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Prospects for Systems Research & Development

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1. Introduction

Recent development of information technology has been astonishing. If the period when a limited number of persons using a system mainly for a key business on a mainframe was called the mainframe age, then the period when user groups were expanded by introducing down-sizing and client server systems is called the open system age. And we have already entered the network computing age; networks now stand at the center of systems.

In the open system age, personal computers were rapidly introduced into households, which played a role in greatly enhancing the computer literacy*1 of people other than computer specialists. At the same time, the information systems of enterprises have been expanded to cover areas other than the key business, raising recognition of information strategy within enterprises.

In the present network computing period, an enormous amount of information is flowing in networks, typically in the Internet, beyond the borders of enterprises and countries. It is very important for enterprises and persons to effectively use such information. System research and development under this situation should be promoted viewing information systems and interaction with persons, enterprises, and society without any limitation by computer science.

2. Flow of System Research & Development

System research and development can be classified according to its history.

2.1 Product technology of the system

At the initial period when computers were introduced, most research was carried out mainly for hardware but seldom for systems including software. Typically, software research was performed to develop the software for specific hardware or for numerical computing algorithms for military purposes. They were individual technology as system components or product technology. Research related to production technology concerning how to construct an entire application system, how to efficiently develop software, and how to assure its quality, was inconspicuous until the 1970s.

2.2 Production technology of the system

In the 1970s, system development/maintenance costs increased, and the production technology for research system development itself was conspicuous. Among these trends, a structured technology was born, and in the 1980s data-oriented technology*2 and object-oriented technology*3 were introduced. With the development of microprocessors and network technology, distributed architectures such as client servers and the 3 tiered model*4 began to be used. These technologies seem to be product technologies at first glance, but they are significant as an integrated technology to produce better systems economically by combining individual technologies. It is a production technology in that context.

The above technologies are all well developed in Western countries but are not well recognized as a system production technology in Japan. The term "system production technology" itself has not yet been widely accepted among us. Classification by the maturity model for the software production process defined by Carnegie Mellon University evaluates the level of software houses in Japan as very low. An exception is the software factories of the computer manufacturers producing the basic software for computers. In Japan's application software field, system production technology is still poorly recognized. System production technology might not be settled in Japan in situations where the key station of software development has been shifted to other countries such as India or China.

2.3 System utilization technology

System utilization technology already existed naturally when computers were invented. The technology, however, was limited to replacement of human activity for a long time. At first, the technology gave only the merit of carrying out routine work rapidly and exactly, such as numerical calculation and bookkeeping. At that time, the crucial point was whether the system could process faster or cheaper than humans did. Since then, the system has been used for a wide range of application areas with real-time processes such as control. In addition, a typical system such as an expert system can emulate human intellectual activity to some extent to expand the possibilities for non-routine process applications.

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*1 Computer literacy: Ability to use computers and computer software.

*2 Data oriented technology: Data oriented approach: An approach focusing on analysis of data item and its flow in an upstream process to define requirements and design in the information system structure.

*3 Object oriented technology: Object oriented: An approach to process information using a unit called an object by combining data (structure) and program (method). This is an object oriented concept, not a procedure oriented one. It is characterized by concealing detailed data structure from outside because data can be operated only by combined programs. This is expected to be the core concept for software technology in the future, with an affect on various levels in software development.

*4 3 tiered model: 3 tiered system: An approach to developing C/S type applications by dividing into three function modules. By clarifying (1) "presentation tier" to realize user interface, (2) "function tier" to execute data processing, and (3) "data tier" to access database, system performance and development and maintenance efficiency are expected to be enhanced.

In this way, with expansions in system availability, new utilization technologies were produced such as digital control technology and knowledge engineering. A system can be connected to a network such as the Internet and Intranet to drastically expand system availability in the information system, and rapidly increase the significance of research and development of utilization technology. For example, the society has been impacted by the acceleration of development/manufacturing speed from CE (concurrent engineering), changes in monetary and distribution practices through EC (electronic commerce), and changes in business and organization among white collar workers due to BPR (business process reengineering).

The recent steady economic expansion in the United States is mainly caused by changes in industrial structure due to innovations in information systems and is recognized as being different from a mere economic cycle. If this is true, then it will be impossible for Japan alone to stay as it is in the mega-competition situation involving internationalized industry structure and severe competition. Therefore, at present, research and development of system utilization technologies becomes a question of vital importance not only for the information industry but also for all industries and countries.

3. Research and Development at Systems Research & Development Center

3.1 Outline of organization and research

The Systems Research & Development Center, where the author works, is a part of the Electronics & Information Systems Division, and it promotes research and development regarding information systems. The organization acts not only as a division laboratory within the Division but also as a corporate laboratory for all of Nippon Steel Corp. Researchers in the Center directly join the actual projects to ensure the effectiveness of the technology as well as routine research works. In addition, education for technical propagation is also an important mission. The Center has only a hundred persons or fewer but has a large-scale experiment field (the steel making site), thus competing with large institutes having more than a thousand persons at leading computer manufacturers, in areas of knowledge engineering and object-oriented fields.

The Systems Research & Development Center consists of four research groups (network applications, object-oriented applications, software engineering, and system technology) and a technical planning group. The two application groups are engaged mainly in application development and the other two groups concentrate mainly on fundamental research. The technical planning group plays a role in planning and promotion of technical policy in the Division. Most resources are introduced into the system production technology, while the remaining resources (less than one fourth each) go into product technology and utilization technology. In the future, product technology will be further reduced and utilization technology is expected to be reinforced.

3.1.1 Network application group

The network application group is mainly intended to accumulate structure/utilization technology of network application systems. Until now, the group has constructed: hierarchical storage system to control, store and distribute large-scale data; integrated document system for Intranets; and EC system for Extranets. Through these developments, the group established utilization technology for large-scale data such as information accumulation and information retrieval, and security technology such as cryptography and authentication. Engineers have been trained in new languages such as HTML (HyperText markup language), VRML (virtual reality modeling language), and Java*5.

3.1.2 Object-oriented application group

This group is engaged in technical development to supply practical application systems to both inside and outside the corporation, assuming that an object-oriented application is a key technology. Recently, a major theme is verification of the effect of object-oriented technology for a large-scale production planning process in the steel making field. Inference technology, optimization technology using genetic algorithm, and simulation technology supplied by this group are classified and applied with the aim of enhancing system performance. At the same time, software is secured for reuse in multiple steelworks for improving the ease of customization.

3.1.3 Software engineering group

This group pursues system production technology as a main research and development target. Recently, the largest theme includes research and development of methodology for processing spiral system development in object-oriented systems, defining related procedures, and developing an environment to support the procedure smoothly. The group also works to develop reverse engineering technology for enhancing productivity of system maintenance and estimation technology for system development. In addition, it provides education and consultation services in object-oriented technologies.

3.1.4 System technology group

This group is engaged in research and development for common technology independent of special applications and consists of two teams, a performance engineering team and a network technology team. The performance engineering team aims at performance evaluation and improvement technology for the system as a main development target and deals with performance prediction/measurement technology by simulation or benchmarking, finding bottlenecks in the actual system using monitoring tools and improving the technology. The theme of the network technology team is mainly technology related to structure and operation of the network. Through the test operation of a large-scale wide area distribution environment, this group verifies and accumulates technology such as route control of the network, mutual connection, security, the next generation of the Internet protocol*6, and mobile host*7.

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*5 Java and Java related trade marks and logos are the trademarks and registered trademarks of Sun Microsystems, Inc. in the United States and other countries.

*6 Next generation Internet protocol: IP (Internet protocol) address of an identifier allocated to each host computer of and within the network has been insufficient when limited to 32 bits due to popularization of the Internet. IETF (Internet engineering task force) is studying IPv6 (version 6) as the next generation Internet protocol. It plans to expand from the existing 32-bit standard to 128-bit addresses.

*7 Mobile host: A host (computer) that can be physically moved such as a notebook personal computer or PDA (personal digital assistant: portable data terminal). This means that it is not always connected to the network but is connected via PHS (personal handyphone systems), portable telephone, or public telephone on a demand basis.

4. Future Prospects

Under the situation mentioned above, the author offers projections regarding what kinds of system research in Nippon Steel Corp. will be performed in the future.

4.1 Advantage and disadvantage of Nippon Steel Corp.

Nippon Steel Corp. is a newcomer in the information and communications field, and its division and Research and Development department are smaller than those of computer manufacturers. Therefore, the range of technical approaches is limited, but it can offer another advantage in quick decision making by young researchers. Nippon Steel Corp. has few original products, but this is rather an advantage, ensuring a neutral position under the recent open system. In addition, Nippon Steel Corp., as a user of the information system, has a long history and has much experience in employing large-scale systems. This brings another advantage at the time when utilization technology becomes important. As mentioned above, having a broad field within the organization greatly contributes to practical application of the technology.

4.2 Direction of system research and development in Nippon Steel Corp.

As mentioned in the previous section, Nippon Steel Corp. is a big user of the information system and is a neutral vendor who started as a user as well. Naturally, research and development of the system technology has two important purposes. The first is strengthening its competitive power through innovation of the information system contributing to the management. For the field, system utilization technology is a target. When the business application system is constructed, it is important to define again the form of the business on the basis of comprehending recent system technology, not to confirm the existing business and organization and replace it with the system. This is called BPR, but there are few persons who can discuss business and organization who also understand new technologies such as networks, artificial intelligence, data warehouses, workflow, etc. This urgently requires the fostering of researchers with knowledge related to office and technical works.

The second is efficiently promoting the system integration business by applying the company's neutral position. Naturally, utilization technology verified within the organization should be provided to customers, but the significant technology developed as an integrator should be production technology for the system. System structure needs speed and flexibility under today's mega-competition situation. Cases are increasing where customers require the system to be greatly improved ahead of competitors in the same field, but they may modify specifications only halfway because the system development was begun without defining detailed specifications. Under these conditions, a technology for constructing stable systems with quality and economical cost is needed. For this purpose, it is necessary to further promote research and development on spiral system development using existing object-oriented systems. It is important to research the framework for integrally handling objects and templates for system architecture. Furthermore, it is desirable to research and develop group dynamics[*8] aimed at efficient application of human resources which are the largest in the system integration business.

5. Conclusions

We will efficiently promote research and development with researchers who are competent in both research and development while applying them in the broad field of Nippon Steel Corp.

[*8] Group dynamics: A field of sociological and/or psychological sciences which assume that the field of a group is a field of force action similar to gravity fields and electromagnetic fields, and the study of such forces.