturbing Factor for Bringing Profitability Gap; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM.

[436] S. Murakami, S. Kimura, X. Lu and K. Mori: Autonomous Competition Avoidance Technology Utilizing Substitution Service in Distributed Database; Proceedings of the 20th Assurance System Conference, 33-40 (2007).

[437] Y. Muraoka and C. Watanabe: Co-Evolutionary Mechanism between Open Source Software and Internet - Management of Innovation by Collective Wisdom of Many and Unspecified,

Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[438] K. Nagata: Apparent Growth by Earnings Management and Pricing; Proceedings of the 65th Conference of Japan Accounting Research Association, 177 (2006).

[439] K. Nagata and T. Hachiya: Earnings Management Behavior of IPO Firms and Stock Return; Proceedings of the 29th Conference of Japan Finance Association, 64-65 (2005).

[440] R. Nakai and C. Watanabe: A Study on Impacts of Intellectual Capital on Outputs Such As Productivity - Empirical Analysis of Japanese Electrical Machinery Industry; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 286-289 (2004).

[441] R. Nakai and C. Watanabe: Analysis of Institution of Japanese Aerospace Industry; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 984-987 (2005).

[442] Y. Nakai and Y. Tanaka: Decision Making for Promoting Software Industry in Inland Area of China; 10th Conference of Japan Society of Kansei Engineering.

[443] T. Nakagawa, X. Lu and K. Mori: Autonomous Cooperation Technology for Quality Assurance in Autonomous Film Distribution System; Proceedings of Assurance System Committee, 1-8 (2008).

[444] M. Nakagawa and C. Watanabe: Management of Technology in Information Society and Organizational Inertia - Analysis of Epidemic Manufacturers; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 147-150 (2004).

[445] M. Nakagawa and C. Watanabe: Organizational Inertia and Inter-Business Spillover in Technology Innovation Strategy in Era of Paradigm Change As Seen in Non-Ferrite Metal Industry; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 1053-1058 (2005).

[446] N. Nakagawa and C. Watanabe: Technology Innovation Strategy in Japanese Non-Ferrite Metal Industry in Era of Paradigm Change - Intra-Company Spillover and Its Effect; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 415-418 (2006).

[447] M. Nakagawa and C. Watanabe: Paradigm Change and Structural Change of Material Technology Innovation - Suggestion to Management of Technology Strategy of Material Industry towards Post-Information Society; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[448] M. Nakagawa and C. Watanabe: Structural Change of Technology Spillover Reflecting Paradigm Change - Interactive Induction of Intra-Company/Intra-Technology Spillover and Inter-Company /Inter-Technology Spillover; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM

[449] H. Nakamura and K. Higa: A Study on Communication Infrastructure Network Contributing to Regional Promotion - Empirical Experiment of IP Phone in Closed Network; Proceedings of 2006 Conference of Japan Telework Society, 46-49 (2006).

[450] T. Nakamura and C. Watanabe: Analysis of Institutional Structures of Leading Companies in Japan and the US; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 13-16 (2005).

[451] H. Nakanishi and K. Higa: Issues on Administration Outsourcing to Realize Vitalization of Local Economy: an Interview-based Investigation in Kochi; Proceedings of 2007 Conference of Japan Telework Society, 85-89 (2007).

[452] Y. Nakatogawa, Y. Jiang, M. Kanda, X. Lu and K. Mori: Autonomous Disorder Recovery Technology for Enhanced Fault Tolerance in Distributed VOD; Proceedings of 17th Assurance System Committee of Institute of Electronics, Information and Communication Engineers, 26-33 (2006).

[453] Y. Nanba and J. Iijima: Evaluation of Introduction of ERP to Corporate Information System Based on City Planning Approach; Proceedings of 2004 Spring Conference of Japan Society of Management Information, 98-101 (2004).

[454] T. Noguchi, T. Inagaki, M. Mamoto, M. Miura and D. Senoo: A Study on Method to Evaluate Knowledge Creation in Organizations; Proceedings of 2004 Fall Conference of Japan Society of Management Information, 258-261 (2004).

[455] S. Nomura and C. Watanabe: A Study on Corporate Strategy through Innovation in Japanese Corporations; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[456] M. Ogikubo, M. Ikeshoji and T. Enkawa: International Comparative Analysis of Structure of Customer Satisfaction on a National Level; Proceedings of the 80th Conference of Japanese Society for Quality Control, 43-46（2006）.

[457] M. Ogikubo and T. Enkawa: A Study on Expectation Level of Consumers and Changes in Product Concepts; Proceedings of the 36th Conference of Japanese Society for Quality Control, 59-62 (2006).

[458] Y. Okimoto, T. Tomita and H. Umemuro: Quantification of Factors that Determine Impressions of Human Faces; The Japan Journal of Ergonomics, Vol. 41 (supplement), 262-263 (2005).

[459] Y. Okimoto and H. Umemuro: The Implementation of the Moderate Supporting System for Divergent Thinking by Showing Images Continually with Text-based Genetic Algorithm; Proceedings of Interaction 2007, Tokyo (2007) DVD-ROM.

[460] K. Ohashi, A. Shiibashi and K. Mori: Method to Evaluate Functional Reliability in Wired/Wireless Integrated IC Card Ticket System - Application to Autonomous Distributed Suica Ticket System; Proceedings of the 17th Assurance System Workshop of Institute of Electronics, Information and Communication Engineers, 5-12 (2006).

[461] K. Ohashi, A. Shiihashi and K. Mori: Method to Evaluate Functional Reliability in Wired/Wireless Integrated IC Card Ticketing System – Application to Autonomous Distributed Suica Ticketing System; Proceedings of the 17th Assurance System Workshop, 5-12 (2005).

[462] A. Omura and C. Watanabe: Empirical Analysis of Technology Spillover in Fine Ceramics Structural Material; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 759-762 (2004).

[463] A. Omura and C. Watanabe: Empirical Analysis of Spillover Dynamism towards Realization of High Performance of High-Intensity Fine Ceramics - Suggestion to Growth Trajectory for Developing New Functionality; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 360-363 (2005).

[464] Y. Osawa and K. Miyazaki: Analysis of Performance of a Company up to Commercialization of R&D Project; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 565-568 (2005).

[465] Y. Osawa and K. Miyazaki: Analysis of Performance of a Company up to Commercialization of Large-Scale R&D Project; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 385-388 (2006).

[466] M. Ota and C. Watanbe: Comparative Empirical Analysis of Institutional Structures towards CO2 Reduction in Leading Coutiries That Ratified Kyoto Protocol; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008）CD-ROM.

[467] T. Otsuka and D.B. Tsao: Case of LCA Computation of Electrical Home Appliances; Proceedings of 2008 Fall Conference of Japan Industrial Management Association, 82-83 (2008).

[468] S. Otsuka and C. Watanabe: Analysis of Changes in

Efficiency-Enhancing Structure of R&D Corresponding to Open Innovation; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM.

[469] N. Ouchi and C. Watanabe: New Functionality Development Mechanism for Attaining Sustainable High Profitability beyond Paradigm Shift - Empirical Analysis of Electrical Machinery Industry; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 581-584 (2006).

[470] N. Ouchi and C. Watanabe: Vicious Cycle Mechanism Enabling High Profitability of Canon - Structural Analysis by System Dynamics; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[471] J. Wang and Y. Tanaka: Research on comparison of Japan and Europe in Firm's patent application action - Selection and Concentration Strategy of Patent Application; The 10th Annual Meeting of the Japan Society of Kansei Engineering (2008).

[472] S. Lei and C. Watanabe: Analysis of Effects of Technological Competing Power on New Functionality Development and Diffusion - Empirical Analysis of Canon Printer and Japanese PCs; Proceedings of the 19th Conference of Japan Society for Science Policy and Research Management, 242-245 (2004).

[473] S. Lei and C. Watanabe: Analysis of Co-Evolutionary Dynamism between Market Structure, Technological Innovation and Institution, Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 487-490 (2005).

[474] Y. Liu and C. Watanabe: Boundary and Essential Difference between Non-Profit Organization and Profit Organization; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM.

[475] T. Saiki: On Case of Patent Management in Pharmaceutical Area; Proceedings of the 2nd Conference of Intellectual Property Association of Japan, 316-317 (2004).

[476] T. Saiki: Patent Application Activities in Bio Ventures; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, 432-435 (2007).

[477] T. Saito, Y. Kanamaru, X. Lu and K. Mori: Technology Regarding Community Autonomous Building System for Quality Enhancement in Information Service System; Proceedings of the 22nd Assurance System Workshop, 26-31 (2007).

[478] Y. Saito and D.B. Tsao: A Study on Customer Behavior Utilizing QG/EP Model; Proceedings of 2007 Fall Conference of Japan Industrial Management Association, 164－165 (2007).

[479] A. Saitou and K. Miyazaki: Development of a Indicator to Assess the Progress of R&D; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, 710-713 (2008).

[480] T. Sanada and C. Watanabe: Basic Study on Effects of R&D Investment on Patent Application- Looking at Structural Change by Pro-Patent Policy; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[481] T. Sanada and C. Watanabe: Analysis of Patent Application Brought by R&D and Knowledge Spillover; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, (2008) CD-ROM

[482] D. Senoo: Effects of Work Place Reform on Creation of Intellectual Properties, Proceedings of the 3rd Annual Conference of Intellectual Property Association of Japan, 78-83 (2005).

[483] D. Senoo and K. Suzuki: A Study on Complimentary Relationship between IT Utilization and Organizational Characteristics, Proceedings of 2005 Fall Conference of Japan Society for Management Information, S34-S37 (2005).

[484] D. Senoo: Transdisciplinary Approach to Visualization of Social Problems; Proceedings of the 1st Symposium of Transdisciplinary Federation of Science and Technology, 33-34 (2006).

[485] D. Senoo: Knowledge Management and Human Resource Development; Proceedings of the 22nd Conference of Japan Society for Educational Technology, 19-20 (2006).

[486] D. Senoo: Corporate Strategy and Succession of Knowledge; Proceedings of Tokyo Tech Grant-in-Aid Symposium "R&D of New IT Model for Financial Risk Management, 273 (2006).

[487] D. Senoo: A Study on Impacts of Drastic Review of Organization/Work system on IT Productivity; Proceedings of 2006 Fall Conference of Japan Society for Management Information, 328-329 (2006).

[488] D. Senoo: State and Effect of Visualization of Technology for Application Possibility Exploration; How is Technology Explained?; Proceedings of the 1st Symposium of Transdisciplinary Federation of Science and Technology, 41-44 (2006).

[489] D. Senoo: Work Place and Institution; Proceedings of The 4th Annual Symposium on The Science of Institutional Management of Technology, 353-363 (2008).

[490] A. Shiihashi, M. Yamana and K. Mori: Multi-Stage Data Integration Technology in IC Card Ticket System: Proceedings of the 20th Assurance System Workshop, 1-8 (2007).

[491] J. Shing and C. Watanabe: Dynamic Interaction between Diffusion Process and Learning Effect of Plasma TVs between Japan, Korea and Taiwan's Companies; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 638-641 (2006).

[492] J. Shing and C. Watanabe: Transition Dynamism in Web 2.0: Emerging Dynamism of New Functionality, Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[493] K. Shijo and C. Watanabe: Empirical Analysis of Diffusion Trajectory by Japanese Technological Products; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 356-359 (2005).

[494] K. Shinjo and C. Watanabe: Changes in Vicious Cycle Mechanism in Japanese Automobile Technology Market - Comparative Analysis Between 1990's and Early 2000's; Proceedings of the 21st Conference of Japan Society for Science Policy and Research Management, 284-287 (2006).

[495] K. Shinjo and C. Watanabe: Analysis of Mechanism of Effects of R&D Investment on Productivity in Recent Years; Proceedings of the 22nd Conference of Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[496] N. Shiraishi and J. Iijima: Strategic Relationship between Communication Service Suppliers and Business Process; Proceedings of 2004 Fall Conference of Japan Society for Management Information, 315-318 (2004).

[497] N. Shiraishi and J. Iijima: Analytical Framework for Inter-Company Relationship Based on Business Processes; Proceedings of 2008 Spring Conference of Japan Society for Management Information, F3-1 (2008) (June, 2008).

[498] S. Chung: Distribution Strategy of Leading Foods Manufacturers in China; Journal of Distribution Economics Institute, 3 (2007).(2007 Conference of Distribution Economics Institute).

[499] S. Chung: Tourist Spot Brand Building for Foreign Tourists - Case of Attraction of Taiwanese Tourists to Hokkaido and Tateyama Kurobe; Proceedings of December Workshop of Research Committee of Commerce (2007).

[500] D. Tsao: A Study on Optimal Traveling Distance Evaluation Method Using Core Distance; Proceedings of Fall Conference of Japan Industrial Management Association, 182-183 (2004) (Kanazawa, Japan, October, 2004).

[501] I. Sou and Y. Tanaka: Comparison of Patent Attorney System in Taiwan and Japan; 10th Conference of Japan Society of Kansei Engineering.

[502] M. Sorakubo and H. Umemuro: Two-nearly: Moderate transmission of awareness for families apart; Proceedings of the

2nd Conference of Japan Chapter of International Society for Gerontechnology, 13-16 (2007).

[503] S. Suzuki and T. Enkawa: Research on the International Comparison between Enterprises with SCM Logistics Score Card; Proceedings of the Fall Meeting of the Japan Industrial Management Association 2005, 140-143 (2005).

[504] S. Suzuki, B. Huang and T. Enkawa: Research on the Current State and Problems of SCM in Chinese enterprise;

[505] S. Suzuki, T. Yoshida, T. Aoki M. Mineshima, T. Akiba and K. Itoh: Analysis of Learning Process to Dialysis Circuit Setting Based on the Ocular Motility and the Operation Analysis; Proceedings of the 46th Annual Meeting of the Japanese Society for Artificial Organs, S-153, 2008.

[506] T. Takahashi and T. Saiki: Analysis of Patent related to Carbon Nanotubes by TIRZ; Proceedings of the 3rd Meeting of the Intellectual Property Association of Japan, 338-341 (2005).

[507] T. Takahashi and T. Saiki: Analysis of Combining Knowledge that Exists Inside Patented Invention - the Case of Photocatalyst Titania and Hard Disk Technology; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 891-894 (2005).

[508] T. Takahashi and T. Saiki: Analysis of Newly Combining Knowledge Focusing on Patented Invention;

[509] H. Takahashi and C. Watanabe: Mass Customization and Cooperation to ubiquitous service - Focusing on Traceability; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 143-146 (2004).

[510] H. Takahashi and C. Watanabe: Problem of Organizational Structure for Information Society - the Necessity of the Japanese Type Service Science; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 276-279 (2005).

[511] H. Takahashi and C. Watanabe: Approval of Safety Model of Food and Adjustment to the New Business Environment; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 633-636 (2006).

[512] K. Takashima and H. Umemuro: Sharing of Television: Communications Activation by Formation of the Common Topic between Families; Proceedings of the 2nd Meeting of the International Society for Gerontechnology Japan Chapter, 17-20 (2007).

[513] Y. Takeno and Y. Tanaka: Research of Relation between Intellectual Property Strategy and Business Strategy Focusing on BSC

[514] M. Takeshita and C. Watanabe: Effect of Immunity in Japanese Type Management System; Proceedings of the 19th Annual Meeting of theThe Japan Society for Science Policy and Research Management, 246-249 (2004).

[515] M. Takeshita and C. Watanabe: Analysis on Regeriens Structure in a Japanese Enterprise; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 851-854 (2005).

[516] M. Takeshita and C. Watanabe: Growth Potential Analysis of Firm's Size and Structure of Profit Focusing on Food Industry; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 304-307 (2006).

[517] E. Tanaka and C. Watanabe: Elucidation of the Dynamism of Japanese Type Management of Technology System - Comparison Analyses of Institution between Japan and Australia; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 258-261 (2004).

[518] K. Tanaka and Y. Tanaka: Extraction of the Problem of the Venture Capital Start from Tokyo-Tech; The 10th Annual Meeting of the Japan Society of Kansei Engineering (2008).

[519] J. Tanaka and T. Saiki: Analysis of Intellectual Property Management in Small and Medium-sized Enterprise; Proceedings of the 4th Annual Meeting of the Intellectual Property Association of Japan, 244-247 (2006).

[520] C. Tanaka and C. Watanabe: Comparison Analysis in effect of M&A of Japan and the US; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 1176-1179 (2006).

[521] C. Tanaka and C. Watanabe: Elucidation of Dynamism of Japanese Type Management of Technology System - Comparison Analyses of Institution between Japan and Europe; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 270-273 (2004).

[522] Y. Tanaka: Proposal to Asian Countries led from History of Patent System and Application Number Use in Japan; World Intellectual Property Organization Asia-Pacific Regional Symposium 2005, (2005).

[523] Y. Tanaka, S. Yonekawa and M. Noguchi: Research on Relation between Intellectual Property Section and Other Business Segment on Management of Company; The 8th Meeting of the Japan Society of Kansei Engineering (2006).

[524] Y. Tanaka: Institutional Background Structure of Unutilized Patent; Proceedings of the 5th Annual Symposium of Science of Institutional Management of Technology (2009).

[525] Y. Tanaka: Research on the Reasons of Unutilized Patents; The 10th Annual Meeting of the Japan Society of Kansei Engineering (2008).

[526] A. Tani and T. Saiki: Comparison analysis of protected period in patent of medicine between Japan and the US; Proceedings of the 4th Meeting of the Intellectual Property Association of Japan, 76-79 (2006).

[527] T. Tanigawa and K. Higa: Proposal of Methodology for Measure of Teleworking and Analysis of its Effect; Proceedings of the Annual Autumn Meeting of the Japan Society for Management Information 2006, 80-383 (2006).

[528] T. Tanigawa and K. Higa: Proposal for Practical Use of Teleworking Introduction Evaluation Method

[529] S. Tanisawa and C. Watanabe: Complexity of Research and Development Investment; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 417-420 (2004).

[530] S. Tanisawa and C. Watanabe: Analysis of Innovation and Catch-up by using Malmukist index - Empirical Analysis Focusing on Electric Machinery Industry; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 364-367 (2005).

[531] S. Tanisawa and C. Watanabe: Analysis of Firm's Productivity - Empirical Analysis Focusing on Electric Machinery Industry; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 654-657 (2006).

[532] Y. Tou and C. Watanabe: Elucidation of Dynamism of Japanese type Management of Technology System - Deepen of Quality of R&D and Market Sensitivity of Technology; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 234-237 (2004).

[533] Y. Tokita, S. Suzuki and De-bi.Tsao: Dynamic Characteristic Analysis in Reverse Logistics; Proceedings of the Fall Meeting of the Japan Industrial Management Association 2005, 156-157 (2005).

[534] Y. Tomita and C. Watanabe: Analysis of Competing Resource Procurement System under the Structure Change of Capitalism; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 1116-1119 (2006).

[535] Y. Tomita and C. Watanabe: Empirical Analyses of Influence of Profitability of Financial Market to R&D Activity on Manufacturing Industry; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[536] Y. Tomita and C. Watanabe: Empirical Analysis of Productivity in Japanese Iron Industry under the Global Mega-Competition; Proceedings of the 23rd Annual Meeting of the Japan Society for Science Policy and Research Management（2008）CD-ROM

[537] H. Umemuro: Usability, Fun, and Aesthetics: Towards technology that is Loved by Older Users; Proceedings of the 1st Annual Meeting of International Society for Gerontechnology Japan Chapter 2006, 17-18 (2006).

[538] V. Jutatip and Y. Tanaka: Support of Intellectual Property Right of Design - When the Design Commodity of Thailand is Exported to Japan; The 10th Annual Meeting of the Japan Society of Kansei Engineering (2008).

[539] C. Watanabe: Dynamism of Japanese type management of technology system - Verification Age Analysis on Co-evolution Dynamism between Innovation Development Cycle and Institution; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 226-229 (2004).

[540] C. Watanabe: Approach to Establishment of institutional management of technology - Elucidation of Co-evolution Dynamism between Innovation and Institution; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 312-315 (2005).

[541] C. Watanabe and M. Hobo: Serving Initiate Manufacturing System - Business Model of Manufacturing for Ubiquitous Society; Proceedings of the 7th Annual Symposium of Research into Artifacts, Center for Engineering (2005).

[542] C. Watanabe: Comparison Analyses of Co-evolution Dynamism between Manufacturing Technology and IT and Competitiveness in Major Countries; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 642-645 (2006).

[543] C. Watanabe: Hybrid Management of Technology - Co-evolutionary Dynamism between Industrial Technology and embodying IT's Self-propergating Structure; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management (2007) CD-ROM.

[544] C. Watanabe: Post Information Society - New Paradigm by "The third mediation"; Proceedings of the 23rd Annual Meeting of theThe Japan Society for Science Policy and Research Management（2008）CD-ROM

[545] M. Yamazaki: Jiang Jieshi's Nuclear Power Program - 1946; Proceedings of the 54th Annual Meeting of the History of Science Society of Japan (2007).

[546] M. Yamazaki: Progressing of Atomic Energy Policy for Peace in Japan; Proceedings of the 55th Annual Meeting of the History of Science Society of Japan (2008).

[547] A. Yamada and C. Watanabe: Relation between Adjustment of R&D and Institution; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 316-319 (2005).

[548] A. Yamada and C. Watanabe: Dynamic Dynamism of Adjustment, Diversification and Learning under R&D Activity on High-tech Firm; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 876-879 (2006).

[549] A. Yamada and C. Watanabe: Co-evolutinary Dynamism between Diversification and Adjustment under R&D Activity; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management (2007) CD-ROM.

[550] J. Yamda and C. Watanabe: Development Mechanism of Internet Advertisements under Post Information Society; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management (2007) CD-ROM.

[551] J. Yamda and C. Watanabe: Analysis of Co-evolution between Transformation of Firm's Employment System and Labor Market Structure; Proceedings of the 23rd Annual Meeting of the Japan Society for Science Policy and Research Management (2008) CD-ROM

[552] S. Yamauchi and C. Watanabe: Co-evolutionary Dynamism between Institution and Management of Technology in Chemical Industry Firms in Japan; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 238-241 (2004).

[553] S. Yamauchi and C. Watanabe: Co-evolutionary Dynamism between Institution and Management of Technology in Chemical Industry Firms in Japan; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 855-858 (2005).

[554] S. Yamauchi and C. Watanabe: Bi-polarization of Competitiveness of the Japan's Chemical Industry Firms - Co-evolutionary Dynamism between Institution and Management of Technology; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 724-727 (2006).

[555] S. Yamauchi and C. Watanabe: Co-evolutionary Dynamism of Institution and Chemical Industry Firms - Focusing on IN-OUT M&A; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management, (2007) CD-ROM.

[556] S. Yamauchi and C. Watanabe: R&D Spillover in Petrochemical Complex; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 597-600 (2005).

[557] E. Yanagisawa and C. Watanabe: Market Sensitivity to Innovation - Elucidation of Circulating Mechanism by using ARFIMA Model; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 230-233 (2004).

[558] H. Yanagimachi and D. Tsao: Research of the Best Resolution Strategy for Reproduction Process for Multi Period; Scheduling Symposium 2007, 245-247 (2007).

[559] J. Yashikida and H. Umemuro: Package Design Elements Generating User Experiences; The Japan Journal of Ergonomics, Vol. 42 (supplement), 246-247 (2006).

[560] J. Yashikida and H. Umemuro: Close To You: Awareness System to Present Information Suggesting Human Being and Existence with Natural Mapping; Proceedings of Interaction (2008).

[561] J. Yashikida and H. Umemuro: Close To You: Unobtrusive Awareness Communication to Bring Family Living Far Apart Closer; Proceedings of the International Society for Gerontechnology Japan Chapter annual meeting 2008 (2008).

[562] X. Yao and C. Watanabe: Co-evolution Dynamism between Inter-firm Technology Spillover and Resilient Institution in China's ICT Development; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 499-502 (2005).

[563] H. Ying and K. Miyazaki: R&D Strategy of Japanese Firms in China; Proceedings of the 23rd Conference of Japan Society for Science Policy and Research Management, 136-139 (2008).

[564] L. Ying and C. Watanabe: Learning Effects and Sustainable Development Trajectory of BRICs: Empirical Comparative Analysis with Japan, US, Europe and NIEs; Proceedings of the 20th Conference of Japan Society for Science Policy and Research Management, 801-804 (2005).

[565] L. Ying and C. Watanabe: Ability of Technology Catch-up and Institution Structure of BRICs - Comparison Empirical Analyses Focusing on Cellular Phone Technology; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 99-102 (2006).

[566] S. Yokoyama and C. Watanabe: Elucidation of Dynamism of Jaoanese Type Management of Technology - Comparison Empirical Analysis between Japan and UK; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 274-277 (2004).

[567] A. Yoshii and K. Higa: Case Study on Success/Failure of Software Development; Proceedings of 2008 Fall Conference of Japan Society for Management Information (2008).

[568] G. Yoshikawa and C. Watanabe: Research on Corporate Reproduction Innovation - Empirical Study on Lost Decade; Proceedings of the 19th Annual Meeting of the Japan Society for Science Policy and Research Management, 405-408 (2004).

[569] G. Yoshikawa and C. Watanabe: International Comparative Analysis of Corporate Reproduction Innovation - Focusing on Japan and US; Proceedings of the 20th Annual Meeting of the Japan Society for Science Policy and Research Management, 1049-1052 (2005).

[570] G. Yoshikawa and C. Watanabe: Comparative Analysis of Corporate Reproduction Innovation between Japan and US; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 1061-1064 (2006).

[571] G. Yoshikawa and C. Watanabe: Structural Source that Enables Corporate Reproduction Innovation - Comparison of Institution of Transportation machinery Industry between Japan and US; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management (2007) CD-ROM.

[572] S. Yoshimura and K. Higa: Understanding of Information Literacy Based on WEB Access; Proceedings of 2008 Conference of Japan Telework Society, 134-139 (2008).

[573] K. Yoshida, D. Senoo and K. Matsuki: Research of Continuing Community in Exchange Association of Different Type of Business in SME; Proceedings of the Annual Autumn Meeting of the Japana Society for Management Information 2005, 324-327 (2005).

[574] K. Yoshida and J. Iijima: Proposal of Process Definition Method for Architecture Modeling in EA; Proceedings of the Annual Autumn Meeting of the Japana Society for Management Information 2004, 200-203 (2004).

[575] Y. Yoshida and C. Watanabe: Analysis of Efficiency and Risk/Return of Public and Private Organization - New Portfolio Theory answered in New Era; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management (2007) CD-ROM.

[576] W. YU and C. Watanabe: New Stream of Innovation in game software: Change of Innovation, Idea, and Conception for Post Information Society; Proceedings of the 21st Annual Meeting of the Japan Society for Science Policy and Research Management, 61-64 (2006).

[577] W. YU and C. Watanabe: New Stream of Innovation in Games Market: Change of Innovation, Idea, and Conception for Post Information Society; Proceedings of the 22nd Annual Meeting of the Japan Society for Science Policy and Research Management (2007) CD-ROM.

[578] W. YU and C. Watanabe: New Stream of Innovation in Games Market: Change of Innovation, Idea, and Conception for Post Information Society; Proceedings of the 23rd Annual Meeting of the Japan Society for Science Policy and Research Management (2008) CD-ROM.

[579] H. Yuhashi and J. Iijima: Communications Factor to Activate Collaboration of Proposal Type Business; Proceedings of the Annual Autumn Meeting of the Japan Society for Management Information 2008, C3-2 (2008).

5. Awards

[1]	Masami Miyagawa	2004	Japan Society of Quality Control Best Paper Award
[2]	Takao Enkawa	2004	Japan Society of Logistics Award
[3]	Chihiro Watanabe	2004	IAMOT (International Association of Management of Technology) Research Award
[4]	Kunihiko Higa	2004	Japan Association of Information Management Best Paper Award
[5]	Chihiro Watanabe	2005	IAMOT (International Association of Management of Technology) Top 50 Excellent Organization Award
[6]	Chihiro Watanabe	2006	JAMR (Journal of Advances in Management of Technology) Best Paper Award
[7]	Yasutoshi Yajima	2006	26th Excellent Case Analysis Award
[8]	Junichi Iijima	2007	International Federation of Information Processing 2007 Best Paper Award
[9]	Chihiro Watanabe	2008	Minister of Education, Science & Technology Award, Science & Technology Prize
[10]	Chihiro Watanabe	2008	Japan Society for Science Policy and Research Management Most Significant Contributor Award
[11]	Chihiro Watanabe	2008	IAMOT (International Association of Management of Technology) Research Award
[12]	Kumiko Miyazaki	2008	The R&D Management Conference 2008 Best Paper Award

Part IV　Organization of the SIMOT

1. SIMOT Core Member

2. SIMOT Professor

3. SIMOT Assistant Professor, Post-doctoral Fellow

4. SIMOT Young Researchers

5. Organizational Structure of SIMOT Research Center

1. SIMOT Core Member

Dimension I Systems Analysis on the Interacting Mechanism between Market and Technology as a Critical Driving Force of Innovation

	WATANABE, Chihiro ・Professor,Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・Technology Innovation, Ph.D. ・Co-evolutionary analysis		MIYAZAKI, Kumiko ・Professor, Graduate School of Innovation Management ・MOT, Ph.D. ・International comparative analysis
	MIZUNO, Shinji ・Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・Optimization Theory, D. Sci. ・Optimal theory		MIYAKAWA, Masami[1)] ・Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・Applied Statistics, D. Eng. ・Causality model analysis
	YAJIMA, Yasutoshi[2)] ・Associate Professor, Dept. of Ind. Eng. & Mgmt., Graduate School of Decision Science and Technology ・Mathematical Programming, D. Eng. ・Operational analysis for resources of management		

Dimension II Identification of Japan's System of Innovation Cycle

II- a) Japan's System of Innovation Emergence

	ENKAWA, Takao ・Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・Production Management, D. Eng. ・Innovation emergence		MURAKI, Masaaki ・Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・Environmental Management, D. Eng. ・Environmental management
	ITOH, Kenji ・Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・Ergonomics, D. Eng. ・Technology risk		SENOO, Dai ・Associate Professor, Dept. of Ind. Eng. & Mgmt., Graduate School of Decision Science and Technology ・Management Theory, D. Com. ・Knowledge creation

II- b) Inventory Management of Intangible Assets

	TANAKA, Yoshitoshi ・Associate professor, Graduate School of Innovation Management ・Intellectual Property, M. Eng. ・Organizational impeding factor		SAIKI, Tomoko ・Professor, Graduate School of Innovation Management ・Intellectual Property, M. Pharm. ・State of intangible assets utilization
	TSAO, De-bi [3)] ・Professor, Faculty of Science and Technology, Keio University ・Process Management, D. Eng. ・Inventory management analysis		

II- c) Technology Start-up in Japan's Institutional System

	IIJIMA, Junichi ・ Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・ Information Systems, D. Eng. ・ Analysis of information services		HIGA, Kunihiko ・ Professor, Graduate School of Innovation Management ・ Management Information Systems, Ph. D ・ Start-up process
	UMEMURO, Hiroyuki ・ Associate Professor, Dept. of Ind. Eng. & Mgmt., Graduate School of Decision Science and Technology ・ Ergonomics, D. Eng. ・ Products market		MORI, Kinji [4] ・ Professor, Dept. of Computer Science, Graduate School of Information Science and Engineering ・ Computer Science, D. Eng. ・ Technology management framework

Dimension III　Historical Suggestion on the Institution Co-evolving with Innovation

III- a) Management Science Perspective into Social Institution

	HACHIYA, Toyohiko ・ Associate Professor, Dept. of Ind. Eng. & Mgmt., Graduate School of Decision Science and Technology ・ Corporate Finance, Ph.D. ・ Business management analysis		NAGATA, Kyoko ・ Associate Professor, Dept. of Ind. Eng. & Mgmt., Graduate School of Decision Science and Technology ・ Accounting Theory, D. Com ・ Evaluation of intangible assets
	CHUNG, Sulin [5] ・ Associate Professor, Dept. of Ind. Eng. & Mgmt., Graduate School of Decision Science and Technology ・ Marketing, D. Com ・ Sociological analysis		

III- b) Historical Perspective into Social Institution

	KIMOTO, Tadaaki ・ Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・ History of Technology, Ph.D. ・ History of Technology		YAMAZAKI, Masakatsu ・ Professor, Dept. of Ind. Eng. & Mgmt.,Graduate School of Decision Science and Technology ・ History of Science, Dr.Sci. ・ History of Science

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[1] Leave of absence from work (from July 23, 2008)

[2] Organizational changes (March 31, 2008)

[3] Organizational changes (March 31, 2006)

[4] Organizational changes (April, 2007)

[5] Arriving at the member (October 1, 2007)

2. SIMOT Professor

Name	Affiliation
KIKUCHI, Takashi	COE-Dedicated, Tokyo Institute of Technology
HOBO, Masayo	Operating Officer, Oracle Corporation Japan
SAMEJIMA, Masahiro	Attorney at Law, Patent Attorney, Uchida-Samejima Legal Office
ADACHI, Toshiyuki	Associate Senior Vice President, NEC Personal Products, Ltd.
HIRANO, Masaaki	Professor of Information Management, Waseda Business School
Peter Mertens	General Manager, Corporate Technology Dept., Siemens K.K.
YAMADA, Taro	President and Representative Director, Nextech Corporation
Pekka Neittaanmäki	Professor, University of Jyväskylä
TOU, Yuji	Assistant Professor, Tokyo Institute of Technology

Name	Affiliation
YASUDA, Hiroshi	Director,Strategic Alliance on Semi-Conductor, Toshiba
Roland Kircher	General Manager, Technology Dept., Siemens K.K.
MASUDA, Tatuo	Executive adviser, SOC Corp. former Vice President, Japan National Oil
KOBAYASHI, Shinichi	Professor, University of Tsukuba
NOMURA, Takahiko	Senior Manager, KDI, Fuji Xerox Co., Ltd.
MINAKAWA, Tatsuya	NEC Personal Products, Ltd.
USHIODA, Kunio	Nippon COMSYS
KUROKAWA, Susumu	Associate Professor, Drexel University

* Passed away on April 6, 2008.

3. SIMOT Young Researchers

(1) Post-doctoral Fellow

Name	Affiliation
MIKETA, Asami	International Atomic Energy Agency (IAEA)
Yuosre Badir	Assistant Professor, Asian Institute of Technology
Magnier Remy-Watanabe	Assistant Professor, Tsukuba University
KOBAYASHI, Manabu	Lecturer, Aoyama Gakuin Momen's Junior Collage
INOUE, Yoshimi	Lecturer, Aoyama Gauin University
IWABUCHI, Takumi	COE researcher, Tokyo Institute of Technology

Name	Affiliation
MIZUSAWA, Hikari	Lecturer, Aoyama Gauin University
Jian Wang	Toshiba Cooperation
Quan Sasaki Tu	Post-doctoral Fellow, Tokyo Institute of Technology
Pablo Ramirez	Post-doctoral Fellow, Tokyo Institute of Technology
YOSHIDA, Kenya	Jaspan Research Institute

(2) SIMOT Young Researchers

Noritomo Ouchi *	Ahmad Rusdiansyah	Shinya Kajiki	Miyuki Mitsuda	Weilin Zhao	Masanori Ohashi
Mizuho Ogikubo*	Carlos Carvajal	Yuya Okimoto	Xuening Yao	Takeshi Kurihara	Yosuke Shibata
Tomonori Kitahara*	Zheng Xi	Tien-Fang Kuo	Korrakot Yaibuathet	Md. Mamunur Rashid	Satoshi Tanaka
Koji Moriyama*	QunZhi Wang	Han-Gook Kim	Gen Abiko	Jae-Ho Shin	Javier P.E. Guevara
Masanori Wada*	Masaomi Ikeshoji	Shanyu Lei	Nazrul Islam	Toru Takahashi	Seunghye Hong
Miyabi Hayama	Zheng Zhao	Akihisa Yamada	Li Bing	Bjoern C. Frank	Yue Wu
Satoshi Yonekawa	Chaojung Chen	Rui Gu	Chan-orn Bongsebandhu-phubhakdi	Solves P. Ramon	Ablat Gulmire
Naoki Takuma	Kwok L. Shum	Kang Chen		Tanyanuparb Anantana	Teng Min

* Super doctor

4. Organizational Structure of SIMOT Research Center

The Center consists of 20 core project members, expanded project members, COE-dedicated members as well as 7 center management members from 7 different disciplines with Tokyo Tech as introduced bellow

(1) Management Committee Members

Name	Affiliation
KISHIMOT, Kikuo (～H20.8.31)	Professor, Dept. of Mechanical and Intelligent Systems Engineering, Tokyo Tech
KONAGAI, Makoto (H20.9.1～)	Professor, Dept. of Electrical and Electronic Engineering, Tokyo Tech
MISHIMA, Yoshinao	Professor, Dept. of Materials Science and Engineering, Tokyo Tech
FURUI, Sadaoki	Professor, Dept. of Computer Science, Tokyo Tech
HIDANO, Noboru	Professor, Dept. of Social Engineering, Tokyo Tech
TANABE, Koji	Professor, Dept. of Technology Management, Tokyo Tech
SHINNO, Hidenori	Professor, Precision and Intelligence Laboratory, Tokyo Tech
SEKIMOTO, Hiroshi	Professor, Research Lab for Nuclear Reactors, Tokyo Tech

(2) Evaluation committee

Name	Affiliation
NAKAHARA, Tsuneo	CEO, Nakahara Research Institute
KURASHIGE, Hideki	CEO, RHJ International
Leen Hordijk	Former Director, Inernationnal Institute of Applied System Analysis (IIASA)
Tarek Khalil	Former President, International Association for Management of Technology (IAMOT)
Keizo Nagatani	Fomer President, University of Marketing and Distribution Sciences
Nathan Rosenberg	Professor Emeritus, Public Policy, Dept. of Economics, Stanford University, Senior Fellow, Stanford Institute for Economic Policy Research
Louis M. Branscomb	Professor Emeritus, Public Policy and Corporate Management, Harvard University, John F. Kennedy School of Government
Mitsuko Shimomura	Vice Chairman, Japan Association of Corporate Executives, Prominent Journalist and President & CEO, Center for Health Care & Public Concern
Norman Neureiter	Appointed Director, Center for Science, Technology and Security Policy, American Association for the Advancement for Science: AAAS
Luke Georghiou	Professor of Science & Technology Policy and Management, University of Manchester. Director, Policy Research in Engineering, Science and Technology: PREST
Robert A. Burgelman	Edmund W. Littlefield Professor of Management and Director of the Stanford Executive Program, Stanford University
MURAKAMI, Norio	Former President & CEO, Google Japan and Vice President, Google Inc
INABA, Yoshiharu	President & CEO, FANUC LTD.
Kotaro Tsuru	Senior Fellow, Research Institute of Economy, Trade and Industry: RIETI
Aino Sallinen	Rector, University of Jyväskylä, Finland
James C. Abegglen*	Honorary Deam & Professor, Graduate School of Management, Globis University, Chairman, Asia Advisory Service K.K.
Michiyuki Uenohara**	Professor Emeritus, University of Tama, Former Vice President of NEC

* Passed away on May 2, 2007.

** Passed away on December 19, 2007.

Attachment

1. Research Activities

(1) Management Committee of SIMOT Research Center

(2) SIMOT Related Section Meeting

2. Educational Activities

(1) SIMOT I - II

(2) Symposium Initiated by SIMOT Young Researchers

3. International Joint Research Collaboration

4. Enlightenment Activities

1. Research Activities

(1) SIMOT Research Center Management Committee

- **1 st :** Sept. 30, 2005）

  Discussion about the structure and the management policy of SIMOT Research Center

- **2 nd :** April. 11, 2006

  Discussion about activity policy focusing on the strategy of research and education

- **3 rd :** Sept. 27, 2006

  Review of the Interim Assessment by JSPS

  Discussion about the management policy for the post-SIMOT

- **4 th :** April. 6, 2007

  Review of the SIMOT's fundamental principle and discussion about management strategy in the future

- **5 th :** Sept. 25, 2007

  Discussion about the discipline of the SIMOT research and education in the global perspective

- **6 th :** April 4, 2008

  Discussion about the perspective of the holistic view of the SIMOT

- **7 th :** Sept. 25, 2008

  Confirmation of the perspective of the holistic view of the SIMOT and Interview from other COE leaders

- **8 th :** March, 2009

(2) The Japan Society for Science Policy and Research Management
- *The Section Meeting of National Problem*

2004

Date	Theme	Lecture	
Oct. 28	Picture of the Future - Planning the Future in a Changing Environment: A Challenge of Siemens	General Manager, Technology Dept., Siemens K.K.	Dr. Roland Kircher
Nov. 24	Mictosoft's Business Model - It's Global Identity	RG Lead, Microsoft Business Solutions, Microsoft Co., Ltd.	Dr. Masayo Hobo
Dec. 8	Interaction between Commercial Elements and Geopolitics in the Oil Markets - Suggestions to the SIMOT	Vice President of Japan National Oil Corporation (JNOC)	Mr. Tatsuo Masuda

2005

Date	Theme	Lecture	
Jan. 25	Convergence of National Industrial Systems? Global Growth and Global Giant Industrial Enterprises in the Twenties Century - Suggestion to SIMOT	Professor of Economics, Faculty of Economics, University of Tokyo	Professor Leslie Hannah
Feb. 15	The Report of the World Economic Forum: Partnering Against Corruption Initiative 2004 - Suggestion to SIMOT	Professor, Tokyo Institute of Technology, The 21st Century COE Program, SIMOT	Professor Tatsuo Masuda
Mar. 31	Science of Institutional Management of Technology: From the View Point of Comparative Culture	Associate Professor, Foreign Student Center, Tokyo Institute of Technology	Dr. Midori Egawa
Apr. 14	Empirical Analysis of the Long-term Economic Development: Identification of the Institutional Systems Stimulating Growth Mechanism- Suggestion to SIMOT	Counselor of the Minister's Secretariat, Ministry of Finance	Ms. Naoko Ishii
May. 11	Science and Technology Policy Endeavoring Technological Innovation: Strategy for Industrial Science and Technology Inducing New Industry (Report by the Advisory Committee of the Industrial Structure Council) - Suggestion to SIMOT	Director Coordinating Technology Strategy Planning, Industrial Science and Technology Policy and Environment Bureau,METI	Mr. Ryoji Doi
Jun. 13	Current Trend in the US's Innovation Strategy focusing on the Council on Competitiveness Report - Suggestion to SIMOT	Senior Fellow, Center for Research and Development Strategy, JST	Dr. Kunihiko Niwa
Jul. 15	Evolutionable Innovation: Japan's Comparative Advantage and Disadvantage - Suggestion to SIMOT	Director, Research on R&D Management National Institute of AIST	Dr. Koh Naito
Aug. 22	International Identity of Japan's Institutional Systems: A Linguistic View - Suggestion to SIMOT	Professor, Nagoya University	Prof. Ken Machida
Sept. 30	International Identity of Japan's Institutional Systems: A Linguistic View - Suggestion to SIMOT	Research Fellow, Oxford University (seconded by MEXT)	Ms. Seiko Arai
Act. 31	Comparative Evolution of R&D Policies in Japan and the US and Its Impact on EU's R&D Policy - Suggestion to SIMOT	Professor, Department of Philosophy, University of Lyon, Visiting Professor, University of Tokyo	Dr. Alain-Marc Rieu
Nov. 14	1. Optimal investment in new technology for an enterprise (by Lukianova) 2. An Approach to Modeling Innovation Activity: Assessment of Business Efficiency and Innovation Potential (by Smirnov) - Suggestion to SIMOT	Assistant Professor of Lomonosov Moscow State University Assistant Professor of Moscow State University	Ms Lilia N. Lukianova Mr Alexey I. Smirnov
Dec. 12	Quality Management System Model Corresponding to the New Paradigm: Sustainable Growth - Suggestion to SIMOT	Professor, Dept. of Chemical System Engineering, University of Tokyo	Prof. Yoshinori Iizuka

2006

Date	Theme	Lecture	
Jan. 25	The Impacts of the Japanese Compulsory Education on Innovative Minds - Suggestion to SIMOT	Director General, The University of the Air	Prof. Mamoru Orihara
Feb. 13	The Analysis of the Evolution Pattern of Technology System by TRIZ: An Innovative Technology Management Approach Created by the USSR - Suggestion to SIMOT	Professor, Research Institute, The Sanno Institute of Management	Dr. Manabu Sawaguchi
Mar. 29	Competitiveness through Effective Technological Innovation - Suggestion to SIMOT	Professor of Technology & Innovation Management at IMD	Dr. Georges Haour
Apr. 20	Trends in Primary and Secondary Science and Technology Education and Its Implications on Developing Innovative Minds - Suggestion to SIMOT	Department for Curriculum Research National Institute for Educational Policy Research	Dr. Yasushi OGURA
May. 15	Competitiveness of Asian Auto Industry - Suggestion to SIMOT	Senior Research Councilor, Mitsubishi Research Institute, Inc.	Mr. Yasuo Tsuchiya
Jun. 22	Organization, system and culture of Japanese firms and high-tech innovation - Suggestion to SIMOT	Vice President & Director, Boston Consulting Group	Mr. Hiroshi Kanno
Jul. 28	Asian people's eyes to Japan: Advice to the era with 4 figures foreign students - Suggestion to SIMOT	Professor, International Student Center, Tokyo Institute of Technology	Dr. Kikuko Nishina
Aug. 30	Human resource mobility in the Japanese society - Suggestion to SIMOT	Partner, Egon Zehnder International Co., Ltd.	Ms. Mika Masuyama
Sep. 25	Argument for Service Management - Suggestion to SIMOT	Professor Emeritus, Seibu University of Humanities & Sciences	Prof. Shigehiko Masukawa
Oct. 19	Institutional MOT: A Systemic Approach	Professor Emeritus Swiss Federal Institute of Technology Department of Management, Technology, and Economics	Dr. Hugo P. Tschirky
Nov. 27	Issues in corporate strategy in the global economy: Dialectic development of innovation by MIT team - A suggestion to SIMOT	Professor, Faculty of Business Administration, Rissho University	Dr. Naoya Yoda
Dec. 25	Japanese Institution and M&A -A suggestion to SIMOT	Partner, GCA Co., Ltd.	Mr. Reijiro Yamamoto

2007

Date	Theme	Lecture	
Jan. 18	"Future Innovations' Impact on Society" - A suggestion to SIMOT	Head of Corporate Technology, Siemens	Dr. Roland Kircher
Feb. 15	Harnessing Innovation through Knowledge Co-Creation in the Business Ecosystem - A suggestion to SIMOT	Visiting Researcher, Hitotsubashi University	Dr. Florian Kohlbacher
Mar. 14	Globalization of R&D and its Institutional Implications - A suggestion to SIMOT	Partner, McKinsey & Co., Tokyo Office	Dr. Ulrich Naeher
Apr. 20	Evolutionary Management: Epistemology of Eco-Process - A suggestion to SIMOT	Professor, Faculty of Business Administration, Toyo University	Dr. Yasuo Matsuyuki
May 28	An Empirical Analysis of the Development of the Telework System for Constructing the Next Generation Organization - A suggestion to SIMOT	Manager, Strategic Development Planning Dept Corporate Planning Development, Canon Inc.	Dr. Daisuke Sahori
Jun. 25	Analysis of the Institutional Framework to Promote Innovation in Nuclear Power Field －A suggestion to SIMOT	Economist / Energy Planner, PESS IAEA	Dr. Asami Miketa
Jul. 30	My personal experience in the US talk show －A suggestion to SIMOT	Former Exective Director of Japan IBM Former Director General, JETRO, New York Office	Mr Nobuya Noguchi
Aug. 20	Similarity and Disparity of Institutional Innovation between Korea and Japan - A suggestion to SIMOT	Professor, College of Economics & Business Administration Hanyang University, Korea	Dr. Tae-Soo Ryu
Sept. 20	National System of Innovation in Iran and Japan: Similarity and Disparity - A suggestion to SIMOT	Graduate School of Decision Science & Technology Tokyo Institute of Technology	Ms. Narges Haghi
Oct. 22	Competitiveness of Science & Technology and R&D:International Comparison －A suggestion to SIMOT	Senior Fellow, Center for R&D Strategy Japan Science and Technology Angency (JST)	Dr Kunihiko Niwa
Nov. 7	Knowledge and Learning in Industry: Academia-Government Collaborative System of Innovation －A suggestion to SIMOT	Director, Knowledge Science and Technology Research Center	Prof. Zhongtuo Wang
Dec. 12	How was the Japanese Way of Education and Research Systems Established?From the Point of Views of Culture and History: Academia-Government Collaborative System of Innovation	Professor Emiritus, National Institute of Informatics	上 Prof. Haruki Ueno

2008

Date	Theme	Lecture	
Jan. 16	Current State of Mobile-phones Customers Behavior:An Approach to Minimizing the Discrepancy of the Sense of the Hazardous Aspects - A suggestion to SIMOT	Assistant Professor, Researvh Center for Advanced Science and Technology, University of Tokyo Special Advisor to the MEXT on Technology	Ms Yukiko Nishimura
Feb. 5	Advancement of the Japanese Hybrid Management - A suggestion to SIMOT	Professor at the School of Commerce, Vice Director of the Institute of Advanced Studies Waseda University	Dr Hideaki Miyajima
Mar. 31	The R&D Cooperation between the Industry and Universities in Finland - A suggestion to SIMOT	Visiting Researcher to Tokyo-tech, Department of Mathematical Information Technology, University of Jyvaskyla	Mr. Juho Heikkinen
Apr. 14	High-Tech Startups and Venture Capitals: VC's supports to the startups in Japan - Suggestion to SIMOT	CEO of Venture Firms	Dr. Kazuyuki Masuda
May. 14	Absorptive capability of Japanese and European multinationals: Importance of balance between autonomy and control of US R&D subsidiaries - A suggestion to SIMOT	Visiting scholar、Haas Business School University of California, Berkeley	Dr Seiko Arai
Jun. 22	Can Japan Lead a New Global Innovation Cycle?: An International Comparison of Four Countries in the Renewal Cycle - A suggestion to SIMOT	Dean and Professor , International MBA Program, Globis Graduate School of Management	Dr John Beck
Jul. 4	Enneagram Approach for the Examination of New Venture Leaders- A Suggestion to the Science of Institutional Management of Technology - A suggestion to SIMOT	President, Toranomonn Institute of Management Research	Mr. Kimio Agata
Aug. 27	Can Japan Still Compete Globally?: A Suggestion to the Science of Institutional Management of Technology - A suggestion to SIMOT	Director of TUJ(Temple University Japan Campus)'s Executive MBA program, Advisor of Business Management majors	Professor William Swinton
Sept. 18	Paradigm Shift to a Pos-oil Society A Suggestion to the Science of Institutional Management of Technology - A suggestion to SIMOT	Material and Energy Sustainability Assessment Group Research Institute of Science for Safety and Sustainability National Institute of Advanced Industrial Science and Technology (AIST)	Mr. Masayuki Sagisaka
Oct. 30	Exploring Cooperation Strategies for Innovation: Case of ICT Industry in India and Japan - A suggestion to SIMOT	Associate Professor, Dept. of Management Studies, Indian Institute of Technology	Dr. Kirankumar Momaya
Nov. 12	Work in the Globally Integrated Enterprise from Ethnographic Viewpoints - A suggestion to SIMOT	Manager, Service Practice, IBM Almaden Research Center	Dr. Jeanettte Blomberg
Dec.12	India's IT industry and its institution relative to Japan - A suggestion to SIMOT	PSA Practice Head-Japan & APAC, Wipro Technologies	Mr Anand Dass

2009

Date	Theme	Lecture	
Jan. 20	Finland's National Innovation Strategy - A suggestion to SIMOT	Professor, University of Jyvaskyla,Member of the Steering Group, Finland's National Innovation Strategy	Dr. Pekka Neittaanmaki
Feb. 18	Global High-technology Strategy: Asia-Pasific Initiative toward a Post-Global Economic Stagnation - A suggestion to SIMOT	Director for Financial System Trade Finance and Economic Cooperation Division Trade and Economic Cooperation Bureau, Ministry of Economy, Trade and Industry	Dr. Takashi Hattori
Mar. 6	The Challenges and Strategy for International Industry, Administration, Academia Collaboration - A suggestion to SIMOT	Head of EHT transfer, The Technology Transfer Office of ETH Zurich	Dr. Silvio Bonaccio

2. Educational Activites

(1) SIMOT I - II

2005	SIMOT I	Apr. 17 ～ July 12
	SIMOT II	Oct. 7 ～ Feb. 10
2006	SIMOT I	Apr.18 ～ July 25
	SIMOT II	Oct.12 ～ Feb. 1
2007	SIMOT I	Apr.12 ～ July 19
	SIMOT II	Oct. 4 ～ Jan. 24
2008	SIMOT I	Apr.10 ～ July 17
	SIMOT II	Oct. 2 ～ Feb. 5

Spring, 2005 10:40～12:10

1	April 12	Chihiro Watanabe	Key Concepts and Discipline
2	April 19	Takashi Kikuchi	Intangible Assets, Brand and Corporate Value System
3	April 26	Hiroshi Yasuda	Strategic Alliances and Collaborative R&D
4	May 10	Masahiro Samejima	Effect of Intellectual Property in a Corporate Management and towards Establishment of Competitive Patent Portfolio
5	May 17	Tatsuo Masuda	Interaction between Market and Geopolitical Factors (Energy Market)
6	May 24		Colloquium
7	May 31	Kou Naitou	Structure of Innovation That Can Evolve and Research Methodologies
8	June 7	Shinichi Kobayashi	Innovation, Policy and Constituency
9	June 14	Roland Kircher	Innovation and Technology Management and the Impact on Society
10	June 21	Toshiyuki Adachi	SCM/CRM Strategy in the Technology Management - A Role of Cross-Functional Management Technology
11	June 28	Masayo Hobo	IT Oriented Business Model
12	July 5		Colloquium
13	July 12		

Fall, 2005 13:20～14:50

1	Oct 7	Chihiro Watanabe	2005 Institutional Management of Technology No.2
2	Oct 14		
3	Oct 28	Midori Egawa	What can we learn from Japanese corporate expatriates?
4	Nov 4	Roland Kircher	Innovation Drives Customer Benefit - Advanced Technology in Cars Increase Safegy, Comfort and Functionality
5	Nov 11	Masahiro Samejima	From the Pursuer to the Pursued～Transition of Technology Management in Japan
6	Nov 18	Masayo Hobo	Organizational Design and Innovation
7	Nov 25	Tatsuo Masuda	The Year 2000 Computer Problem: IEA Y2K Response Plans
8	Nov 29	Shinichi Kobayashi	Human Resource Development in Japan - Education: An Issue of Innovation
9	Dec 2	De Bi Tsao	Institutional Logistics
10	Dec 9	Hiroshi Yasuda	Firms' Competitiveness Building from a Financial Perspective
11	Jan 13	Junichi Iijima	How to Obtain Business Performance with IT Investment?
12	Jan 27	Toshiyuki Adachi	Practical Production Innovation
13	Feb 3	Masakatsu Yamazaki	Symbiosis from Biological to Social Systems
14	Feb 10		Colloquium

Spring, 2006 15:00～16:30

1	April 18	Chihiro Watanabe	2006 Institutional Management of Technology No.1
2	April 25		
3	May 9	Masahiro Samejima	Effect of Intellectual Property in a Corporate Management and towards Establishment of Competitive Patent Portfolio
4	May 23	Tomoko Saiki	Intellectual Property Management and Pharmeceutical Patent Practices In Japan
5	May 30	Hiroshi Yasuda	Strategic Alliances and Collaborative R&D
6	June 6	Tadaaki Kimoto	Taisho' Democracy and the 'Riken' (The Institute of Physical and Chemical Research)
7	June 13	Tatsuo Masuda	Asian Premium in the Petroleum Market - An Analysis from Power Game Perspective
8	June 20	Masayo Hobo	IT Oriented Business Model
9	June 27	Takao Enkawa	Japanese Culture, and Strength and Weakness of Japanese Manufacturing (the "Monozukuri")
10	July 4	Toshiyuki Adachi	Cross-Functional Management in the Technology Management - CRM Technology Management
11	July 11		Colloquium
12	July 18		
13	July 25		

Fall, 2006 12:15～13:20 & 13:20～14:50

1	Oct 12	Chihiro Watanabe	An Elucidation of the Role of Institutional Systems in Characterizing Technology Development Trajectories: Co-Evolutionary Management Leads to the Hybrid Management Fusing East and West
2	Oct 19		
3	Oct 26	Shinichi Kobayashi	Institution and Innovation: From the Viewpoint of the Innovation Policies
		Peter Mertens	Trendsetting-An Innovation Strategy for a Global Diversified Company
4	Nov 2	Chihiro Watanabe	Q&A Session
		Toyohiko Hachiya	Intangible Assets
5	Nov 9	Hiroshi Yasuda	Analysis of Firms' Competitiveness from Financing Perspective - Cases in the Semiconductor Industry -
		Masaaki Hirano	IT Investment/Expenditure and Firm Performance
6	Nov 16	Yoshitoshi Tanaka	Role and Functions of Technology Management Offices from the Viewpoint of Technology Licensing
		Masayo Hobo	Transition and Trend of Business Solution Software
7	Nov 30	Masahiro Samejima	From the Pursuer to the Pursued ～Transition of Technology Management in Japan
		Takashi Watanabe	Technology Transfer from Academic Institusions and High-Tech Start-ups
8	Dec 7	Kenji Itoh	Safety Culture and Risk Management
		Tatsuo Masuda	The Year 2000 Computer Problem: IEA Response Plans and Institutional Observations
9	Dec 14	Susumu Kurokawa	Global R&D Activities of Japanese MNEs in the US: A Triangulation Approach
10	Dec 21	Kenya Yoshida	Networks of small and medium-sized enterprise(SMEs)
		Susumu Kurokawa	Global R&D Activities of Japanese MNEs in the US: A Triangulation Approach
11	Jan 11	Akira Kamoshida	Cisco as Living Innovator Why Cisco can drive Innovation ?
		Dai Senoo	Institution and Management paradigms
12	Jan 18	Roland Kircher	Future Innovation's Impact on Society
		Shinji Mizuno	Complexity of Optimization Problems
13	Jan 25		Colloquium
14	Feb 1		

Spring, 2007 10:40～12:10 & 12:10～13:10

1	April 12	Chihiro Watanabe	Science of Institional Management of Technology : SIMOT - Education of Japan's Co-evolutionary Dynamism Accruing to Global Assets Fundamental view point, Objectives, Perspectives, What has learned and what should endeavor, SIMOT as a science
2	April 19		
3	April 26	Takashi Kikuchi	Knowledge Base, Brand and Institution
4	May 10	Kunihiko Higa	Telework Research
		Masayo Hobo	IT as a Strategic Tool for Company
5	May 17	Tatsuo Masuda	Asia Premium in the Petroleum Market - Analysis from the Perspective of Rule Making-
		Yasutoshi Yajima	Data Mining for SIMOT
6	May 24	Takashi Watanabe	Innovation Process : Japanese Model and Silicon Valley Model
		Hiroshi Yasuda	Issues & Challenges for Japanese Semiconductor Industry
7	May 31	Shinichi Kobayashi	University-Industry Relationship(in Japan)
		Masaaki Hirano	Building a Mechanism to Enhance Internal Control and Compliance
8	June 7	Peter Mertens	Innovation Benchmarking
		Takahiko Nomura	Work Way Design for leveraging the productivity and creativity of knowledge workers
9	June 14	Florian Kohlbacher	Knowledge-based Innovation - Putting Knowledge Creation and Management to Work -
		Yuji Tou	Techno-Economics
10	June 21	Hiroyuki Umemuro	Funology for Products
		Akira Kamoshida	What Holds a Modern Company Together?
11	June 28	Kumiko Miyazaki	Sectoral Innovation Systems
		Kunihiko Higa	Telework Research(part 2)
12	July 5	Masahiro Samejima	IP strategy with Business
		Hideto Nakajima	Science and Creativity
13	July 12		Colloquium
14	July 19		

Fall, 2007 12:15～13:20 & 13:20～14:50

1	Oct. 4	Chihiro Watanabe	Science of Institional Management of Technology : SIMOT - Education of Japan's Co-evolutionary Dynamism Accruing to Global Assets Fundamental Viewpoint, Objectives, Perspectives, What Has Learned and What Should Endeavor, SIMOT as a Science
2	Oct. 11		
3	Oct. 18		
4	Oct. 25	Akira Kamoshida	How do the JECs survive in the global economy?
		Junichi Iijima	Does CIO contribute to Firm Performance?
5	Nov. 1	Masaaki Hirano	Issues around the Return of IT Investments
		Kouji Tanabe	Innovation and Institution in Singapore
6	Nov. 8	Peter Mertens	Challenges from Demographic Change to High Tech Companies
		Takashi Watanabe	Technology Transfer from Academic Institutions and High-Tech Start-ups
7	Nov. 15	Hiroshi Yasuda	Analysis of firms' growth process - Comparative study between U.S. and Japanese firms in the semiconductor industry -
		Masaaki Muraki	Environmental Issues
8	Nov. 29	Takahiko Nomura	In Quest of Knowledge Innovation
		Tomoko Saiki	Intellectual Property Management in Pharmaceutical Industry
9	Dec. 6	Tatsuo Masuda	The Year 2000 Computer Problem: IEA Y2K Response Plans and Institutional Observations
		De Bi Tsao	Institutional SCM
10	Dec. 13	Masayo Hobo	Transition and Trend of IT Software Industry
		Masakatsu	Symbiosis
11	Dec. 20	Hideto Nakajima	Savages in a Civilized Society
		Shinichi Kobayashi	Current Sage of Science & Technology in Society
12	Jan. 10	Tatsuya Minakawa	CRM Technology Management in PC Business
		Masahiro Samejima	The Enhancement of Patent Management to Achieve Competitiveness Introducing newly established "Essential Patent Portfolio Theory"
13	Jan. 17		Colloquium
14	Jan. 24		

Spring, 2008 10:40～12:10 & 12:10～13:10

1	April 10	Chihiro Watanabe	Science of Institional Management of Technology : SIMOT - Education of Japan's Co-evolutionary Dynamism Accruing to Global Assets Fundamental view point, Objectives, Perspectives, What has learned and what should endeavor, SIMOT as a science
2	April 17		
3	April 24		
4	May 1	Masahiro Samejima	The Enchancement of Patent Management to Achieve Competitiveness Introducing newly established "Essential Patent Portfolio Theory"
		Yoshimi Inoue	Relationship Marketing
5	May 15	Chung Su-lin	Marketing Channels and Vertical Marketing Systems
		Kyoko Nagata	Earnings Management in Equity Offerings
6	May 22	Kumiko Miyazaki	Sectoral Innovation Systems
		Peter Mertens	Pictures of the Future
7	May 29	Dai Senoo	Institution and Management paradigms
		Tatsuya Minakawa	CRM Strategy of 121Contact Center as Core Company of PC Business
8	June 5	Takao Enkawa	Operations Management and Country Culture
		Manabu Kobayashi	The Industrial Revolution and Innovations that Made it Happen
9	June 12	Hiroshi Yasuda	The Semiconductor Industry in Japan & Challenges for Growth
		Shinichi Kobayashi	Human Resource Issues Changing Scene of Graduate Education How Do You Benefit from Ph.D Training?
10	June 19	Tatsuo Masuda	Asian Premium in the Petroleum Market - Analysis from the Perspective of Rule Making -
		Kunihiko Higa	Discussion on a Practically Useful e- Commerce Analysis Method
11	June 26	Shinji Mizuno	Complexity of Optimization Problems
		Masanori Kaji	The History of the Tokyo Institute of Technology in the Japanese History
12	July 3	Yoshitoshi Tanaka	Reason of Unutilized Patents
		Remy Magnier-Watanabe	The Effect of Institutional Pressures on Knowledge Management and the Resulting Innovation : The Case of The Smartcard in France
13	July 10		Colloquium
14	July 17		

Fall, 2008 12:15～13:20 & 13:20～14:50

1	Oct. 2	Chihiro Watanabe	Science of Institional Management of Technology : SIMOT - Education of Japan's Co-evolutionary Dynamism Accruing to Global Assets Fundamental view point, Objectives, Perspectives, What has learned and what should endeavor, SIMOT as a
2	Oct. 9		
3	Oct. 23	Chihiro Watanabe	Hybrid Management of Technology for Co-evolutionary Domestication in Open Innovation
		Takeshi Kurihara	Report of the Research Activities in U.S.A.
4	Oct. 30	Masaaki Hirano	Organizational IQ and IT Investment
		Kenji Itoh	Safety Culture
5	Nov. 6	Tatsuya Minakawa	PC Business SCM Innovation Activity - Production Innovation, RFID system -
		Hiroyuki Umemuro	Your Own Affective Thing
6	Nov. 13	Dai Senoo	Theory and Research on Organizational Knowledge Creation
		Tomoko Saiki	Intellectual Property Management in Pharmaceutical Industry
7	Nov. 20	Junichi Iijima	"Guanxi" beyond walls improves IT utilization
		Sadami Suzuki	SCM Competencies Benchmark through SCM Logistics Scorecard(LSC)
8	Dec. 4	Kazuhide Nakata	Symmetric Cone Programming and Interior-Point Method
		Takashi Watanabe	Innovation by Startups
9	Dec. 11	Masaaki Muraki	Environmental Issues
		Yoshitoshi Tanaka	Study of Effective University-Industry Partnership
10	Dec. 18	Kunio Ushioda	Visualized Information & Knowledge
		De Bi Tsao	Institutional SCM
11	Jan. 8	Taro Yamada	The Mechanism of Specification Management and PLM Methodology " Developing Salable Products
		Kyoko Nagata	Earnings Management in Seasoned Equity Offerings
12	Jan. 15	Toyohiko Hachiya	Intangible Assets
		Chung Su-lin	Global Marketing
13	Jan. 22	Shinichi Kobayashi	Interdisciplinarity and Innovation
		Masakatsu Yamazaki	Symbiosis From Biological to Social Systems
*	Jan. 23	Pekka Neittaanmaki	Innovation Strategy in Finland
14	Jan. 29		Colloquium
15	Feb. 5		

(2) Symposium initiated by SIMOT Young Researchers

1st : Feb. 27, 2006

Miyabi Hayama, Manabu Kobayashi, Kang Chen,
Akihisa Yamada, Magnier Remy-Watanabe,
Chaojung Chen

2nd : Feb. 28, 2007

Korrakot Yaibuathet, Noritomo Ouchi, Weilin Zhao,
Tomonori Kitahara, Jae-Ho Shin, Bjoern C. Frank,
Mizuho Ogikugo, Koji Moriyama

3rd : Feb. 27, 2008

Yuosre Badir, Noritomo Ouchi, Mizuho Ogikugo,
Weilin Zhao, Tanyanuparb Anantana,
Solves Pujol Ramon, Jae-Ho Shin

4th : Feb. 23, 2009

Koji Moriyama, Tomonori Kitahara, Bjoern C. Frank,
Tanyanuparb Anantana, Solves Pujol Ramon,
Jae-Ho Shin, Seunghye Hong , Ablat Gulmire,
Eguez Guevara Javier Patricio, Yue Wu
Yosuke Shibata, Teng Min, Masanori Wada















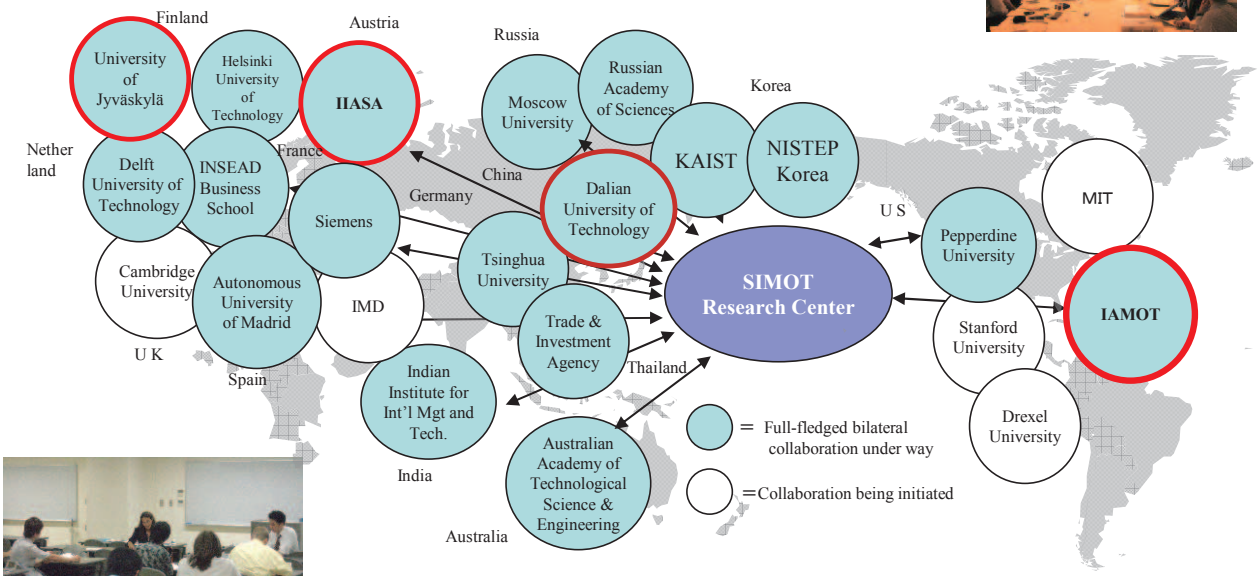


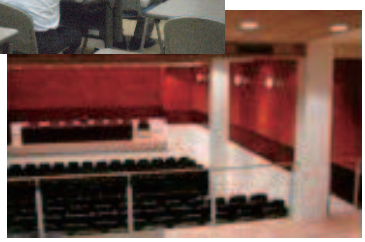


3. International Joint Research Collaboration

1) Build and extend spirally an international collaboration network with the US, Europe (Germany, France, Great Britain, Austria and Netherlands, Spain, Austria, Russia, Switzland and Finland), Asia (China, Korea, Thailand and India), and Australia.

2) Based on 1), promote co-researches aggressively. In addition to the regular exchanges of researchers, pursue researchers further as follows: a) Co-sponsored symposia; b) Co-workshops and so on.





■ SIMOT International Symposium

1st: Feb. 28 − Mar.1, 2005

2nd: Feb. 27-28, 2006

3rd: Feb. 27-28, 2007

4th: Feb. 27-28, 2008

5th: Feb. 21-23, 2009

■ IIASA：International Institute for Applied Systems Analysis)

(i) Non-governmental international organization established in 1972. 18 member countries including Japan, the US, Germany, Russia and China.
(ii) World COE in applied systems analysis.
(iii) Challenge to elucidate global issues including innovation, energy and environment, and national security.
(iv) Maximize the benefits of the complementarity by advancing and developing the ongoing cooperation.

＜Workshop＞

2005 Spring：May 1-2, 2005

2005 Fall：Sept. 28-29, 2005

2006 Spring：Sept. 17-18, 2006

2007 Fall：Sept. 8-9, 2007

2008 Spring：May 1-2, 2008

■ University of Jyväskylä (Finland)

JYVÄSKYLÄN YLIOPISTO
University of Jyväskylä

(i) Located in the north 200km of Helsinki, and establishes as the first teacher training school in Finland in 1863.
(ii) Pioneer role in industry-academia cooperation with high-tech firms including Nokia
(iii) SIMOT served as an incentive for Tokyo Tech to make an agreement with this university.

＜Event＞

Pre-meeting：June, 2007

Symposium: Feb. 27-28, 2008

Meeting with President: Feb. 28, 2008

Invite Researchers: Sept., 2008 ~

SIMOT Professor: Janualy, 2009 ~

■ IAMOT：The International Association for Management of Technology

(i) Non-governmental international organization established in 1992. There is about 670 enrollment as a member from 79 countries.

(ii) The only international organization dedicated to advancing state-of-the-art in the MOT education and research.

(iii) Accomplishes this purpose through various activities, including sponsoring international conferences: publishing newsletter/ periodicals, conference proceedings, a book series and a scholarly archival journal on MOT and Innovation (Technovation).

■ Dalian University of Technology


大连日报

大连科技创新论坛昨举行

(i) One of the “key universities” (universities accredited by the government as a priority academic center) established in 1949.

(ii) The trigger of the cooperation is that Prof. Zhongtuo Wang (Director, Knowledge Science and Technology Research Center) received great impression from the concept of SIMOT presented by SIMOT Leader in "Institutional innovation" international symposium.

<Event>

Workshop：June, 2007

Workshop：Nov., 2007

Workshop：Mar., 2008

Symposium：Nov., 2008


大连举办科技创新论坛

中华人民共和国科学技术部

The Ministry of Science and Technology of the People's Republic of China

6月5日，由大连市科技局组织的大连科技创新论坛在中日友好大连培训中心举行。日本东京工业大学渡边千仞教授和中国工程院院士、大连理工大学王众托教授以渡出席论坛并做了主题演讲。渡边教授围绕技术创新与制度的共进化阐述了新颖的观点。他说，日本和中国都重视技术创新，日本在技术创新方面的经验和教训值得中国借鉴。王众托院士在随后的演讲中，重点围绕自主创新发表了个人独到的见解和认识。他提出的系统集成创新和创新三螺旋模型理论得到了与会100余名政府管理部门、相关科研院所以及部分高新企业代表的充分肯定和认同。（大连市科技局）

4. Enlightenment Activities

(1) Book

[Autohr] **Chihiro Watanabe**
[Title]
Managing Innovation in Japan: The Role Institutions Play in Helping or Hindering how Companies Develop Technology

[Contents] Why is the difference of innovation caused between the high-tech firms? Why did the reversal of the competitiveness between Japan and the US happen in the 1990's? This book elucidate that the institution such as culture, consumption styles or organization rules firm's technological development by using a lot of empirical analysis.

[Authors] **Marina van Geenhuizen, Chihiro Watanabe, Vinnie Jauhari and Enno Masurel eds.**
[Title]
Technological Innovation Across Nations: Applied Studies of Coevolutionary Development

[Contents] Where does the difference of the innovation of each country happen? This book elucidate the factor of those differences through the case study of Japan, US, Finland, China and India focusing on the co-evolution between institution and innovation.

(2) Special Issue

[Title]
Special Issue of the International Journal of Production Economics
Institutional Perspectives on Supply Chain Management

[Contents] A better understanding of the institutional considerations in SCM would not only contribute to improved performance of individual supply chains but would also contribute to the sustainable development of national and global economies. We seek manuscripts that address institutional perspectives on SCM.

(3) SIMOT Research Center News Letter

Tokyo Institute of Technology, 21st COE Program, SIMOT,
"5-year Project Report of the Science of Institutional Management of Technology,"
2009, Tokyo Institute of Technology, Tokyo.

Tokyo Institute of Technology, 21st Century Center of Excellence Program
The Science of Institutional Management of Technology

Dept. of Ind. Engineering & Management, Tokyo Institute of Technology
2-12-1 W9-51, Ookayama, Meguro-ku, Tokyo 152-8552 Japan
TEL : 03-5734-3606 FAX : 03-5734-2251
Email : tou.y.aa@m.titech.ac.jp
URL : http://www.me.titech.ac.jp/coe/

21st Century COE Program, Tokyo Institute of Technology

Science of Institutional Management of Technology: SIMOT

SIMOT Research Center
Room 208B, West 9 Bldg., O-okayama Campus
Tokyo Institute of Technology
2-12-1 O-okayama, Meguro-ku, Tokyo, 152-8552 Japan
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