

Proposal

Towards the Establishment of an Informatical Foundation of Services to Realize Innovation



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Service Innovation Research Initiative

Division of University Corporate Relations
University of Tokyo

The present proposal, “Towards the Establishment of an Informatical Foundation of Services to Realize Innovation,” was formulated based on discussions held under the Service Innovation Research Initiative of the Division of University Corporate Relations, the University of Tokyo, and is released to the public, summarizing measures for promoting research and development through industry-academia collaboration. In addition to this proposal, another report of this Research Initiative is also released to the public as “Towards Innovation through the Scientific Study of Services.”*

* <http://www.ducr.u-tokyo.ac.jp/service-innovation/index.html>

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For over two-and-a-half years, commencing October 2006, discussions have been held under the Service Innovation Research Initiative in a collaboration between industry and academia with an eye towards realizing innovation through the establishment of a perspective based on *Scientific Study of Services*. While the range of general services is broad and diverse, we have focused the scope of our discussions on those services that are provided in an information society, where most activities of people and organizations are directly or indirectly dependent on information systems and information technology, and have thereby studied specific and effective measures for conducting research and development in this area.

Based on the results of these discussions, we would like to make the following proposal on how research and development should be promoted.

Details of the Proposal

In order to establish a scientific methodology for studying services, one of our current approaches to innovation will be to promote research limited to services in an information society, where most activities of people and organizations are dependent on information technology. In this approach, at the core of the research is the development of methods, such as investigation/measurement, analysis/visualization, modeling/prediction, design/optimization, design/evaluation technology, and system construction technology, aiming at the establishment of an *Informatical Foundation of Services*. From this perspective, methodologies can be systemized to identify and analyze various phenomena concerning services in an information society towards realizing the most suitable systems. For this purpose, it is desired to research and develop specific themes through industry-academia collaboration.

In order to establish a scientific methodology concerning services, research should be

conducted through the integration of academic fields based on the knowledge available in existing fields. The following research areas will have to be established to promote this type of integration. These are the areas (1) to (4) detailed in “Research and Study Report on Emerging/Integrated Fields (December 2008)” formulated jointly by the Center for Research and Development Strategy, Japan Science and Technology Agency (JST/CRDS), and Basic and Generic Research Division, Research Promotion Bureau, Japan Ministry of Education, Culture, Sports, Science and Technology. There will also be an additional area (5):

- (1) Understanding human psychology and behavior
- (2) Handling large amounts of data
- (3) Overcoming the complexity of systems
- (4) Dealing with evolution/variation
- (5) Consensus formation/system design

The names of these research areas may give us the impression that these areas are not only related to services but also encompass other fields. In this proposal however, the concept of each research area is defined clearly in terms of services and the development of related methods.

This type of research is mainly conducted at research institutions, such as universities, and the research assets available there in existing fields should be fully utilized. For example, the University of Tokyo has accumulated abundant essential technology that can be utilized as a foundation for service innovation. It has also created the “Service Innovation Research Collaboration Unit of the University of Tokyo” and thereby established a system to promote research that integrates a number of areas. A steady and promising approach to research will be to utilize these research assets and collaboration systems and establish the integrated research areas shown above to systemize existing technology, as well as to research and develop essential new technologies, and thereby construct an informatical foundation of services. In each research area, practical research should be promoted through the development of methods required by service providers to resolve specific issues, so that the informatical foundation of services can work effectively. At the same time, through such research, human resources that can take the initiative in service innovation should also be nurtured. Furthermore, we hope that if the achievements of this research can be recognized as a discipline through the generalization of results and the promotion of systemization of methodologies

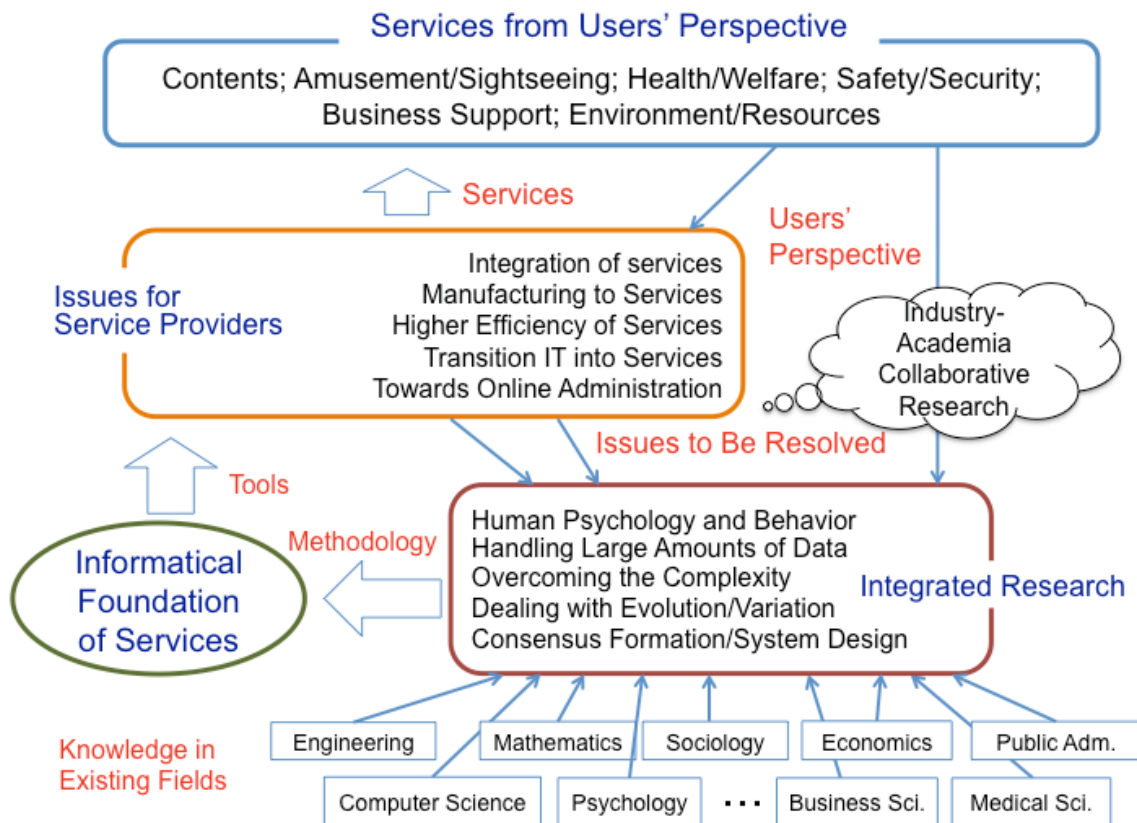
concerning services, a new curriculum that may be called either *Service Informatics* or *Services* (in the broader sense) will be formed and positioned as a new discipline to be passed on to the next generation.

In order to generate innovation through the establishment of services for ordinary people in society based on research conducted at universities and other institutions, service providers must first understand the users' perspective and promote research and development to resolve related issues. While the specific issues to be resolved in industrial and other fields are diverse and vary depending upon the time and situation, such issues will include the following:

- a. Integration of services
- b. Transition of manufacturing into a service-oriented economy
- c. Higher efficiency in services
- d. Transition of information technology into a service-oriented economy
- e. Transition towards online administration services

In working to understand and resolve these issues, the knowledge and experience of service providers, as well as developers of information systems that realize services based upon information technology will be essential. It is therefore important that service providers/developers and researchers of scientific methodologies share an approach to these issues, understand the relevant research and development policies, and cooperate with each other, utilizing the available means towards creating an informatical foundation of services and engendering steady innovation. From the perspective of deepening this type of collaboration, research and development should be promoted through industry-academia cooperation.

Taking these points into consideration, we would like to propose that, in order to establish an informatical foundation of services toward innovation, research and development should be conducted from a viewpoint of five to ten years, based on industry-academia collaboration organized in a manner to integrate a variety of fields.



Innovation through Industry-Academia Collaboration

Commentary

Towards the Establishment of an Informatical Foundation of Services

What do we have to do for the services in an advanced information society in order to comprehensively understand the mechanism of society to bring about innovation and activate society? What science and technology can do to respond to this challenge and contribute to society will be to establish a scientific methodology for providing effective and highly reliable services to bring affluence to society in the truest sense. Now that society is becoming increasingly complex, the establishment of a scientific methodology is required in various fields. It is also an urgent issue to establish a methodology for services that have a significant impact on industry and society. Described in the following is how research of *Scientific Study of Services* should be promoted from these perspectives.

Scientific Methodology to Realize Innovation

In many cases, innovation in society is only recognized as having occurred when reflecting on the past. How can such innovation be brought about? Has the best mechanism for generating innovation been found? A number of innovations have been analyzed and research to find the most appropriate mechanism has already started. Such research has found that, in many cases, innovation is brought about in the process where a business plan has generally originated from needs and the business has started utilizing the necessary intellectual assets. On the other hand, it is considered difficult to generate innovation when a business has started based on technological seeds purely in a manner to utilize such seeds in whatever way possible. In short, the former case implies activities in society and industry, while the latter case activities at research institutions, such as universities.

Even if an approach to innovation is found, no innovation will occur without a scientific methodology. However, a scientific methodology by itself cannot contribute to innovation. As long as services are required in society and deemed valuable, a scientific methodology for developing services has itself academic significance and is expected to become fully utilized to realize innovation. This process will help create services that are widely appreciated in society and should promote the spread of such services, and eventually innovation in services will be recognized to have occurred in the true sense. A method discovered by chance or dependent on experience or intuition may bring temporary success but such a method cannot be expected to

take root in society with continuing and sustainable achievements.

In this context, in order to generate innovation in services, the first step is to establish, as a common foundation, a scientific methodology that can be widely utilized. When the provision of new services is planned, this common foundation can be used as a means to select a methodology for enacting the plan in order to realize specific services, and this common foundation may thereby become in turn a foundation that takes root within the wider society to bring about innovation. The significance of *Scientific Study of Services* lies in maturing this kind of common foundation as an intellectual asset. In other words, for innovation in services, one issue is to aim to establish a scientific methodology relating to services, something that has not been achieved so far.

From Manufacturing to Services

It is said that, in recent years, services account for over 70% of the gross domestic product (GDP) in advanced countries. Japan is no exception. The classification of industries into primary industries (agriculture and forestry), secondary industries (manufacturing), and the remainder, or tertiary industries, is based on the industrial structure of the 1930s, a century after factory-based machinery industries were born in the 18–19th century. The invention of the steam engine, and engineering as a scientific methodology supporting manufacturing on the basis of this invention indeed brought about the industrial revolution. There are various kinds of services as tertiary industries, which were simply defined as “the rest” when industrial fields were classified as mentioned above. Nowadays, many kinds of services are characterized by their integration of information and knowledge. Such services include distribution of goods, transportation, accommodation, leisure, entertainment, finance, education, information, medical care, rental business, and outsourcing.

The increase in the ratio of industries involved in services to total industries indicates the relative decrease in the role of manufacturing. The same phenomenon can be also observed in the changes in the engineering field that supported manufacturing. The high-growth period in Japan from the mid-1950s to the beginning of the 1970s was a prosperous period for secondary industries, and research areas were centered on manufacturing. However, the engineering field has subsequently spread from industrial production to peripheral areas. It is now no longer uncommon for those who have studied engineering to be engaged in the services area. This implies that the logical thinking and design skills developed by education related to the engineering field are also required in the field of services. However, from the perspective of the

productivity and quality assurance established in manufacturing, as well as the technology supporting them, the situation in services as an industry is completely different in both quantity and quality from that of manufacturing, and still remain far from adequate. Consequently, while the buds of the methodologies required in fields related to services are observed even in the engineering field, the intellectual foundation available is still inadequate.

Innovation of the Information Revolution

To think of a common foundation where a newly developed technology develops into an intellectual asset that bring about innovation, the innovations of the information revolution we have experienced will be a good reference. It happened to be in the 1930s, when industrial classifications were first used, that discussions were held on computability, which may be regarded as the basic theory of computation. Although it was proved that there are problems in the world that cannot be solved merely by computation, subsequently-appeared computers were undoubtedly one of the source of the information revolution which changed society through the reinforcement of human intellectual ability.

With the emergence of usable computers in the 1960s, information processing began to be carried out everywhere, having a significant impact on social infrastructure, together with the development of information communications. While such developments in computers and information communications were included in the spreading engineering field, *Computer Science* having its own discipline as science and engineering for computation has matured, showing the process where innovation was brought about in both industrial and social aspects as a result of the establishment of the intellectual foundation of a reliable scientific methodology. Through collaboration and integration with peripheral areas, this field is now positioned as *Information Science and Technology*, or Computer Science in the broad sense of the term. As mentioned above, the change in engineering that supported manufacturing and the development of the information science and technology that supports the information society, suggest the characteristics of the intellectual foundation needed to bring about innovation in services.

Necessity of a Methodology for the Scientific Study of Services

As described above, the situation in industry and the achievements of science in the 1930s have had a range of impacts on research in the engineering and the information science and technology fields until today, 80 years later. While the present industrial structure implies that the source for creating affluent lives in a highly advanced society lies in services, it is a matter of

course that a methodology for “scientific study of services” is required to respond to the expectation for the provision of better services. Attempts have been also made to date to apply methods used in engineering and the information science and technology fields to matters concerning services. As is usually the case with any particular field, no systematic discipline emerges all of a sudden out of nothing. In this sense, a core concept or method must already be in existence. Needless to say, the existing knowledge and methods in engineering and the information science and technology fields alone are inadequate and the knowledge in the fields of science related to human behavior and social systems must also play an essential part. Now that the necessity of the scientific study of services is increasingly recognized, such as in the social background for pursuing an affluent life through services, the situation of an industry where the productivity, reliability, and creativity of services are required, and the interest of academia in establishing a scientific foundation, the pursuit of methodologies by systemizing the definition of concepts, and the methods that are already being nurtured, will together be regarded as a science of the 21st century for society.

Toward the Establishment of a Methodology for the Scientific Study of Services

In order to establish a scientific methodology for services, it would be effective to learn from the knowledge of people that have created and developed new methodologies, while taking the characteristics of the relevant services into consideration. Natural science has an approach similar to quantitative science based upon observation, where a phenomenon is first qualitatively understood, and this is followed by analysis, where the observed results are quantitatively handled. In the case of services, the characteristics of the relevant services should be understood through qualitative observations and the observed results then quantitatively analyzed to realize services as a system based on the analyzed results. As the first step to pursue this type of methodology, it would be more appropriate to focus on the information society, where the activities of people and organizations are dependent on information technology, than to address services in general. One methodology obtained in the area of information society, which is limited but clear, could be the *Informatical Foundation of Services*,* which is an abstraction of the essence of the concept and methods common to individual services that are realized as a system. Realization of services by applying the methods developed upon this foundation to individual matters will give clear grounds for providing better services, as well as demonstrate

* The term “Informatical Foundation” is used as corresponding to “Mathematical Foundation.”

the validity of the methodology. This kind of methodology is, through its embodiment, expected not only to be effective for the information society but also to become a foundation for handling a wider range of services.

From the Informatical Foundation of Services to Service Informatics

To deploy methodologies concerning services in the information society, it is desirable to establish a research area where individual matters are first abstracted. This is the same as in physics, where the motion of objects and the structure of materials are established as a study area. Now, typical issues concerning services include the efficient provision of services, the transition in manufacturing towards a service-oriented economy, and measures for expanding administration services. The research areas required to resolve these issues will include dealing with evolution/variation, handling large amounts of data, overcoming the complexity of systems, understanding human psychology and behavior, and designing social systems/administration systems. These are examples of research areas to systemize investigation/measurement, analysis/visualization, modeling /prediction, design/optimization, design/evaluation technology, system construction technology, etc., for services in respective areas. Needless to say, the issues to be resolved here are not limited to these but other issues may emerge anew within the research process. Nevertheless, all of these issues are keys for promoting integrated research in its true sense based on knowledge in existing academic fields, including, notably, engineering and information science and technology, as well as social science, with these individual fields mutually stimulating each other. Included among them are also visualization, optimization, and simulation, which have developed as methodologies that can be applied to various objects and phenomena in engineering and in the information science and technology fields. However, sufficient studies have yet to be conducted on the issues concerning people and society, which are characteristic of services, and the means to resolve them. Such issues include indices concerning human sensitivity and behavior, mechanisms for decision-making in society, and co-creation by multiple parties from different perspectives. As mentioned earlier, it is clearly necessary to conduct research integrating different fields for the scientific study of services. However, the achievements of integration will not be realized until individual concepts and methods are integrated into a methodology based on the informatical foundation of services and such methodology is recognized as *Service Informatics* or *Services* in the broadest sense.

Research and Development through Industry-Academia Collaboration via an Informatical Foundation of Services

It is said that innovation usually originates from needs, and is brought about through the utilization of the necessary intellectual assets. In research and development through industry-academia collaboration, the requirement of service providers for a method to resolve the issues they face can be adopted as an issue for integrated research at institutions such as universities. The methods or methodologies developed by researchers should be organized as an informatical foundation of services, which can then be used as a tool by the service providers. In this manner, achievements in the area of integrated research may be used via the informatical foundation to resolve issues concerning the provision of services, and thereby promote service innovation originating from actual needs. In the picture, shown below, are specific examples of the allocation of roles to industry and academia in the research and development of services and approaches to resolving issues through industry-academia collaboration.

In order for service providers to understand the whole scene from a long-term perspective, methods used in engineering or information science and technology are inadequate—even for the provision of services by information technology. It is therefore essential to resolve issues through a number of research areas concerning human organization, behavior, and mentality, such as the fields of sociology and psychology. However, from a realistic standpoint of industries engaging in services, it is impossible to continue research and development in all of these areas, and research and development has to be limited to the most relevant areas by monitoring the changes in markets and customers and changes in the environment. In particular, it is difficult to promote research and development in fields where long-term research is required and in fields other than a specialty area. On the other hand, such realistic issues concerning services will naturally promote the formation of integrated areas to deal with issues that cannot be resolved by the existing areas of academic research in universities and other institutions, which will in turn lead to the development of a new discipline. In pursuit of solutions and sharing issues between industry and academia, continual collaboration in integrated areas of multi-faceted research will be effectively realized.

Collaborations have always occurred between industries and universities when necessary. In the case of collaboration in the service field, however, many cases require collaboration in integrated areas, and needs in the targeted service field can fluctuate significantly. Further, the research and development system is required to be directly linked to the provision of services to customers. These factors will require an implementation method and a system that are different

from those in conventional industry-academia collaboration. In other words, due to the fluidity of services, it is predicted that priority issues in the research area and research of necessary elemental technology may continually change, and even if broad service fields and areas are established from a long-term perspective, an organization and a methodology for appropriate management of the fluidity of research areas will be required, for example, to alter the subject of research to an appropriate research element in accordance with the change in service fields. In addition, because of the simultaneity of services, the location where research is conducted should be closely related to the provision of services. Therefore, it is also expected to be necessary to establish a system to promote research that takes into account the impact on the collaborating company, the management of customer information, and so forth.

As for research concerning public administration services, it is difficult to predict short-term profits, making it hard for a single company to conduct the necessary research. Since such services also involve a way of consensus building and the design of the social system, it is indispensable to collaborate with not only industry or academia but also with the government, a major services provider. In this type of services, since it is necessary to give consideration to not only value for individual users but also value for the whole of society, ability and knowledge in engineering and the information science and technology fields that are involved in system construction, as well as in humanities and social sciences, will be required. Thus, integrated research areas are also formed in this case. Through industry-academia collaboration, the strength of universities in academic and foundational technologies, and the strength of companies in practical experience at workplaces and in application technology are expected to be integrated in order to promote research toward the resolution of issues in the area of public administration services.

We believe that the pursuit of an informatical foundation of services to realize innovation proposed here, and promoting research and development to establish such a foundation, will mark a major contribution by science and technology to realizing an affluent society through service development.

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