Graduate Program in Multi-Disciplinary System Design and Management

Naohiko Kohtake, Takashi Maeno, Hidekazu Nishimura, Yoshiaki Ohkami
Hiyoshi 4-1-1, Kohoku-ku, Yokohama 223-8526, Japan
Keio University
kohtake@sdm.keio.ac.jp

Abstract. "System Design and Management" program, a study that integrates humanities and sciences by crossing many disciplines, is essential to foster talented persons who can lead in the development and operation of large-scale complex systems. A graduate school of this program was established at Keio University in 2008. The subject of the education is large-scale complex technological and social systems, with an education curriculum constructed and practically oriented lectures provided such that students can acquire a capacity of system thinking, a design faculty in line with system life cycles and system management abilities. By collaborating with industries and related stakeholders such as domestic and international educational research institutions, we designed an educational curriculum and recruited faculty members, developed educational facilities and research centers, recruited students, provided education, and moreover designed the method of publishing accomplishments. As for the establishment of the graduate school in April 2008, the educational curriculum was formed to provide students with opportunities to acquire must-learn capability and knowledge that were classified into six groups. The validity of the education method was confirmed based on verification of the students' self-evaluation, evaluation by the external evaluation committee and accomplishments by students such as papers, after the first two years of graduate education.

Introduction

Education and research in the universities and graduate schools of Japan is generally based on "education in a single academic discipline" and "Type 1 Basic Research, which is research for the discovery, explication and formation of universal knowledge (theories, principles, theorems, laws etc.) through the systematic search for as yet unknown phenomena". Education and research from this kind of background in universities and graduate schools has produced the results of cultivating capable people who possess long-standing and advanced expertise. However the refinement and specialisation of learning has an aspect of not being suited to the cultivation of capable people who can deal with cross-discipline problems (Yosihkawa 2008).

Meanwhile, various issues have continued to arise in the advanced practical technological systems of the industrial world in recent years, which are difficult to deal with through just the specialisation and refinement of a certain field. For example, the difficulty of coping with unexpected trouble or failures in the development of generation and energy systems or aerospace systems or the difficulties of safety design to meet the development of control systems and software for automobiles and robots. In both there are many causes for the large-scale and complex nature of the target system (Leveson 1995). At the same time, the increasing severity of the global

environmental problem which, it should be said, modern technology has produced, is a crucially important challenge for modern society. That is to say, there is continued difficulty in designing technological systems appropriately when the issues of safety faced by technological systems and the global environmental problems that surround them are perceived as separate issues. in order to realise systems that simultaneously resolve problems of the differing space and time scales represented by safety and environmental symbiosis, it is necessary to accurately perceive the complex interaction between various values of differing categories and scales such as the issue of safety, the global environmental problem, and the associability of the system and individual elements that compose it. The systemization of a cross-sectional study to design the entire system and education and research from a perspective of system integration based on this is also indispensable. However, it is hard to say that sufficient education and research into methods to resolve issues that span multiple disciplines and occur in the business world when various products are developed and actually operated takes place in domestic education and research institutions.

In view of this kind of social background, the Graduate School of System Design and Management (hereafter Keio SDM) was established at Keio University in 2008. In this graduate school, a curriculum of uniquely oriented education with a practical focus hitherto not available in graduate schools was established with education is provided to people with practical experience who have acquired some kind of specialisation in order to produce capable people able to design large-scale complex systems with consideration for the requirements of society such as environmental symbiosis, peace of mind and safety. To rephrase, the education of capable people who can lead the Type 2 Basic Research and practical research, the cultivation of which was hitherto difficult in Japanese graduate schools. The definition of Type 2 Basic Research is as follows: “a form of research that integrates the knowledge of different disciplines or creates new knowledge when necessary, and transforms a concept into artifacts (product or service) that can be recognized by society” (Yoshikawa 2008).

The following section describes and considers the external assessment results and those from students one year after establishment together with an introduction of the details and characteristics of the system design and management graduate school education implemented by the Keio SDM and specific details of education and research, and also issues to be considered hereafter.

Previous Trials

Some education and research efforts have already been put into place domestically in relation to methods to resolve issues that span multiple disciplines. At the National Institute of Advanced Industrial Science and Technology in Japan, the results of cross-discipline Type 2 Basic Research to resolve social problems are actively collected, in relation to which frequent workshops and symposiums are held. The Journal “Synthesiology”, which covers Type 2 Basic Research in order to facilitate the expedient return of research results back to society has also been periodically published since 2008 (AIST 2008). With regards to this, systems engineering in the West has come to shoulder part of the role of resolving issues that span multiple disciplines. Furthermore, in Japan, systems engineering seems to be taken in the narrow sense of engineering for IT systems. However in the future it will refer to engineering relating to the analysis and integration of various systems from mechanical and IT systems to society systems. According to INCOSE, systems engineering is defined as “An interdisciplinary approach and means to enable the realization of successful systems.” (INCOSE 2007). Particularly in America, education in line with systems engineering as

defined by INCOSE is systematically and practically carried out in 75 universities and graduate schools (Fabrycky and E. McCrae 2005). However in the universities and graduate schools of Japan, this kind of education is mostly not given with the few examples being the System Design Engineering Departments of Keio University, the Tokyo Metropolitan University and Department of Systems Innovation, the University of Tokyo etc. However, systematic and practical education at a graduate school level running from systems engineering to people with practical experience who have acquired a specialisation is not sufficiently provided.

Requirements made of Universities and Graduate Schools by the Business Community

It is always necessary to grasp the needs of the business community in education carried out at universities and graduate schools. According to the "Results of the questionnaire concerning the image of human resources sought by corporations" by Japan Business Federation on Education Issues (Japan Business Federation 2004), the items displayed in Table 1 were primarily raised as points of expectation in the cultivation of capable people by scientific universities and graduate schools. These are the results of a questionnaire put to 520 companies about what is expected from universities and graduate schools (science departments, faculties and special courses) in terms of training from the standpoint of adopting technical personnel. The five most frequent responses are shown. This questionnaire allowed the selection of up to 3 responses by each company.

Table 1: Expectations of Universities and Graduate Schools (Science)

Response	No. of Companies
The firm acquisition of specialist knowledge by students	340
Training in the assembly of knowledge and information and the derivation of one's own thoughts	287
The acquisition of fundamental knowledge of other areas relating to one's own specialist field	231
To provide education with an awareness connected to the real world in addition to theory	162
To give students the experience of assembling teams and tackling specific challenges	119

From these results, the necessity of universities and graduate schools that produce people who can leverage sophisticated expertise and produce and manage next-generation technology and society systems that deal with current and significantly changing social conditions can be understood.

Also, the demands from the business world with regards to education and research curricula in the field of systems engineering in universities and graduate schools have been acquired in various forms and analysed (Jain and Verma 2007). When establishing the Keio SDM, members of the domestic and overseas business community were interviewed concerning their expectations of universities and graduate schools. The result was the confirmation of expectations of scientific universities and graduate schools almost identical to the contents described in table 1. Based on needs from the business community similar to the above mentioned, Keio University conceived the Keio SDM over a roughly ten-year period and established it in 2008.

Keio SDM Establishment Details and Education and Research Curriculum

A pioneering Science and Engineering System Design Engineering Department was established at Keio University in 1996, providing education and research in “System Design Engineering” crossing the borders of engineering disciplines such as mechanical engineering, electrical engineering, computer science and architecture, and cultivating engineers possessing fundamental academic ability and integrated opinions. Meanwhile, the Keio SDM was established in 2008 in order to provide education and research in “System Design and Management”, which is a multidisciplinary study crossing the borders of technical and sociological disciplines such as engineering, physical science, economics and political science and is offered primarily to experienced people who have already acquired some kind of specialisation. The Keio SDM is a graduate school independent of the Graduate School of Science and Technology and aims to form a “melting pot” of students and teaching staff possessing diverse specialisations besides engineering. That is to say one of its aims is to produce people possessing the flexibility to coordinate and survive in the international competitive era here on after.

The education consists of master and Ph.D. courses and is based on Western cutting-edge systems engineering techniques, design techniques for large-scale complex systems such as the automobiles and robots in Japanese businesses, and system design methodologies learned from life as a system that Keio University established in the 21st century COE era program “System Design from Intelligence Towards Life” (Yoshida 2008) (Masuoka 2008). On the master course, importance is placed on interactive education between staff and students and between fellow students, and students are encouraged to have a professional character suitable for a graduate school. On the Ph.D. course, importance is placed on research and the cultivation of system design and management specialists.

Abilities To be Obtained Through Education and Research. In establishing the Keio SDM, study results from Japan and the West were analysed in relation to the requirements made of universities and postgraduate schools by the business community as already described, and the abilities that should be acquired due to the education and research of the Keio SDM were established as follows.

A) System Thinking Ability

B) Design Ability along System Lifecycle

a.	Stakeholder Analysis	b.	System Requirement Analysis
c.	System Architecting	d.	System Design
e.	System Integration	f.	Verification
g.	Validation	h.	System Operation

C) System Management Ability

a.	Project Management	b.	Communication
c.	Collaboration	d.	Interface Control
e.	Modelling and Simulation	f.	Concurrent engineering

g. Knowledge of Economics, Administration and Accounting

h. Legal Knowledge

D) Fundamental Knowledge of Other Areas relating to Field of Speciality

Table 2: Education and Research Curriculum Corresponding to the Abilities Considered Necessary by the Business Community

		Core Courses						Recommended Courses												Elective Courses																
		Core Subjects						Technical Subjects							Social Subjects					Technical Subjects						Social Subjects										
		Introduction to Systems Engineering	System Architecture and Design	System Integration	Project Management	Design Project: ALPS	Research of System Design and Management	System Environment	Human Factors	Risk Management of Engineering System	Dependable Systems	System Life	Digital Manufacturing System	Model Based System Engineering and Architecting	Introduction to International Affairs	Communications	Human Relations	System Management	Ethics for System Design Engineers	Mathematical Modelling and Statistics	Mathematical Technique of Prediction and Optimization	Mathematical Technique of Dynamical Analysis and Control	Database Management System under Network Environment	Software Safety Engineering and Reliability	Software Engineering	Fundamentals of Accounting, Marketing and Economics	Introduction to Legal Issues forEngineers	System Simulation Technique	Global Standardization Strategy	Methodology of Creative Decisoin Makings	Business Intelligence	Design Philosophy for Policy and Regulation	Political Economy of International Systems	Methodology and Management of Socio−Critical System	Special Lectures	(Subjects in the Other Graduate School)
System Thinking Ability		◎				◎	○	◎				○			○	○		○	○			○				○	○	○		○	○	○	○	○	○	
Design Ability along Sys. Lifecyc	a. Stakeholder Analysis	◎				◎	○	○						◎	◎			○	◎						○					○		○			○	
	b. System Requirement Analysis	◎	○	○		◎	○	○			○	○		◎	○			○	○						○					○		○			○	
	c. System Architecting	○	◎	○		◎	○	○			○	◎	○	◎	○			◎	○		○	○	○		○				○			○			○	
	d. System Design	○	◎	○		◎	○		○	○	○	◎	○	○	○			○			○	○	◎	◎	○				○			○			○	
	e. System Integration	○	○	◎		○	○		○	○	◎		○	○										○	○				○						○	
	f. Verification	○	○	◎		○	○		◎	◎	◎		○	○						○	○	○		◎	◎										○	
	g. Validation	○	○	◎		○	○		◎	◎	◎		○	○						○	○	○		◎	◎										○	
	h. System Operation	○	○	○	○	○	○		◎	◎	○		○	○								○			○										○	
System Management Ability	a. Project Management				◎	◎	○			○							○			○	○					○	○		○						○	
	b. Communication				◎	◎	○	○	○	○						◎	◎	○	○										○	○					○	
	c. Collaboration				◎	◎	○	○	○	○				○		○	◎	○	○										○	○					○	
	d. Interface Control	○	◎	○		○	○		○	○	○		○	○	○									○	○				○						○	
	e. Modelling and Simulation			○		○	○		○				◎	○				○		◎	◎	◎	○		○			◎	○	○					○	
	f. Concurrent Engineering				○	○	○						○	○							○	○	○					○							○	
	g. Knowledge of Economics, Administration and Accounting					○	○											○			○	○				◎					○	○	○	○	○	
	h. Legal Knowledge					○	○			○																	◎				○	○	○	○	○	
Fundamental Knowledge of Other Areas relating to Field of Specialty							○																													◎

Education and Research Curriculum and Feature. The lecture course established for the master course is shown in Table 2. Items that are relevant to each ability to be acquired through education and research described in the previous section are marked "○" for each lecture course, and those with particularly strong relevance are marked "◎". In establishing the curriculum, importance was placed on making a practical lecture system, and the curriculum was created with the acquisition of abilities necessary to implement a multidiscipline, intergenerational and international cooperation by the time of graduation in mind. These abilities each produce various next-generation systems that respond to social conditions with a base of sophisticated expertise and are necessary faculties for leaders engaged in management.

Each lecture was for 2 credits with the exception of communication techniques, which was 1 credit

and the design project ALPS (Active Learning Program Sequence, hereafter ALPS), which was 4 credits. Figure 1 shows the curriculum framework. Values in parenthesis are the number of credits necessary for each course in order to acquire a degree. The requirement for completion of the master course is the acquisition of 30 credits or more in the lecture course, within which 8 credits should be acquired from the common core course, 4 credits from ALPS and 2 credits from the master course special graduate course. Also in the case 6 credits or more are acquired from technical elective required courses and 2 credits or more are acquired from social elective required courses or 2 credits or more are acquired from technical elective required courses and 6 credits or more are acquired from social required courses then a master's degree (System Design and Management or System Engineering) may be acquired. In order to increase the convenience of taking lectures, many lectures are delivered by an e-learning system and in order to accept students internationally, a lecture course is established with the required courses in English.

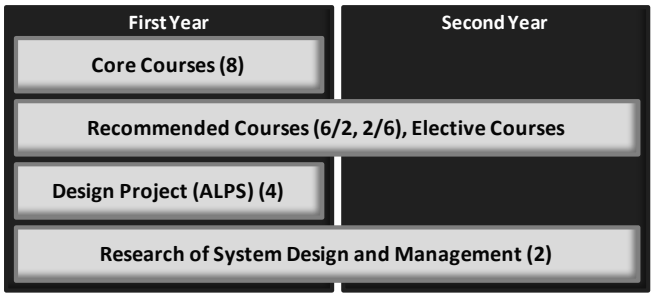

Figure 1 Framework for the Master Course Curriculum

A summary of the required courses from the common core courses, ALPS and System Design and Management Research is shown in Table 3. Many lectures are of a method whereby the students form the core such as group work and exercises or discussions etc. A format of 14 lectures of 90 minutes is generally adopted as a basis. Specialists from within the country and overseas actively participating in the business community in the field of system design and management are invited as lecturers and an intensive course of eight hours of lectures per day for a consecutive five days is enacted several times during the year. This forms a good opportunity to understand the latest issues in the business world and the attempts being made to deal with them. Furthermore, in the Keio SDM, education and research is currently implemented by 12 full-time staff and an equal number of special teaching staff and invited lecturers. Subjects intimately related to society are targeted and as the graduate school always promotes education and research with customer value in mind, the presence of many staff members with practical experience of the business world is a feature of the course.

The Ph.D. course places importance on research and the qualification of a doctorate degree (System Design and Management or System Engineering) may be acquired through the acquisition of 12 units or more in the latter period of the Ph.D. course special postgraduate course and by submission of a doctoral dissertation and passing a final exam.

Table 3: Summary of Required Courses

Common Core	Introduction to System Engineering	
	Lectures on the foundation of the latest strategic system engineering in accordance with the V model in system development process. I.e. lectures and exercises on system consideration, requirement analysis, function physical analysis and architecting and the study of system design and management architecture that responds to the various demands of society. In training, students experience system development starting from a hearing	

	with a customer concerning “a remote control automatic cleaning system” and “a radio controlled car garage parking system”.
	System Architecting and Design
	Lectures on visualisation from multiple perspectives in response to the demands of society and the architecting of problem solving constructions and detailed structures. There is also group discussion on the architecting and design of each research theme.
	System Integration
	Lectures on the study system for the reliable integration of system integration element disassembled systems. In short, education for creation of system requirement specifications, analysis, design and validation of requirement specifications. Practical group exercise tasks and discussions are also carried out
	Project Management
	Teaches the foundation of project management. Specifically, lectures and exercises on design and management of complex systems, the foundation and practice of logistics (HR and supply), and techniques for cross management and project management.
	Design Project ALPS
	An international cooperation group project course with Stanford and MIT carried out in English. An intensive course (approximately 2 days) is carried out four times over the year with group work in between based on entire themes such as “Enriching Senior Life in Japan” (2008) and “Sustainable Community” (2009). Students experience all processes in system life cycle in groups and in the final session present and discuss system proposals (Ishii, de Weck, Haruyama, Maeno, Kim, and Whitfield 2009) (Ishii and Iino 2008). All lectures given on the Keio SDM are individually related courses with individual lectures understood from in relation to the main course, making a structure whereby knowledge acquired in individual lectures can be applied to the main course. The lecture subjects are as follows. 1. Identification of Voice of Society and defining the project focus - Customer Value Chain Analysis - Scenario Generation by Brainstorming - Object Process Methodology (OPM Level 0) 2. Requirements Flowdown and Concept Development - Quality Function Development (QFD) - Concept Generation (Morphological Analysis) - Concept Selection (Pugh Method) - Prototyping Rapidly 3. System Architecture and Evaluation - System Architecture (OPM Level 1) - Scenario-based Amorphous System Design - Quality Scorecarding - Net Present Value (NPV) Analysis 4. Design for Robustness and Variety - Design of Experiment - Design for Variety - Decision Analytical Scorecarding - Project Definition Assessment - Design for Changeability 5. Communicating the Proposed Idea - Elevator Pitch - One Page Advertisement - Showcasing the Idea
	Research of System Design and Management
	Equivalent to a Master’s thesis research. This is not to the existing format of individual research, but rather a

	cross-discipline organisational and system engineering research in a group project format. Research complying with society's needs including peace of mind, safety, environmental symbiosis and social contribution is strongly endorsed.

Research for the master and Ph.D. courses in the Keio SDM is carried out in a group project in principle with the sections conducted individually collected as a Master's thesis or doctoral dissertation. The application of knowledge and techniques acquired in the Keio SDM by means of the ALPS course etc. is strongly endorsed.

Results and Discussions

The Keio SDM was established in April 2008 with students accepted in both the spring and fall semesters of 2008 and 2009 to date. At the present point, 138 students are enrolled on the master course and 46 students are enrolled on the Ph.D. course. The results of education and research implemented to date, the results of an external assessment conducted at the end of 2008 one year after establishment of the course and the evaluation results from students are given, and the challenges hereafter are mentioned in this section.

Composition of Students. One characteristic point of the course is a student composition spanning a wide range of ages, various fields and nationalities. The age of enrolled students shows a broad distribution from those in their 20s through to 60s with an average age of 32 for students on the master course and of 42 for those on the Ph.D. course (Figure 2, Figure 3). Scholastic backgrounds range from engineering to law, political science, economics, literature, commercial science and agriculture with a large number of students with practical business experience accounting for 64% on the master course and 89% on the Ph.D. course (Figure 4). The occupations of students with business experience are from many fields including manufacturing, communications, consulting, information technology, aerospace, finance, real estate, government administration, construction, energy, systems, medical care, mass communication and publication, and legal (Figure 5). The proportion of foreign national students including exchange students from overseas universities is 10%. Therefore it can be said that a "melting pot" of students and staff with various backgrounds has been formed as per the initial intention.

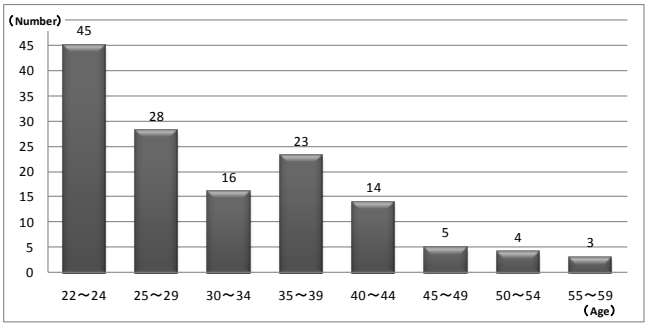

Figure 2 Age Distribution of Students Enrolled on the Master course

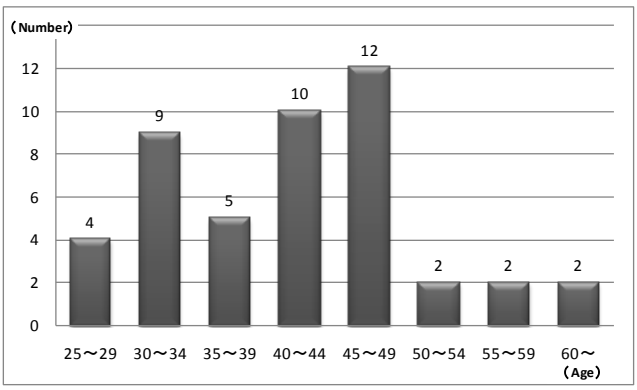

Figure 3 Age Distribution of Students Enrolled on the Ph.D. course

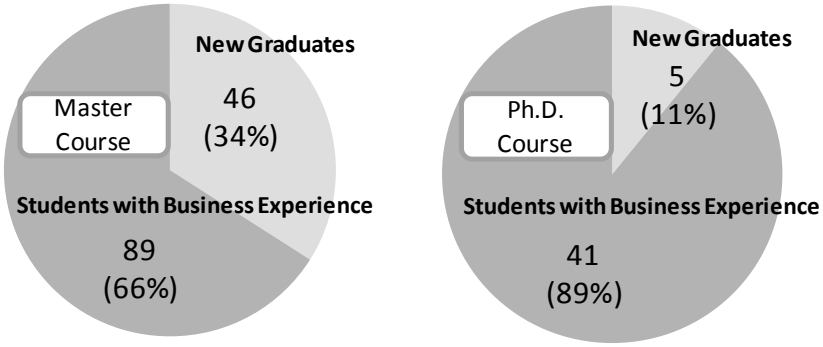

Figure 4 Proportion of New Graduates to Students with Business Experience

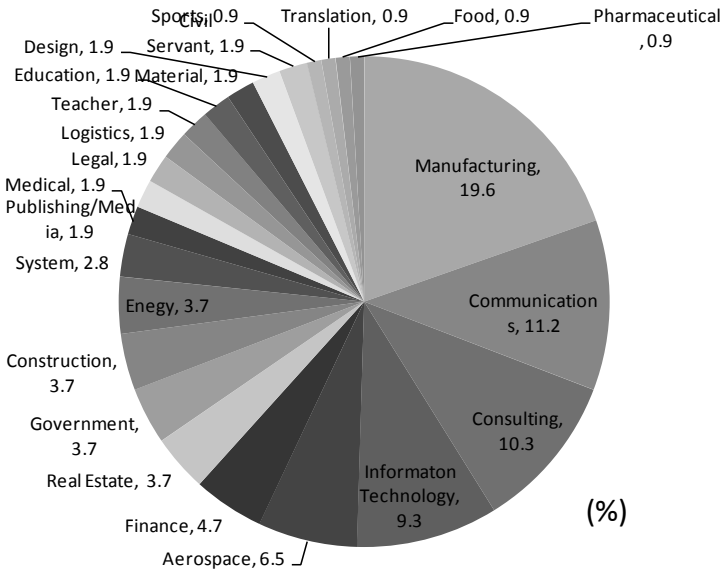

Figure 5 Occupation Distribution of Students with Business Experience

Evaluation by Students. An opinion poll was carried out on 36 second year students on the master course who matriculated in the spring semester of 2008 concerning the abilities they considered to have improved through education on the Keio SDM in the one year since matriculation, to what degree they have improved, and the details of experiences with which they were satisfied, and to what degree. As a comparison with the results of the study, the same opinion poll was conducted on 23 second year students in the Mechanical Engineering Course in the Graduate School of Science and Technology, Keio University. Evaluation was in the form of a possible six grades for each item. The t-test was implemented for each item based on the results of the studies for each postgraduate course. A significance level of 1% was taken and the evaluation results in which there was a superior difference are shown in Figure 6. The upper section of the graph for each item shows the average result obtained from students for the Keio SDM as well as the standard deviation, and the lower section of the graph shows that obtained for the Graduate Schoool of Science and Techology as well as the standard deviation.

Although this is a self-assessment by students, from these results the education and research curriculum of the Keio SDM is evaluated as offering education and research that to some degree meets the expectations made of a scientific university and graduate school by the business community, as shown in Table 1. As education and research is also important to promote sophisticated expertise and associated research implementation ability, the creation of a curriculum which can simultaneously promote such abilities was also investigated.

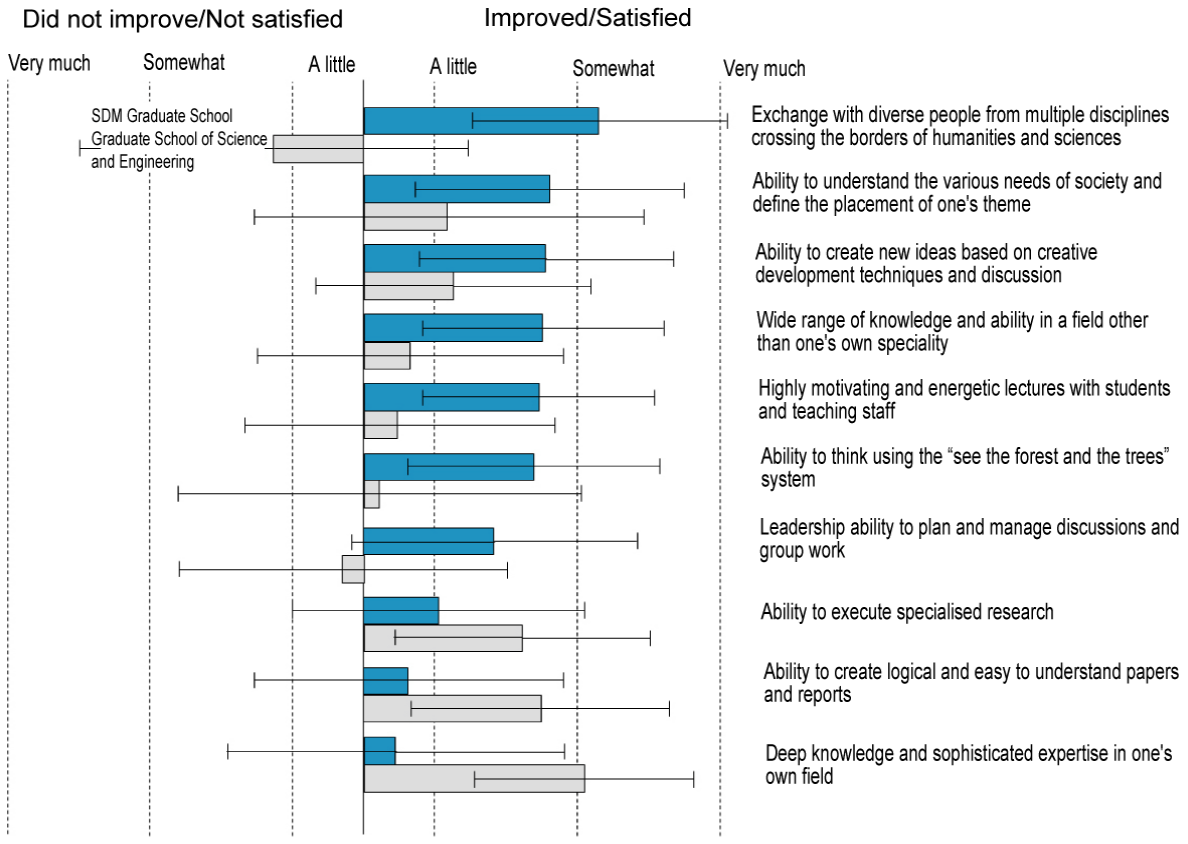

Figure 6 Comparison of Students' Opinions of SDM and Science and Technology

Results of Education and Considerations.

Student Core Lectures:

The result of carrying out group projects in teams of around 5 to 8 people in the design project ALPS (Ishii, de Weck, Haruyama, Maeno, Kim, and Whitfield 2009) was that students could acquire various techniques and ways of thinking that systematically create and embody ideas by means of practical work. Some students are already applying this experience to research or practical business respectively and results in the form of a doctoral dissertation etc. are beginning to appear (Yasuoka 2009).

Also the Keio SDM concept, which places importance on group work and group discussion was confirmed to be valid for many lectures in addition to ALPS. that is to say, the educational results of discussions held with the purpose of sharing knowledge acquired in lectures together with the mutual understanding of the diverse background of fellow students, in addition to frequent training such as cooperating and tackling a challenge were evident. Furthermore the effect of a deeper knowledge and understanding between fellow students and students and teaching staff is also evident. For example, students with practical business experience can understand issues and initiatives in various industries by means of discussion with students of practical experience in a different field. For new graduates, there is the advantage of being able to specifically understand issues in industry and therefore industry needs through discussions on each industry with students of practical business experience. For lecturers, there is also the advantage of being able to learn the newest trends in the business community in relation to one's own lectures from various perspectives and a synergy greater than hypothesised was obtained from these points.

Results of Multidiscipline Lectures and Considerations:

In addition to implementing lectures spanning many disciplines by means of cooperation between fellow teaching staff as well as with students, feedback was acquired from students attending said lectures. As an example, in contrast with the Yokohama city “Call Triage (classification of patient by severity of condition) Emergency System” handled by a research group in which teaching staff possessing specialisation in social science play the central role, teaching staff possessing technical specialisations cooperate to give the “Systems Simulation Techniques” lecture and system design and verification is carried out using simulation techniques. In addition, analysis, investigation and proposals were conducted to improve the system itself from both a technical and social science perspective. As mentioned above, effective education was given from the perspective of offering lectures from a variety of disciplines between which cooperation was traditionally scarce.

Cooperation with the Business Community and Overseas Institutions:

It is constantly necessary to grasp the needs of the business community in graduate school education however the education curriculum constructed in the Keio SDM is returned back to society and education is proactively given targeting people other than students with the purpose of acquiring knowledge and know-how from the business community.

Domestically, 4 courses of lectures concerning system engineering and project management were given to staff in relation to the Japanese Aerospace Exploration Agency and was extended to accepting 93 people in 2008. Together with sharing various issues that arise in the field of space

development, lectures organised by the SDM Graduate School are taken and discussions are held on resolution methods for each issue. The research establishment affiliated with the Keio SDM organises and offers a course for working adults on specific themes, where lectures and group work are carried out by a lecture team consisting of SMD Graduate School staff and invited specialists. Attendees possessing awareness of common issues from various business circles gather, receive education, and through the holding of discussions that include the lecturers, this resolution approach and experience is gathered by attendees and the Keio SDM. The result of the questionnaire to attendees was that all acquired a high level of satisfaction. Of particular note was the high evaluation for lectures from the holistic system perspective that cannot be acquired in other graduate schools.

Also cooperation with overseas institutions was proactively promoted in addition to the aforementioned structure and application of ALPS and Stanford/MIT lectures. Contracts of cooperation were made with TU Delft (Holland), Stevens Institute of Technology (America) and INSA (France) for reciprocal utilisation of education curricula and a mutual exchange of three master's students each was held with TU Delft increasing the results of international cooperation education. Furthermore, requests for construction of a "System Design and Management" course that responds to the needs of the industrial world in each nation and education curriculum design support for this field were received from KUSTAR (Abu Dhabi), AMET (India) and the Egyptian Japanese University for Science and Technology, with cooperation arrangements currently being pursued.

Cooperation with the Business Community and Overseas Institutions:

In addition to project and service design, distinctive research was carried out targeting the design of various systems including management design and policy proposals etc. Research was promoted on main research themes relating to the integral values of safety and peace of mind, environmental symbiosis and social contribution etc. whilst also keeping in mind the values of multidiscipline, cross-generational and international cooperation. Currently, cooperative research with the business community and overseas research institutions comprises a large part of this. The various research results are displayed in part below. There are various systems with these research themes such as consumer electronics, information, finance, insurance, humans and education etc.

- Thermal/Acoustic trade-off design for consumer electronics in a distributed design environment (Seki, Nishimura, Ishii, and Balmelli 2009)
- A Case Study of the Effects of Platform Software Selection on Information System Maintenance Cost (Shimadu, Morita, Mori, and Okumura 2009)
- The Evaluation of the Alliance Systems Designed by "Enterprise Currencies" in Japan (Yasuoka, and Ohkami 2009)
- Claim-Payment Failures Of Japan's Insurance Companies And Designing Better Payment Architecture (Yasui 2009)
- A Method for Analyzing Fundamental Kinesiological Motions of Human Body by Applying Interpretive Structural Modeling (Kayo and Ohkami 2009)
- Active Learning Project Sequence: Capstone Experience for Multi-Disciplinary System Design and Management Education (Ishii, de Weck, Haruyama, Maeno, Kim, and Whitfield

2009)

External Assessment:

Five people from the industrial world engaged in large-scale complex system design were inaugurated as external assessment committee members and held periodic discussions with the purpose of improving the education and research in the Keio SDM. An external assessment was conducted by these five at the end of 2008, one year from the establishment of the Keio SDM. Whilst the new education received a high assessment, the following points for improvement were also identified as a result. The proactive opening to and further cooperating with the industrial world on the results from the Keio SDM acquired after one year; The creation of educational structures that impart independence to students appointed as lecture mentors for students who have already undertaken lectures such as ALPS etc.; Thoroughness in the concept of the Keio SDM education and research to probe the nature of individual topics whilst keeping a wide outlook to "see both the forest and the trees".

Improvements seeking the elevation of education and research are already being enacted based on each identification, however investigations are continuing concerning the creation of structures such as further cooperation with the industrial world, for example receiving evaluations from persons in related business circles on the system proposals that are the final results of each team in ALPS, or implementing cooperation with the business community at the proposal stage. The matching of topics that are the targets of each lecture with tasks in the business world and a structure to feedback the proposals created through these lectures to the businesses supplying the task is being considered.

In relation to a thoroughness of SDM Graduate School education and research concept that "sees both the forest and the trees", importance is placed on design ability that targets large-scale complex systems and the increase of management abilities, and as students possessing some kind of specialisation are primarily targeted, giving education on all individual disciplines over a wide scope is difficult. Hence, cooperation through reciprocal sponsoring of educational opportunities with existing graduate schools is important, and unit compatibility and joint research is being promoted with the Graduate School of Science and Technology, the Graduate School of Business Administration and the Graduate School of Media Design at Keio University. Accordingly, students will be able to undertake lectures from each as necessary and raise their design ability in various systems whilst improving each specialisation and advance their management ability.

Conclusion

In this paper, initiatives in graduate school education were introduced relating to "System Design and Management", which is a new, multidisciplinary study crossing the boundaries of technology and sociology disciplines. Students of the Keio SDM span a wider range of ages, disciplines and nationalities than hypothesised at the establishment, and whilst having the expected role as a "melting pot", it is continuing to produce multidiscipline educational results and research results that cross disciplines. Hereafter there are plans to attempt the further improvement of the education and research curriculum to support needs from the business community by means of follow-up surveys on the results of students who graduate from the Keio SDM.

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BIOGRAPHY

Naohiko Kohtake. Associate Professor, Keio University. He was engaged in research and development on avionics systems for H-IIA rocket at Japan Aerospace Exploration Agency, and ubiquitous computing systems at Keio University. He was also involved in research for on-board software at European Space Agency and user interface at Sony Computer Science Laboratories as a visiting researcher. After working on software independent verification and validation for satellites and the international space station as an associated senior engineer at Digital Innovation Center in Japan Aerospace Exploration Agency, he is in charge of space system engineering and intelligent system as a director of Aerospace and Intelligent Systems Laboratory, Keio University.

Takashi Maeno. Professor, Keio University. He received his B. S. and M. S. degrees in mechanical engineering from the Tokyo Institute of Technology, Tokyo, Japan, in 1984 and 1986, respectively. From 1986 to 1995, he worked for Canon, Inc. He was a Visiting Industrial Fellow at the University of California, Berkeley, from 1990 to 1992. He received his Ph. D. degree in mechanical engineering from the Tokyo Institute of Technology, Tokyo, Japan, in 1993. From 1995 to 2008, he was with the Department of Mechanical Engineering at Keio University. Since 2008, he has been with the graduate school of System Design and Management, Keio University as a Professor. His research interest is on system design and management and its education.

Hidekazu Nishimura. Professor, Keio University. His research area includes model-based systems engineering and control systems design for symbiosis and safety. He is now interested in model-driven systems development using SysML. He is currently Professor of Graduate School of System Design and Management, Keio University. He is a member of INCOSE, IEEE, JSME and JSAE.

Yoshiaki Ohkami. Professor and currently, Dean of Graduate School of System Design and Management, Keio University. His speciality includes strategic systems engineering with application to social and technical systems, together with dynamics and control of large space systems. He has been the president of the INCOSE Japan Chapter since its establishment in March 2008. He is Fellow of Japan Society of Mechanical Engineers, and Fellow of INCOSE, and a member of IEEE, CISE and other academic societies.