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—Handling Tomorrow's Problems Today—

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JIPDEC is a non-profit organization founded in 1967 with the support of the Ministry of International Trade and Industry, the Ministry of Posts and Telecommunications and related industry circles for the purpose of promoting information processing and the information processing industry in Japan.

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CONTENTS

No. 72

FROM THE EDITOR

Two oil shocks followed by a rise in the value of the yen made going extremely tough for Japan and its economy in the mid and late 1970's. Now declining international competitive power in the coal, shipbuilding, steel and textile industries, a slump in world demand, and the recent impact of an increasingly stronger yen are rapidly deteriorating employment and economic conditions in general in Japan. Manufacturing industries such as the electric machinery and automobile industries have always been able to absorb large percentages of the Japanese workforce. However, even these industries are exporting less and putting more emphasis on overseas production schemes, and can not be counted on to provide much in the way of employment opportunities in future.

On the brighter side, however, such high technology fields as microelectronics, biotechnology, superconductivity and new materials are rapidly developing into full-scale industries in their own rights. Technological innovations being made in these fields are also giving a big boost to the growth of the information industry with its basis in computers and communications.

The advance of the information revolution in these areas is having an enormous impact on existing industries, rapidly pushing forward informatization programs throughout industry in general. The manufacturing industries in particular are swiftly automating their operations.

As a result, employment opportunities in the primary and secondary industries are steadily declining, and unemployment is expected to finally become a major problem in Japan as well.

However, informatization will also produce new job opportunities. Not too long ago, JIPDEC conducted a survey for the OECD titled "Microelectronics: Impact on Employment." This survey was carried out to determine whether or not there was any basis for apprehensions that the introduction of computers into companies would result in large-scale cutbacks in office personnel. The results of that study indicated quite the opposite. That is, the introduction of computers into corporate operations created demand for new EDP personnel without giving rise to unemployment problems. As a matter of fact, we have not experienced any major unemployment problems resulting from the use of computers in business to date.

Moreover, the progress of the informa-

tion revolution is requiring that companies expand the intangible aspects of their operations, such as information, technology and design. At the same time, it is also influencing personal consumption trends away from material products to services, which in turn is giving rise to a need for more diverse, advanced types of services. In other words, informatization is making the economy more service oriented. As automation and artificial intelligence (AI) technology continue to progress in future, the time workers spend on the job will steadily decline as they get more and more days off. More free time is expected to give rise to more interest in leisure activities, which in turn, is seen as giving a big boost to the leisure and services industries in Japan.

As new industries spring up and grow in this way, the industrial structure will gradually change. Unemployment in certain segments of industry should be more than compensated for by the anticipated shortage of personnel in the information industry. It is this projected shortage of information industry personnel that constitutes the main theme of this edition of the "Japan Computer Quarterly."

According to a report on the Japanese population titled "Japan's Future Population Growth" compiled by the Ministry of Health and Welfare's Institute for Population Problems, the total Japanese population is expected to increase at an annual rate of 0.5% between 1985 and 1993. This rate of growth is seen as increasing slightly to 0.6% per annum for the period 1993 to 2000. However, average life expectancy is also expected to increase, resulting in the senior citizen population growing at a rate in excess of that of the total population. In other words, Japanese society is expected to age quite rapidly in future. More specifically, the percentage of the total Japanese population accounted for by persons 60 years of age and over is expected to increase from the 14.8% recorded in 1985 to 19% in 1993, and then jump up to 22.1% by 2000. That will mean that one out of every 4.5 Japanese citizens will be 60 or over by the year 2000. The ratio of older workers in the labor force can thus be expected to grow larger in future.

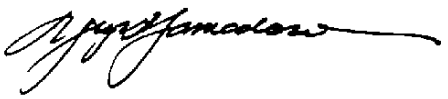
The sprawl of industry and the move toward a more service oriented economy are changing the Japanese industrial structure and producing a new employment structure. Statistically speaking, the theory that new industries should be able to absorb the surplus labor created by automation seems sound. However, the demand for the high-level engineers required by the new knowledge-intensive industries in future can not possibly be satisfied by the simple transfer of personnel from other industries. This situation is further compounded by the fact that the Japanese workforce is aging so rapidly.

This problem will have to be given much thought and study, and dealt with jointly by the public and private sectors working together.

In this edition of the "Japan Computer Quarterly," therefore, we take up the future outlook for Japan's information industry from the standpoints of

industry itself and the education and training of personnel. We also discuss recent trends in the small-scale computer market, which is expected to have a significant impact on the development of the information industry in future. And finally, we present an overview of JIPDEC's approach to tackling a number of new themes related to informatization.

We sincerely hope the information compiled herein proves of interest and value to our readers.



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FUTURE OUTLOOK FOR JAPAN'S INFORMATION INDUSTRY
— Information Industry Vision For The Year 2000 —

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The Ministry of International Trade and Industry (MITI) has been preparing mid- and long-term visions, or outlooks, for Japanese industry for some time now. These visions are based on the results of research and surveys of leading figures from a variety of fields concerning changes in the overall industrial structure, future trends and the types of policies needed to achieve the most suitable industrial structure. MITI has also been preparing similar visions for individual industries. The first such visions for the information industry were compiled back in the 1960's. The most recent of these was put together in 1981 under the title "Informatization and Information Industry Vision for the 1980's." This report was highly acclaimed for its detailed image of informatization in Japan and the design it set forth for achieving an advanced information society. However, changes in the economic and social environment subsequent to that report made it necessary to once again review the future course of the information industry in Japan.

To accomplish this, MITI in February 1987 set up a long-term outlook working group within the Basic Policy Subcommittee of the Industrial Structure Council (ISC)'s Information Industry Committee (Yoshihiro Fujii, vice-chairman of the Sanwa Bank, chairs the committee.). After meeting a total of six times, this working group compiled on June 19, 1987 a report of its findings, entitled "Information Industry Vision for the Year 2000." The main points brought out in that report are discussed herein. It should be noted that the information industry vision report deals with the information industry in the broadest sense of the word, lumping those industries that support informatization into one category. More specifically, however, the information industry can be broken down into the following three major sectors:

1) Electronics industry — this is the industry that manufactures computers and accessory devices and equipment; other electronic devices; electron tubes; semiconductor elements/integrated circuits; data communications equipment and related devices; electric measuring instruments; electric sound equipment; and radio and television receivers.

2) Telecommunications — this industry

is comprised primarily of Nippon Telegraph and Telephone Corporation (NTT) and the Kokusai Denshin Denwa Co., Ltd. (KDD), Japan's domestic and international Type I telecommunications carriers, respectively. Type II telecom services will not fall into this sector for the time being, being classified instead under the information services industry. NTT's data communications business also falls into the information services industry, but for convenience sake, is included in the telecommunications sector.

3) Information services industry — this industry includes information processing services, software services and information provision services.

The future outlook for the information industry also includes those new industries expected to be born out of the influx of outside industries into the information arena.

I. BACKGROUND AND PERSPECTIVES

The steady progress being made in informatization in Japan is bringing about a number of changes in the information industry. First, there are the qualitative changes in the demands being levied on that industry; second, there are changes stemming from the industry's becoming more international; third, there are the changes in the role the information industry is playing in reforming the industrial structure of Japan; and fourth, there are the structural changes taking place in the information industry itself as a result of the liberalization of telecommunications laws and the subsequent growth of the telecommunication services business here.

These various changes make it necessary to analyze the information industry in Japan from a semi-macro perspective in order to clarify the direction in which it is heading.

II. CHANGING DEMANDS AND THE INFORMATION INDUSTRY

Advances in informatization are giving rise to major changes in the demand structure of the information industry. This industry will have to respond to these changes appropriately.

1. Demands Expected to Persist in the Future

The information industry will have to continue to respond to the existing demand for 1) enhancement of equipment performance and reduction of costs for information processing; 2) skilled human resources; 3) improved software development techniques; and 4) more advanced, diversified information processing. To accomplish this, the industry must strive even harder to develop new technologies, to train more highly-skilled human resources, to make software production more efficient and to advance the state of the industry itself.

2. Changing Demands

Progress in the industrial usage of information techniques, the increased numbers of diversified users and the penetration of informatization into everyday life are changing the demands being levied on the information industry. These changing demands include:

(1) a rising demand to promote OSI and to provide "systems integration services" to cope with increased systematization and networking;

(2) a demand to change the division of labor and responsibilities between computer manufacturers, users and software producers and to provide "professional services" in order to deal with increasing and expanding applications of information systems brought on by the further advance of informatization in industry;

(3) an increased demand for easier-to-operate, more "user-friendly" systems to meet with the growing numbers of personal users of information systems and services;

(4) a growing demand for standardized open interfaces to make better use of increasing information-related assets such as software and databases;

(5) an increasing demand to improve information system security measures via technology development and the use of systems auditing services to deal with the growing dependency on information systems in Japanese economic and social endeavors;

(6) a demand for improved information provision services that offer electronic-library-type functions to handle the increased importance being placed on efficient information selection and use; and

(7) the demand to rectify the differences in long- and short-distance telecommunications charges and to promote the informatization of outlying regions of Japan in order to achieve well-balanced, nationwide informatization as opposed to the informatization of major metropolitan areas alone.

These changing demands characterize the future direction of the development of the information industry in Japan. As such, they will have to be appropriately dealt with by the information industry.

III. INTERNATIONALIZATION AND THE INFORMATION INDUSTRY

As Japan's overall economy becomes more and more international in nature, the information industry, which is closely linked with internationalization, will be required to deal positively and effectively with this phenomenon.

1. Trends in Direct Investment

Investments by foreign capital in electronics and information services industries in Japan, and investments by Japanese capital in the electronics and information services industries of other countries are on the rise. In line with this, a horizontal division of labor is manifesting itself with other industrialized countries, and a vertical division of labor is coming into being between

Japan and the developing countries. These factors raise hopes that the trade-related earnings and expenditures of the information industry will achieve a state of balance.

Japan will have to more actively co-operate with developing countries to support their efforts in informatization.

2. Information Industry Trade in Services

Trade with other countries in the form of information services is expected to increase in the future. When this happens, information services imported into Japan will continue to exceed those services exported overseas.

In response to demands from a number of foreign countries; Japan will have to strive to increase provision of Japanese databases to overseas users.

3. International Telecommunications

Demand for international telecommunication services should continue to rise in the future, with the progress of internationalization of industries' activities. Service menus and utilization charges that meet with the new role of telecommunications systems as transportation medium for service trade are required.

IV. INDUSTRIAL STRUCTURE CHANGES AND THE INFORMATION INDUSTRY

1. Supporting Economic Growth

(1) As a Leading Industry

The information industry continues to have potential for high growth, and is one of the major sources of continued growth in the Japanese economy as a whole. This industry also has the role of fostering the switchover of the Japanese industrial structure to one that is driven by domestic demand.

Future growth of the information industry based on a (nominal) 5% growth in GNP:

% of GNP:	1984 = 6.4%
	2000 = 20.6%
Output value:	1984 = 20 trillion yen
	2000 = 140 trillion yen
Average growth rate:	1984 – 2000 = 13.3%

(2) Increasing Domestic Demand

Increase of consumer demand for home and personal services is the key to domestic-demand-driven growth of the Japanese economy and information industry. The ratio of information industry demand accounted for by this type of consumer demand is expected to grow. Japan will therefore have to devise comprehensive measures aimed at coping with "personalized" information.

Japan will also have to provide appropriate incentives for information-related investments, which may lead to growth of domestic demand.

Table 1. Production Output Per Information Industry Sector and Respective Percentages of GNP

(Units: 100 million of yen/%)

		1959	1965	1970	1975
Electronics Industry	Output	134,436	296,944 (1.141)	584,415 (1.145)	1,101,552 (1.135)
	Percentage of GNP	4.38	7.06	10.75	15.67
Telecommunications Industry	Output	49,557	75,530 (1.073)	124,309 (1.105)	185,392 (1.083)
	Percentage of GNP	1.61	1.81	2.32	2.67
Information Services Industry	Output	12,399	31,935 (1.171)	71,706 (1.176)	158,226 (1.172)
	Percentage of GNP	0.40	0.76	1.33	2.27
Total Output		196,392	404,409 (1.128)	780,430 (1.141)	1,445,170 (1.131)
	Percentage of GNP	6.39	9.63	14.40	20.61

Note: The figures in parentheses represent average yearly growth.

Table 2. Number of People Employed in the Information Industry

(Units: ten thousands)

	1951	1959	1965	1970	1975
All Industries	5,271	5,766 (1.011)	5,973 (1.006)	6,151 (1.006)	6,335 (1.006)
Electronics Industry	54	91 (1.067)	136 (1.069)	183 (1.061)	236 (1.052)
Telecommunications Industry	35	32 (0.989)	35 (1.015)	42 (1.037)	47 (1.023)
Information Services Industry	6	37 (1.255)	63 (1.093)	93 (1.081)	127 (1.064)
Information Industry Total	95 [1.8%]	160 [2.8%]	234 [3.9%]	318 [5.2%]	410 [6.5%]

Note: Figures in parentheses represent average yearly growth, and those in brackets indicate percentage of overall employment industrywide.

2. Entrants to the Information Industry

Entry into the information industry has been quite lively in recent years. This has been due in large part to firms moving their EDP divisions outside the company, to the marketing of software developed in-house, and to providing in-house databases to outside users. The informatization of traditional media industries like the newspaper and printing industries has also made progress.

3. Mutual Inter-industry Dependence

Rising interdependence of each sector in the information industry will result in a division of labor and close cooperation among the members of this industry. The information industry will serve as a multi-layered infrastructure supporting the business operations of other industries.

V. INFORMATION INDUSTRY AS INFRASTRUCTURE

Informatization is an effective tool in attaining goals such as improved lifestyles and animated economic activity. The information industry is therefore being looked to to fulfill the role of an infrastructure in the Japanese economy.

In light of this, emphasis should be put on the following conditions to enable the information industry to play the role of an infrastructure.

1) protection of intellectual property rights;
2) lifting of regulatory controls as a means of ensuring freedom of private actions; and
3) Creation of a better framework for offering wider telecommunication services and for telecommunication rates.

TRAINING FOR INFORMATIZATION

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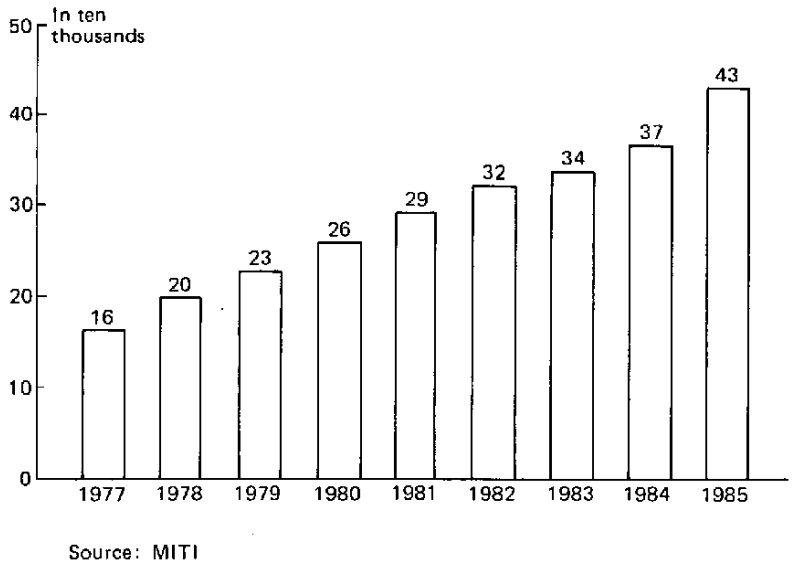
Informatization is making rapid progress in Japan, and is expected to reach advanced levels in future in the realm of economics and in society at large. The advanced information society will make it possible to overcome physical distances and to accumulate and utilize information to achieve a national lifestyle that is richer socially, economically and culturally. However, at the same time, it also has the potential for producing a variety of problems, such as new types of crimes, an overabundance of information and a situation whereby people-to-people contact and interaction are radically lessened. The success or failure of the advanced information society will therefore depend on how well we train the personnel required to maximize the merits of informatization while promoting its smooth development.

CURRENT STATE AND PROBLEMS OF TRAINING INFORMATION PERSONNEL

Fast paced advances in electronics technology have resulted in the rapid spread of computer hardware. But the supply of software needed to operate this hardware has not been able to keep pace with demand. This gap between software supply and demand could well prove a major bottleneck to informatization in future. Software engineers are increasing in number every year (As of 1985, there were 430,000 software engineers in Japan, 170,000 of whom were systems engineers. The remaining 260,000 were programmers (See Figure 1).). However, companies still have program development backlogs that will take a year or longer to clear up, and these are causing considerable supply shortages. Whatismore, the increased, widespread utilization of information systems and advances in technology that require more complex, diverse types of software are giving rise to software reliability and quality problems (the software crisis).

Issues Related To The Training Of Software Engineers

As it stands now, out of 38,000 people who recently became programmers, 17,000 received their basic education and training at specialty and/or technical schools, while another 13,000 received theirs at universities and colleges, indicating that Japanese programmers are



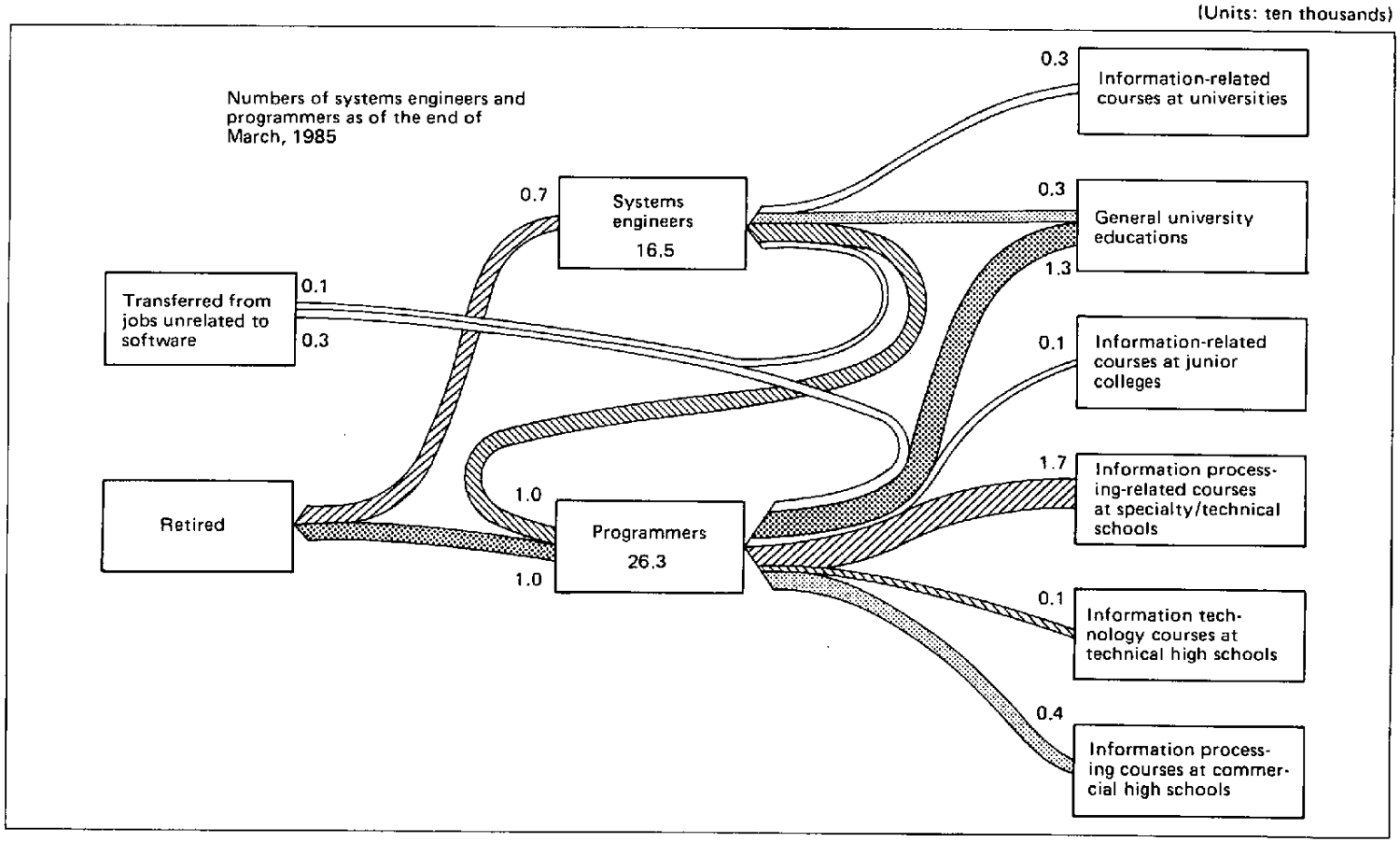
Source: MITI

Figure 1. Yearly Increases In Numbers Of Software Engineers

trained primarily at specialty/technical schools. Out of 17,000 new systems engineers, 10,000 were trained at company expense, and another 6,000 received their training at universities and colleges. In the case of systems engineers, then, most seem to get their training at the companies where they work (See Figure 2). These trends pose a number of problems.

Specialty and technical schools currently account for a large percentage of the supply of new software engineers, and with this field growing as it is (See Table 1), these schools will probably prove a principal supply of software engineers in future as well. A problem arises from the fact that industry is claiming that the quality of software engineers graduating from these specialty/technical schools is poor. For example, the pass ratio for the junior programmers examination given in 1987 worked out to an overall average of 14.8%, of which only 10.1% were accounted for by specialty/technical school graduates. Some of the specific problems that can be cited here include 1) insufficient numbers of quality instructors; 2) poor curriculums; 3) incomplete facilities and equipment; 4) incomplete training systems for instructors; and 5) unsatisfactory training materials.

Systems engineers trained at their companies currently receive an average of 6.8 days of training a year (See Figure 3), but there is a great deal of dissatisfaction with the incomplete nature of this training (See Table 2). Specific problems being pointed out include 1) investments in training are large, placing a considerable burden on small- and medium-sized firms; 2) work is so busy that time can't be found for training; 3)



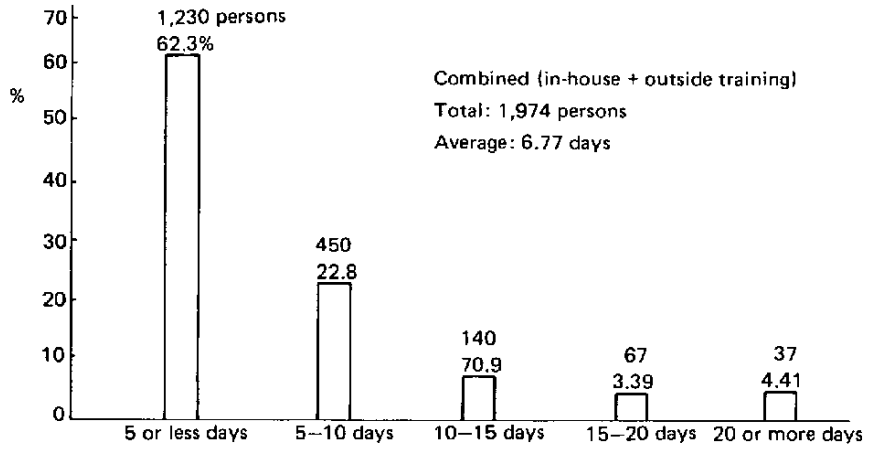
Source: MITI

Figure 2. Influx/outflow Of Software Engineers During Fiscal 1985

Table 1. Yearly Growth Of Computer Specialty Schools and Computer Courses

Fiscal Year	1980	1981	1982	1983	1984	1985	1987
No. of Schools	39	46	51	73	120	157	227
No. of Courses	73	85	96	133	223	303	

Source: Ministry of Education



Source: CAIT

Figure 3. Number Of Training Days Per Year Per Systems Engineer

Table 2. Degree Of Completeness Of Corporate Education/training

Degree of completeness	Very complete	Complete	Can't say	Not complete	Totally incomplete	Unknown
Systems engineers (%)	3.5	22.8	29.8	35.1	5.3	3.5
Programmers (%)	7.0	38.6	29.8	17.5	1.8	5.3

Source: MITI

training methods are incomplete; and 4) career development programs and training systems are incomplete.

Problems With Computer Literacy Training

In order for the economic and social merits of an advanced information society to be widely enjoyed, the people of that society must be able to utilize computers and other information-related equipment plus the information handled by that machinery. And to do that, they must be properly educated and trained, that is, they must be computer literate. Computers must therefore be made a part of elementary and secondary education programs. The introduction of personal computers (pc's) into schools in Japan still lags far behind the levels achieved in the United States and Europe (See Table 3).

Table 3. Rate Of Personal Computer Utilization In Schools

	Elementary Schools	Middle Schools	Remarks
Japan	2.1%	13.9%	1985
America	84.8%	91.8%	1984
United Kingdom	99.0%	100.0%	1984

Source: Ministry of Education

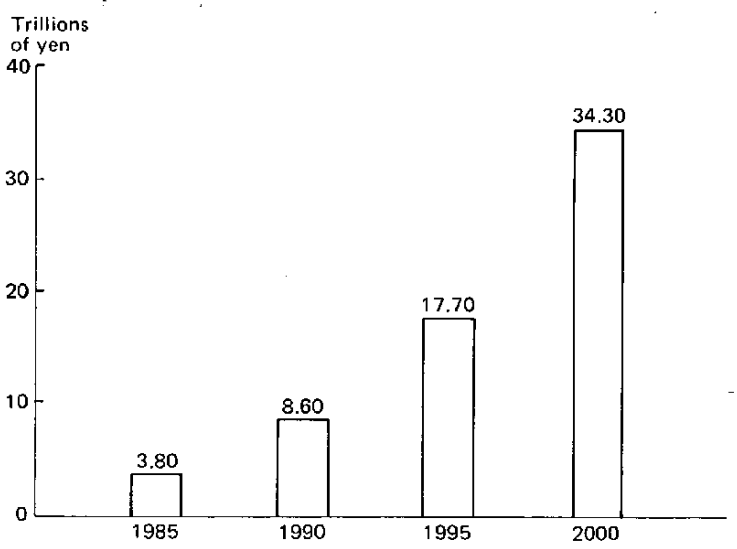
SOFTWARE ENGINEERS IN THE YEAR 2000

The information revolution will continue to spread in Japan, penetrating ever deeper into this country's social fabric until by the year 2000 we are on our way toward achieving an advanced information society. This means that huge amounts of very advanced software will be required, that software requiring maintenance will continue to accumulate and that software engineers will have to be highly skilled and numerous. The areas software engineers will be expected to cover will also broaden considerably, requiring specialization in such areas as artificial intelligence (AI) technology, networking, computer graphics, databases and systems auditing, to mention but a few.

Under these circumstances, the demand for software will rapidly increase. Whereas software demand in 1985 reached 3.5 trillion yen by value (or 1.05% of GDP), by 2000 it is expected to reach 34.3 trillion yen on a value basis (or approximately 3.97% of GDP) (See Figure 4).

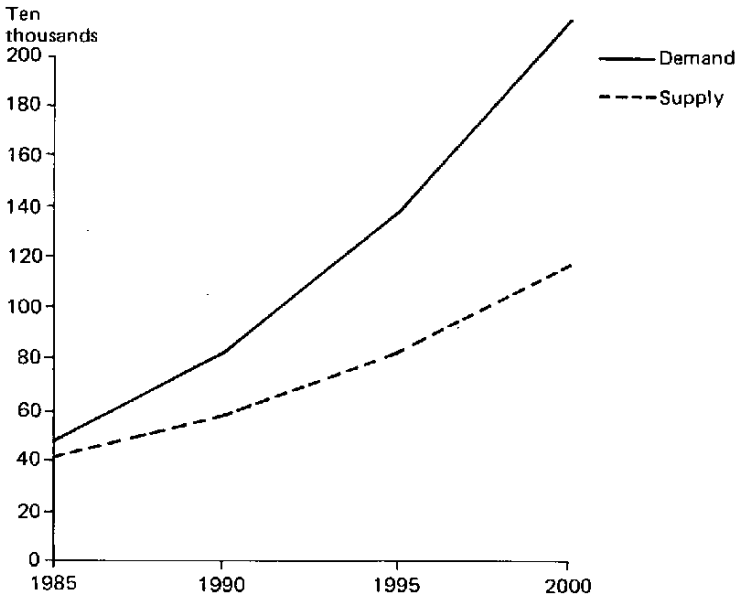
In order to meet this anticipated 34.3 trillion yen worth of software demand, some 2.15 million software engineers will be needed based on current trends. At the present rate of increase, however, there are expected to be only 1.18 million software engineers available by the year 2000. This means we can look forward to a shortage of 970,000 software engineers by then (See Figure 5).

To cope with this situation, the first thing that must be done is to enhance software productivity. Some factors presently prohibiting the enhancement of software productivity are a lack of software development technologies; insufficient development supervision; and



Source: MITI

Figure 4. Future Software Demand Predictions



Source: MITI

Figure 5. Anticipated Supply-Demand Curves For Software Engineers

Table 4. Factors Inhibiting Software Productivity

Inhibiting Factors	%
Insufficient software development technology (development tools, modularization, reutilization)	90.0
Lack of software development control (insufficient process control, etc.)	44.3
Lagging standardization (non-standard protocols)	27.1
Insufficient software education/training	18.6
Unskilled software engineers	42.9
Incomplete software development environments	32.9
Changes to specification requirements during development process	31.4
Others	4.3

Source: MITI

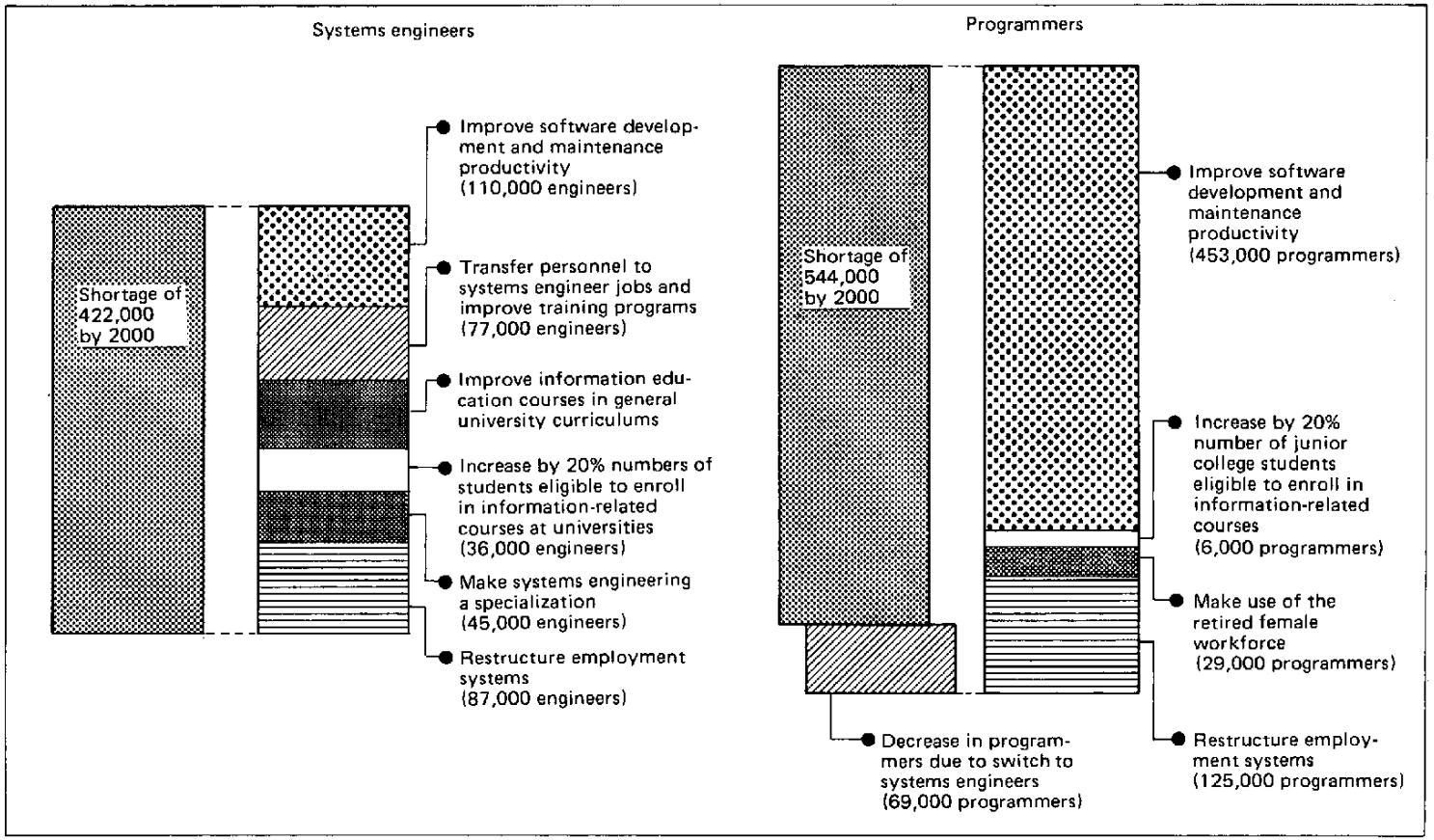
unskilled software engineers (See Table 4). Considerable progress will have to be made in software development and maintenance technologies in future if these shortcomings are to be overcome.

Japan is currently carrying out a large-scale national project aimed at enhancing software productivity. This is called the Software Industrialized Generator and Maintenance Aids (SIGMA) System Project. Once developed, the SIGMA system is expected to greatly enhance productivity in the downstream processes (programming) of software development, thus considerably alleviating problems related to the anticipated shortage of programmers. However, the productivity of upstream software development processes, such as systems analysis and design, are not expected to improve much. By the year 2000, therefore, the SIGMA system should help reduce the shortage of programmers to 90,000, but the shortage of systems engineers is expected to come to 310,000, making the cultivation of systems engineers a vital task in future (See Figure 6).

METHODS USED TO TRAIN SOFTWARE ENGINEERS

Alleviating The Systems Engineer Shortage

The following measures should be taken to eliminate the shortage of systems engineers in Japan: 1) education programs for systems engineers should be improved (Improving training programs at companies as well as the curriculums and facilities at specialty/technical schools will enable the cultivation of human resources capable of doing quality work as systems engineers.); 2) information education in college and university courses outside of those directly related to the field of information should be improved; 3) the number of students eligible to take information-related courses at colleges and



Source: MITI

Figure 6. Policies Aimed At Alleviating Software Engineer Shortage

universities should be expanded; and 4) special career programs should be introduced which enable systems engineers to specialize in their field until retirement.

Even if these measures are forcibly pushed through, they probably won't in themselves be enough to alleviate the shortage of systems engineers. To ensure sufficient numbers of systems engineers, companies are going to have to reassign surplus personnel to information-related positions and revise their employment structures to divert personnel away from those jobs where surpluses tend to occur.

Another factor that must be taken into consideration in alleviating the shortage of systems engineers is the "back to the countryside" trend currently in vogue in Japan. If this trend continues in future and more and more people decide to settle down in outlying regions of Japan, then methods for utilizing computer networks to take advantage of the skills of regional software engineers will have to be studied. Before that can be done, however, we will have to improve information processing education and training programs in rural areas.

Improving Corporate Information Training Programs

In order to enhance the training and skills of in-house software engineers, companies are going to have to put together specific personnel training programs. These programs must establish career paths for software engineers, specifying the skills and knowledge required at each career level, and providing the necessary education and training opportunities to achieve these. Such programs should also offer individual training packages that are implemented in such a way that the trainee gets a combination of on-the-job and off-the- job training, and his performance is evaluated and those results made available to him in the form of feedback.

To put such programs together, companies will have to 1) develop education/training methods and curriculums; 2) formulate in-house education/training guidelines; 3) provide education/training materials; 4) establish training systems that effectively combine on- and off-the-job training (paid vacations for training purposes, improvement of public training facilities and the opening of universities, junior colleges and specialty/technical schools to corporate trainees.); and 5) establish jointly-operated training centers.

Training programs that make use of computer-aided instruction (CAI) and which utilize two-way communication networks would also be effective.

PERSONNEL TRAINING POLICIES FOR INFORMATIZATION

Based on these circumstances, the Ministry of International Trade and Industry (MITI) is promoting a number of personnel education/training policies designed to advance informatization.

Information School Concept

In June, 1987 MITI reorganized the Institute of Information Technology (IIT), an organization affiliated with the Japan Information Processing Development Center (JIPDEC), and renamed it the Central Academy of Information Technology (CAIT). CAIT now serves as the central organization for promoting MITI's concepts 1) for advancing software engineer education that meets the needs of industry; and 2) for activating software engineer education programs in outlying regions and spurring the informatization of rural Japan. To achieve this, CAIT carries out surveys and studies related to industry's requirements for information processing engineers and the curriculums needed for training such engineers. It also conducts surveys and studies related to the construction and efficient utilization of computer-aided revolution on learning (CAROL) systems (CAROL systems are explained in more detail below). The Academy is also responsible for training the instructors that teach organizations involved in the education and training of information processing personnel.

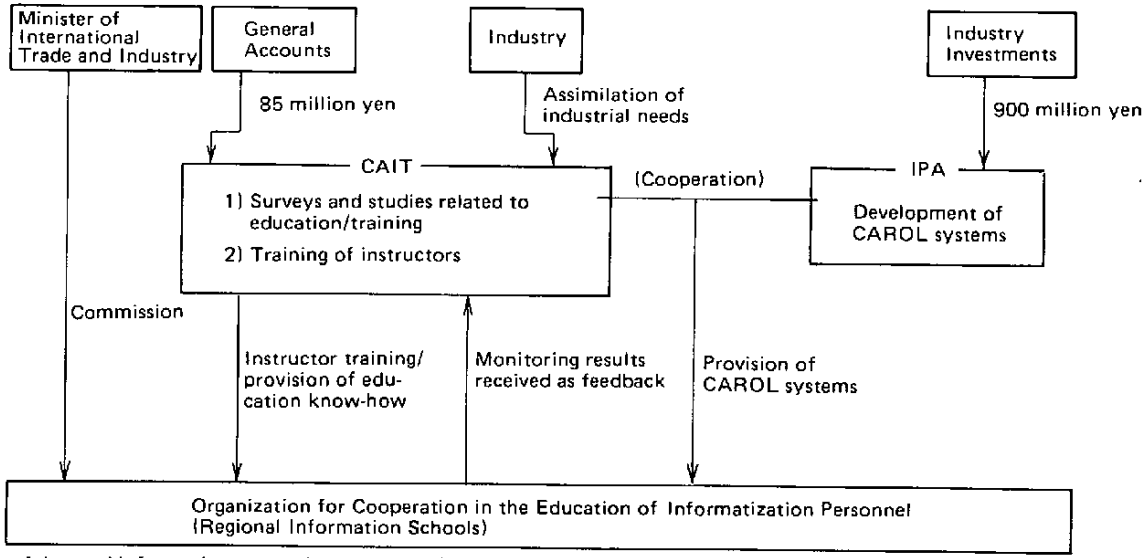
The minister of international trade and industry is also designating schools that excel in information processing education from each region of Japan as regional information schools. These regional information schools will be affiliated with one another and will be entrusted with promoting MITI's information school concept and enhancing the level of information processing education nationwide. Regional information schools will use the latest information processing education techniques available, such as CAROL systems, to promote the advance of information processing education in their respective regions. MITI will support these regional information schools by providing them with education know-how and instructor training through CAIT (See Figure 7).

CAROL System Development

To cope with a shortage of instructors at information processing educational facilities and to enhance information processing education, MITI is promoting the development of CAROL systems, computer-aided instruction courseware designed to use computers in the education of information processing engineers.

CAROL systems are expected 1) to help cope with the problems of insufficient basic training, insufficient hands-on training on computers and poorly put together curriculums at information processing educational facilities; 2) to help avoid situations where it is difficult to find instructors with qualifications above a fixed level of expertise, and to deal with the shortage of instructors in rural areas; and 3) to help working information processing engineers receive refresher courses and in some cases, retraining.

The Information-technology Promotion Agency (IPA) and CAIT, with financial support from industry, have been working together since fiscal 1986 to develop CAROL systems. The project



Source: MITI

Figure 7. Overview of MITI's Information School Concept

is scheduled to take 5 years to complete, and is expected to cost approximately 3.6 billion yen before it is done. Once these CAROL systems are developed, they should be equivalent to 2000 hours of courseware.

Promoting Computer Utilization At Schools

Before Japanese citizens can use computers as everyday tools, they are first going to have to be instilled with a thorough understanding of the capabilities and limitations of these machines. This education process will have to start in their elementary and middle school years. Computers at elementary and secondary schools can also be used to diversify education methods. In order to promote the utilization of computers in Japanese schools, we will have to 1) introduce computer hardware into schools; 2) develop and promote the widespread use of educational software; and 3) provide teachers with educational training.

To achieve this, MITI established the Center for Educational Computing (CEC) in July, 1986. CEC serves as the central force promoting the utilization of computers in school education programs. CEC also conducts research and development work on basic educational-use computer systems.

More specifically, CEC 1) conducts studies related to the formulation of standard specifications for computer systems designed for use in school education programs, and 2) studies the possibilities for introducing new technologies into the field of education.

CEC studies aimed at determining the optimum standard specifications for computer systems utilized in education programs concentrate on interface specifications and operating methods. The goal is to establish compatibility in three major areas: 1) operation compatibility that enables numerous different types of educational computer systems to be operated in the same way; 2) software compatibility that makes it possible to use the types of courseware desired on the makes and models of computers available; and 3) peripheral device compatibility that enables the interconnection and mutual exchange of information between any two different computer systems.

In studying new computer-related technologies such as AI for possible introduction into the field of education, CEC must determine whether those technologies can make computer-based education more efficient, as well as whether or not they can effectively diversify educational methods.

TRENDS IN SMALL-SCALE COMPUTER SHIPMENTS

When discussing future trends in the information industry, we can't overlook the actual tools used to process information. Among these tools, higher performance, lower cost small-scale computers have begun to impact the growth of the information industry in a big way recently. Most Japanese computer vendors group minicomputers, small business computers (SBCs) and personal computers (PCs) under the heading of small-scale computers. However, recent advances in technology and increased computer utilization are making it more and more difficult to distinguish a minicomputer from a SBC or PC, and vice versa. The Japan Electronic Industry Development Association (JEIDA), a trade organization that counts among its members large numbers of Japanese computer manufacturers, recently set up special committees to study the shipment trends for each of these three categories of computers. The following report is an outline of JEIDA's findings.

MINICOMPUTERS

What Constitutes A Minicomputer?

A minicomputer can be defined as 1) a computer that possesses a basic design concept that lends itself to applications in a broad range of fields, from control and computing to communications, which is very expandable and flexible, and which can be sold as a system tool or component; 2) a computer that can be provided on an OEM basis and can have its I/O interfaces made public; 3) a computer which is digital, features built-in programs and is equipped with a maximum internal storage capacity of over 16KB; 4) a computer which comes equipped with I/O devices and file storage equipment; and 5) a computer that comes equipped with a minimum of at least one high-level programming language, such as FORTRAN, COBOL or BASIC.

Minicomputers can also be broken down into size categories: small (two categories), medium, large and very large. This classification is not based on performance or functions, but rather on the price range for each standard configuration (See Table 1).

Shipments Of Minicomputers

Shipments of minicomputers during fiscal 1986 amounted to 12,725 units worth a total of 227.9 billion yen. This

Table 1. Definitions of Minicomputers by Size Categories

	Size		Criteria	
S_1	S_1 – 16	16-bit machines	Sold primarily in board format	Small-size: Standard configurations priced at less than 3 million yen.
	S_1 – 32	32-bit machines		
S_2	S_2 – 16	16-bit machines	Includes power source and chassis (sold in mainframe format)	
	S_2 – 32	32-bit machines		
M	M – 16	16-bit machines	Medium-size: Standard configurations priced between 3–20 million yen.	
	M – 32	32-bit machines		
L	L – 16	16-bit machines	Large-size: Standard configurations priced between 20–40 million yen.	
	L – 32	32-bit machines		
VL	VL – 16	16-bit machines	Very-large-size: Standard configurations priced over 40 million yen.	
	VL – 32	32-bit machines		

worked out to a 12% increase by volume and a 4% increase by value over figures reported for the previous fiscal year (See Tables 2 & 3).

Minicomputers have exhibited stable growth since the latter half of fiscal 1983, supported in large part by demand from the fields of communications control and technical design. In fiscal 1985, shipments of minicomputers broke the 200 billion yen barrier for the first time.

This growth trend continued in fiscal 1986 as well, with shipments by volume recording double-digit growth (shipments by volume for fiscal 1985 had exhibited minus growth.). Year-to-year growth by value, however, was only a single-digit figure. This can be attributed to such factors as a decrease in shipments of very-large-sized minicomputers in favor of lower-priced medium- and large-sized machines, and the overall lower prices put on these machines as a result of the rising yen and the removal of customs tariffs.

Thirty-two-bit machines served as the work horses of this growth in shipments during fiscal 1986, accounting for 32% of overall shipments by volume and a big 59% of those by value. Sixteen-bit minicomputers maintained the shipment levels they achieved in fiscal 1985, thus indicating that demand for these machines is as strong as ever.

Certain special characteristics concerning the shipment of 32- and 16-bit minicomputer have been noted in recent years. For example, 32-bit machines seem to have established a firm place in the market, as indicated by their accounting for 59% of overall minicomputer shipments by value during fiscal 1986 (They accounted for 56% of overall shipments by value in fiscal 1985.). Another feature of these machines is that although very-large-sized 32-bit minicomputers led the way in shipments during fiscal 1985, the leader in fiscal 1986 was the medium-sized machine. Medium-sized 32-bit minicomputers exhibited a sudden four-fold

Table 2. Shipments by Volume Per Size Category

(Units: units)

	Fiscal 1982			Fiscal 1983			Fiscal 1984			Fiscal 1985			Fiscal 1986			Year-to-year Growth (Fiscal 85–86)		
	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total
S_1	1,213	–	1,213	985	–	985	3,082	–	3,082	639	691	1,330	2,197	114	2,311	248%	–84%	174%
S_2	1,252	–	1,252	1,379	–	1,379	1,693	–	1,693	1,599	–	1,599	1,818	–	1,818	13%	–	13%
M	3,763	46	3,809	4,436	182	4,618	5,617	471	6,088	5,182	651	5,833	3,888	2,469	6,357	–25%	279%	9%
L	2,187	201	2,388	1,730	297	2,027	1,153	699	1,852	822	752	1,574	683	804	1,487	–17%	7%	–6%
VL	221	362	583	227	634	861	112	494	606	120	887	1,007	50	702	752	–59%	–21%	–25%
Total	8,636	609	9,245	8,757	1,113	9,870	11,657	1,664	13,321	8,362	2,981	11,343	8,636	4,089	12,725	3%	37%	12%

Table 3. Shipments by Value Per Size Category

(Units: millions of yen)

	Fiscal 1982			Fiscal 1983			Fiscal 1984			Fiscal 1985			Fiscal 1986			Year-to-year Growth (Fiscal 85–86)		
	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total	16-bit	32-bit	Total
S_1	930	–	930	813	–	813	1,011	–	1,011	477	1,915	2,392	3,812	236	4,048	699%	–88%	69%
S_2	4,305	–	4,305	4,932	–	4,932	5,514	–	5,514	5,186	–	5,186	5,725	–	5,725	10%	–	10%
M	38,157	1,129	37,286	47,943	3,510	51,453	55,839	7,121	62,960	55,944	7,676	63,620	44,356	29,258	73,614	–21%	281%	16%
L	68,342	7,765	79,107	49,530	13,376	62,906	44,096	20,682	64,772	30,924	26,574	57,498	34,292	32,420	66,712	11%	22%	16%
VL	25,005	22,432	47,437	17,973	35,729	53,702	7,782	43,099	50,881	4,196	86,114	90,310	4,243	73,594	77,837	1%	–15%	–14%
Total	136,739	31,326	168,065	121,191	52,615	173,806	114,242	70,902	185,144	96,727	122,279	219,006	92,428	135,508	277,936	–4%	11%	4%

increase in shipments by both volume and value during fiscal 1986, and accounted for 60% of shipments of all sizes of 32-bit machines. This rapid growth can be attributed to the fast-paced price drops for 32-bit machines in general, as well as the complete line-ups of medium-sized minicomputers that were available during fiscal 1986. The market for 32-bit minicomputers in fields such as research, technical design, measurement and analysis and communications control, which require high performance and high-level functions like high-speed processing, high-speed input/output and mass storage capabilities, is expected to increase, thus ensuring continued growth of shipments.

As noted previously, demand for 16-bit minicomputers remained strong during fiscal 1986 with shipment figures more or less the same as those recorded the previous fiscal year. Overall shipments of 16-bit machines by volume rose 3% while shipments by value were down by 4% on a year-to-year basis. However, shipments of medium-sized 16-bit minicomputers dropped in fiscal 1986 from what they were the previous year, even though demand for these machines remained more or less unchanged. This gap was filled by the increased shipments of small-sized 16-bit machines. Shipments of medium-, large- and very-large-sized 16-bit minicomputers by volume dropped across the board during fiscal 1986 as demand for 32-bit machines in these size categories continued to grow.

Figure 1 shows future predictions for the minicomputer market based on fiscal 1986 results.

SMALL BUSINESS COMPUTERS

Definition Of A Small Business Computer

SBCs can be defined as 1) small- and/or very-small-scale computers whose principal application is the processing of business data; 2) computers operated directly by the operator, and capable of performing all levels of business operations, from issuing vouchers to processing ledgers and preparing tables; 3) computers that come equipped with I/O devices and file storage equipment, and which, if necessary, can be interconnected for online or inline processing; 4) computers that can be used by employees other than computer specialists, and which come equipped with programming languages that make it easy to write business processing programs as the need arises; 5) computers that can be used in the same room as and together with ordinary office equipment, which do not necessarily require a computer specialist to be operated, and which do not require special installation spaces or facilities; and 6) computers that cost less that 40 million yen for standard configurations.

The above definition of SBCs is from the standpoint of applications, and does not include those computers generally referred to as general purpose computers, minicomputers or personal computers. Also, the terms small- and very-small-scale computers as used in this definition refer to MITI's method of classifying com-

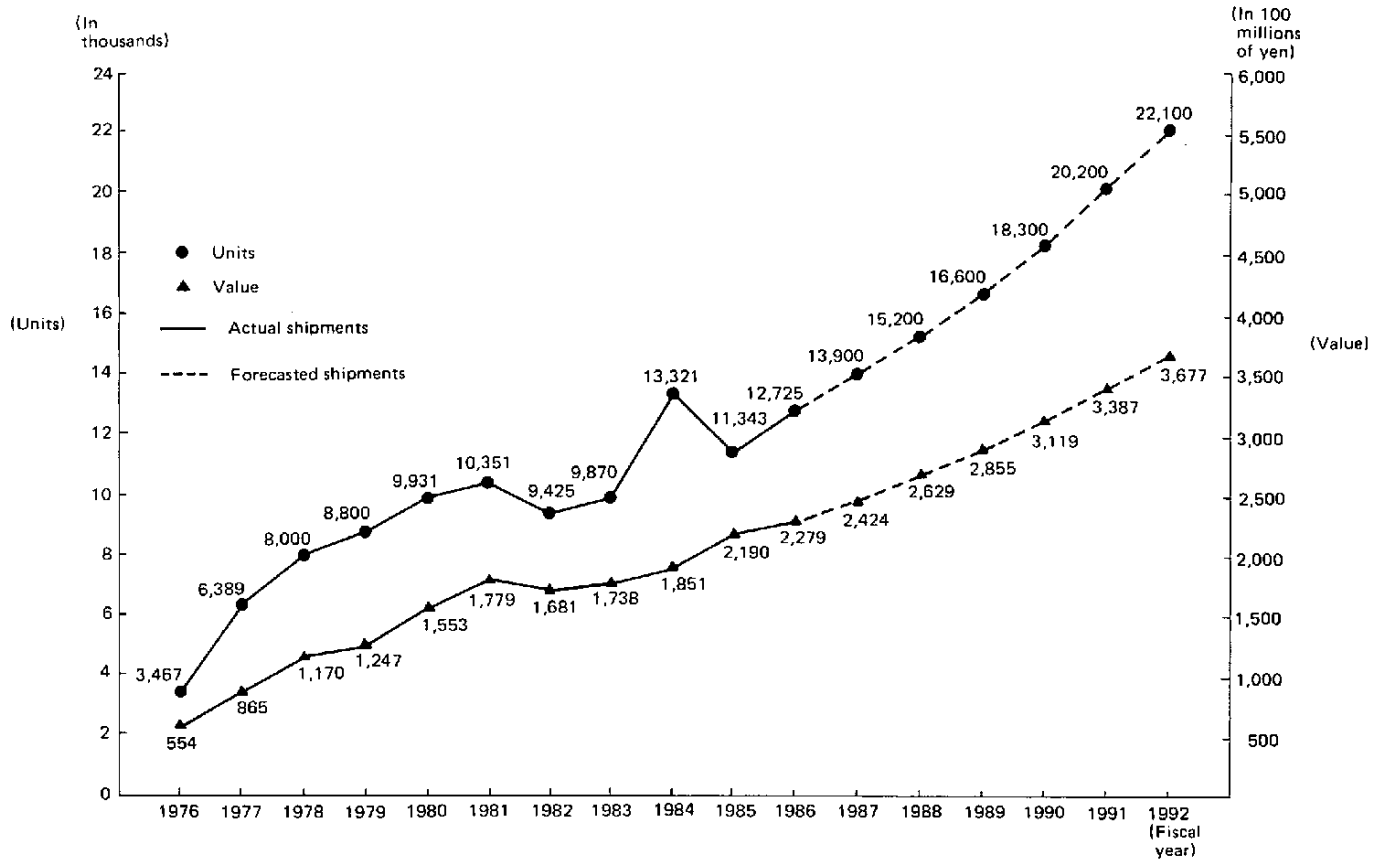


Figure 1. Numbers and Values of Minicomputers Shipped Between 1976 and 1986, and Predicted Shipments Between 1987 and 1992.

puters according to price range.

The I/O devices that come as standard equipment with SBCs consist of basic input/output devices such as keyboards, CRT displays and printers, as well as specialized peripheral devices such as cordless input devices. File storage equipments refers to auxiliary (external) storage devices (hard and floppy disk storage devices and magnetic tape storage devices) for storing programs and data.

As for the business-use programming languages mentioned above, these refer to languages like COBOL and RPG, i.e. programming languages specially designed for business processing. FORTRAN and assembler languages do not fall into this category.

A standard configuration SBC refers to those SBC system configurations most often sold. And the cost of purchasing such a system includes the hardware and basic software, but does not include the price of the individual user's application packages or maintenance fees.

SBC Shipment Trends

Shipments by size

Shipments of small-sized SBCs during fiscal 1986 grew between 9—10 percent both by value and volume compared to figures recorded for fiscal 1985. This was about the same growth rate exhibited for SBCs overall, down considerably from the remarkable growth demonstrated by small-sized SBCs in recent years. Shipments of medium-sized SBCs, however, increased significantly on a year-to-year basis, rising 35.5% by volume and 36.6% by value over the previous fiscal year. Large-sized SBC shipments dropped slightly overall, but shipments of SBCs in the over 10 million yen price range rose by both value and volume over fiscal 1985 figures (See Table 4).

Table 4. Breakdown of Small Business Computers by Size Categories

Size	Price Ranges for Standard Configurations	Prices by Class
Small-sized SBCs	3 million yen or less	3 million yen or less
Medium-sized SBCs	Between 3—7.5 million yen	5 million yen or less 7.5 million yen or less
Large-sized SBCs	Between 7.5—40 million yen	10 million yen or less 20 million yen or less 30 million yen or less 40 million yen or less

Note 1: Figures include cases where prices of auxiliary equipment has been added to the price of the large-sized SBCs.

Note 2: The 10 million yen or less class of SBCs was included in the large-size category because of their mass storage capabilities and ability to add on extra input devices.

Shipments by industry

The industry categories "Wholesale/commercial," "Service" and "Retail," respectively, accounted for the most shipments of SBCs by both volume and value once again during fiscal 1986. The number one outlet for SBCs, the "Wholesale/commercial" industry category, accounted for 27.9% of overall shipments for all industries, exhibiting an increase in shipments by volume of 22.6% and by value of 13.3% over fiscal 1985 figures. The largest year-to-year growth rate recorded on an industry basis was for the category of "Government," which accounted for 563.2% more SBCs in fiscal 1986 than in fiscal 1985. This was followed by a 171% increase in shipments to the industry category of "Mass media/telecommunications." The category of "Regional municipalities" also continued to show high growth over previous year figures.

The percentage of overall shipments accounted for by the sales industry worked out to 37.0%, up 1.4% over the previous year and continuing to show steady growth. The manufacturing industry accounted for 27.2% of overall shipments of SBCs during fiscal 1986, about the same ratio as the year previous. Shipments of SBCs to service-related industries in fiscal 1986 were down 2.2% from figures reported in fiscal 1985, accounting for 18.9% of overall shipments. Although shipments to public and government organizations dropped in fiscal 1985, they recovered during fiscal 1986, rising 9.3%.

Shipments by region

Compared to the favorable growth in shipments of SBCs by volume and value nationwide in Japan during fiscal 1985, in fiscal 1986, shipments of these machines differed considerably from one prefecture to the next. However, Tokyo and Osaka, the hubs of SBC demand in Japan, continued to exhibit relatively high growth rates.

Past and future trends

Table 5 gives figures indicating the

Table 5. SBC Shipments Between Fiscal 1981–86

(Units: units; 100 millions of yen)

Fiscal year / Shipments	1981	1982	1983	1984	1985	1986
Shipments by Volume	50,073	65,321	73,280	77,633	105,365	116,681
Growth Ratio (%)	52.3	30.5	12.2	5.9	35.7	10.7
Shipments by Value	3,067	3,550	3,828	3,900	4,287	4,664
Grwoth Ratio (%)	33.6	15.8	7.8	1.9	9.9	8.8

Table 6. SBC Shipment Forecasts for Fiscal 1986–1991

(Units: units; 100 millions of yen)

Shipments \ Fiscal Year	1986	1987	1988	1989	1990	1991
Shipments by Volume	116,681	130,000	144,000	159,000	175,000	193,000
Growth Ratio (%)	10.7	11.4	10.8	10.4	10.1	10.3
Shipments by Value	4,664	5,000	5,500	5,900	6,300	6,800
Growth Ratio (%)	8.8	9.3	7.8	7.3	6.8	7.9

volumes and values of SBC shipments for the six-year period from fiscal 1981 through fiscal 1986, and Table 6 presents a six-year forecast (fiscal 1986–91) of anticipated trends in this market.

As shown in Table 6, the forecast for fiscal 1987 anticipates sound growth, with shipments by volume expected to reach 130,000 or better (up 11.4% over fiscal 1986 figures), worth a total of around 510 billion yen (up 9.3% over fiscal 1986).

The five-year forecast for SBC shipments between fiscal 1987 and fiscal 1991 also anticipates stable growth, with average yearly growth expected to work out to 10.5% by volume and 7.8% by value. At the same time, the average unit cost per SBC system during that same five-year period is expected to drop 2.6%.

Recent Characteristics In The SBC Market

The market for small-sized SBCs in Japan has continued to grow well in recent years. In fiscal 1986, medium-sized SBCs also exhibited significant growth, thus lessening the bipolar demand trend that had existed up until that year. Demand for all sizes of SBCs are growing stronger.

Under these circumstances, and with the remarkable progress and widespread use of semiconductor and telecommunications technologies, the improvements being made to software programs and the appearance of new types of terminal equipment, SBCs are expected to play an increasingly major role in processing office work in future as well. Some specific characteristics exhibited by the SBC market in recent years are pointed out below.

LSI technology: compact, higher performance, lower cost SBCs

SBCs utilize the latest in semiconductor technology, and 32-bit MPUs are serving as the central processing units of more and more of these machines. This is making SBCs faster and increasing their storage capacity, enabling them to process more and different kinds of information. SBCs are no longer limited to processing textual data alone, but are now capable of handling a variety of image data as well, and are therefore being put to a wide range of new applications. The role of SBCs in the office environment

has become a central one.

We must not overlook the remarkable progress being made in the development of numerous specialized LSIs and advanced LSI packaging technology, which in turn is making possible more compact, lower priced SBCs.

Linking of SBCs to host computers for total OA

SBCs can be readily interconnected to host computers and, with the steady spread of local and global area networks, are becoming commonplace components of horizontal distributed processing systems and distributed database systems. All this is contributing toward improving the user friendly aspects of these machines and systems.

Since SBCs are being required to handle an increasingly wide range of office applications, small-sized SBCs are being used more and more like office workstations. They have been equipped with mouse input devices and multi-windowing capabilities, and have been used to construct large numbers of high-performance office automation (OA) systems.

Software portability

The trend towards truly portable software programs that can be used on small-sized SBCs as well as large-sized SBCs, and, under certain circumstances, can even be run on computers larger and more powerful than SBCs, is growing stronger. This means, for example, that application programs developed for use on small-sized SBCs can also be run on large-sized machines, thus considerably enhancing the expandability, developability and flexibility of SBC systems.

Appearance of new peripheral devices

In line with the enhanced functions and expanded applications of SBCs, we are now seeing SBCs equipped with new peripheral devices such as optical disk drives, which are low cost and offer mass storage capabilities.

Small-sized SBCs are being equipped with CD ROMs, while large-sized SBCs are employing optical disk drives. This is giving rise to expectations for totally new applications for SBCs, and as such, is drawing attention to future trends in this direction.

As an offshoot of this trend, SBCs are also being hooked up to video cameras and scanning machines, providing them with image data input capabilities.

PERSONAL COMPUTERS

Definition Of A Personal Computer

Personal computers (PCs) have achieved widespread use, and the applications to which they are being put are continuing to expand.

As a result of this, PCs no longer adhere to the image most people have of them, and the definition of what a PC is must be revised to meet with current realities. For example, in compiling

statistics on PC shipments, we ran into problems trying to determine how best to handle such things as workstations, word processing PCs and PCs used primarily for telecommunications purposes.

The JEIDA PC Committee, therefore, once again this year had its Special Committee on PC Technology Trends study the definition of what a PC is. However, in the end, this committee came to the conclusion that it would be extremely difficult to define PCs simply and concisely based on the attributes of price and performance. This is because almost all PCs are configured similarly, perform tasks (fulfill applications) primarily by running programs, and can be made to do a variety of different jobs. Also, although PCs possess practically the same application and performance capabilities, manufacturers of these machines have a tendency to call them different names as part of their sales strategies.

The committee therefore decided to follow the definition of PCs used by the independent working group for PC shipment statistics with only one minor addition. This definition is given below. The committee has also included a table (Table 7) outlining its views on ambiguous points regarding PCs.

Computers that adhere to the following definitions are considered PCs: 1) small-sized computers that are put to a number of different uses, such as for business, science and technology, measurement and control, terminal, educational and hobby uses; 2) computers whose basic configurations consist of a microprocessor, a video display as an output

Table 7. Ambiguous Points Concerning PCs, and Corresponding JEIDA Committee Views

Ambiguous Points	Special Committee Views
(1) Numerous products sold as workstations fit the definition for PCs	These machines should be handled as PCs.
(2) There is no clear distinction between high-level PCs and low-end minicomputers.	There is no problem handling these machines as PCs.
(3) There is no clear distinction between business-use PCs and low-end SBCs.	There is no problem handling these machines as PCs.
(4) There is no clear distinction between SBC workstations and PCs.	Those used as dumb terminals (vice distributed function machines) fall into the category of PCs by their degree of dedication.
(5) Word processors capable of using high-level languages can not be distinguished from PCs.	Since their main use is for word processing, they are categorized as PCs.
(6) Family Computer-brand game machines will probably be equipped with PC functions in future.	Since their main use is as game machines, they are presently categorized as PCs.
(7) The engineering workstation is one example of where PCs are heading, but don't readily fit the definition for PCs at this point in time.	From the aspects of price and degree of dedication, engineering workstations are presently categorized as PCs, but this categorization will have to be re-studied in future.

device, a keyboard as an input device and an output interface, and which can be equipped with auxiliary storage devices and other peripheral equipment as required; 3) computers that utilize high-level programming languages like BASIC, COBOL and PASCAL, and which allow users to do their own programming; and 4) computers that cost less than 3 million yen for a complete system.

PC Shipment Trends

Fiscal 1986 was the year when computer manufacturers hoped to extricate themselves from the computer slump in the United States and other nations around the world, and this mood visibly rose throughout the year. However, the Japanese economy was faced for the first time in its history with a rising yen that refused to stop, making numerous industries suffer slowed growth and violently fluctuating revenues.

Quite naturally, the PC market also felt the effects of this phenomenon. Nevertheless, PC shipments were able to achieve relatively favorable growth bolstered by a powerful information revolution.

More specifically, overall shipments of PCs during fiscal 1986 (including both domestic shipments and exports) reached roughly 637.3 billion yen on a value basis. This exceeded the figure of 620.0 billion yen worth of PC shipments predicted for fiscal 1986 by this Committee's Special Committee on Market Trends in its interim forecast made in fiscal 1985.

However, even those industries that had been growing by leaps and bounds began to show signs of change around fiscal 1985. That is, while PC shipments continued to exhibit favorable growth on a value basis in fiscal 1986, recording 15% annual growth over the previous year, it became obvious that shipments by volume had not grown since fiscal 1984. This trend was especially marked for domestic shipments of PCs. Two possible factors contributing to this phenomenon are 1) the overall trend towards ever higher performance machines; and 2) sluggish sales of low-cost machines.

Whereas the market for 16-bit machines grew considerably during fiscal 1986, shipments of 8-bit PCs gradually declined throughout the year. During the third quarter of fiscal 1986, for example, shipments of 16-bit PCs by volume were 134% of what they were during the same period the previous year, and by value reached 119%. However, shipments of 8-bit machines during the third quarter of the year came to just 94% by volume and 86% by value of what they had been during the same period in fiscal 1985. The ratio of 8-bit to 16-bit PCs shipped throughout fiscal 1986 thus came to 43:57, almost the exact opposite of what it had been for fiscal 1985 (56:44). For the first time in the recorded history of PC shipments in Japan, 16-bit machines accounted for more shipments than 8-bit machines. This focuses attention on the move toward higher performance machines in general, and requires that this trend be looked at more closely from now on.

Overall shipments by volume of low-cost PCs such as the MSX2 machines were about the same in fiscal 1986 as they were the previous year. However, whereas shipments of these machines were sluggish during the first half of the fiscal year, they picked up significantly during the latter half of the year. For example, during the third quarter alone, shipments of low-cost PCs accounted for 34% of all PC shipments by volume for that period. This can be attributed to the emphasis placed on these machines by the various manufacturers during the peak demand season around Christmas and New Years.

The rising yen is a serious concern to the export market. However, exports

Table 8. Shipments of Personal Computers Between Fiscal 1977 and 1986, and Predicted Shipments Between Fiscal 1986 and 1990.

(Units: unit; million of yen)

Fiscal Year	Total Shipments			
	Actual Shipments		Predicted Shipments	
	Units	Values	Units	Values
1978	9,976	5,979		
1979	46,402	15,949		
1980	110,610	33,697		
1981	282,759	107,019		
1982	762,166	231,352		
1983	1,141,079	341,602		
1984	1,873,867	470,615		
1985	1,983,551	555,208		
1986	2,059,451	637,341	2,000,000	621,000
1987			2,200,000	696,000
1988			2,470,000	784,000
1989			2,810,000	888,000
1990			3,230,000	1,015,000

Note 1: Values given for both actual and predicted shipments include price of mainframes and peripheral equipment.

Note 2: Machines covered include MSX and portable PCs, but do not include pocket and game computers.

Note 3: Figures for actual shipments were compiled from independent statistics provided by 17 manufacturers in fiscal 1982, 20 in fiscal 1983 and 24 in fiscal years 1984, 1985 and 1986.

Note 4: Figures for predicted shipments were calculated as of February 1987.

of PCs during fiscal 1986 were favorable. This can be attributed perhaps to the fact that the impact of the stronger yen was not felt until after contracts had already been signed, as well as to increased exports of compatible machines. As a result, overall shipments of PCs for fiscal 1986 amounted to 114% by value and 103% by volume of those recorded the previous year.

However, the anticipated effects of an increasingly stronger yen and the preference for ever higher performance PCs compelled JEIDA's Special Committee for the Study of Market Trends to revise its five-year forecast downward from what it had been the previous year. That is, whereas in fiscal 1985 this committee had predicted that shipments of PCs would reach 3.65 million units worth 1,051.0 billion yen by fiscal 1989, in fiscal 1986, it revised these figures downward to reflect anticipated shipments of 2.81 million units in fiscal 1989, worth approximately 888.0 billion yen. This downward revision was especially marked for shipments by volume, thus indicating allowances being made for the trend toward more advanced, higher performance PCs. Also, whereas the fiscal 1985 forecast predicted that average yearly growth on a value basis for the four-year period from fiscal 1986–89 would work out to around 17%, the fiscal 1986 forecast predicted that average annual growth by value for the four fiscal years 1987–90 would come to just 13%. Consequently, the PC market isn't expected to break the one trillion yen mark until fiscal 1990 now, a year later than was predicted in JEIDA's report for fiscal 1985 (See Table 8).

JIPDEC'S THREE-PRONGED APPROACH TO INFORMATIZATION

The Japan Information Processing Development Center (JIPDEC) is dedicated to promoting the use of computers to process information, not only in industry but in society at large as well, thereby contributing to the overall economic and social development of Japan as a whole. To achieve these objectives, JIPDEC conducts research in a variety of areas related to information processing (IP) and IP systems, designs and develops IP systems for specific applications, and generally fosters the use of IP technologies. JIPDEC also works hard to promote the informatization of industry, and to train and test the programmers, systems engineers and IP-related managers required by the information revolution.

JIPDEC performs these various activities at the request and with the support of a number of government agencies, as well as private companies. Figure 1 provides a breakdown of JIPDEC's major activities, and the departments responsible for carrying them out.

This report introduces three relatively new organizations established by JIPDEC to further its efforts at promoting informatization. These are the Center for the Informatization of Industry, the ICOT-JIPDEC AI Center and the Central Academy of Information Technology. The particular roles assigned to each of these organs by JIPDEC and the activities they engage in to fulfill these roles are described in some detail below.

CENTER FOR THE INFORMATIZATION OF INDUSTRY

The Center for the Informatization of Industry (CII) was established by JIPDEC in 1985 as a forum for intra- and inter-industry liaison and coordination aimed at achieving smooth networking in industry. Being an independent (non-government/non-industry) organization comprised of experts in the fields of information processing and networking, CII makes good use of its neutral status and expertise knowledge to support the construction and operation of information networks; to conduct research on standardized business protocols for the more efficient operation of information networks; and to study problems related to network utilization in order to enhance the performance of data communication systems. CII also produces reports and sponsors seminars and other educational events designed to promote informatization in industry. A more

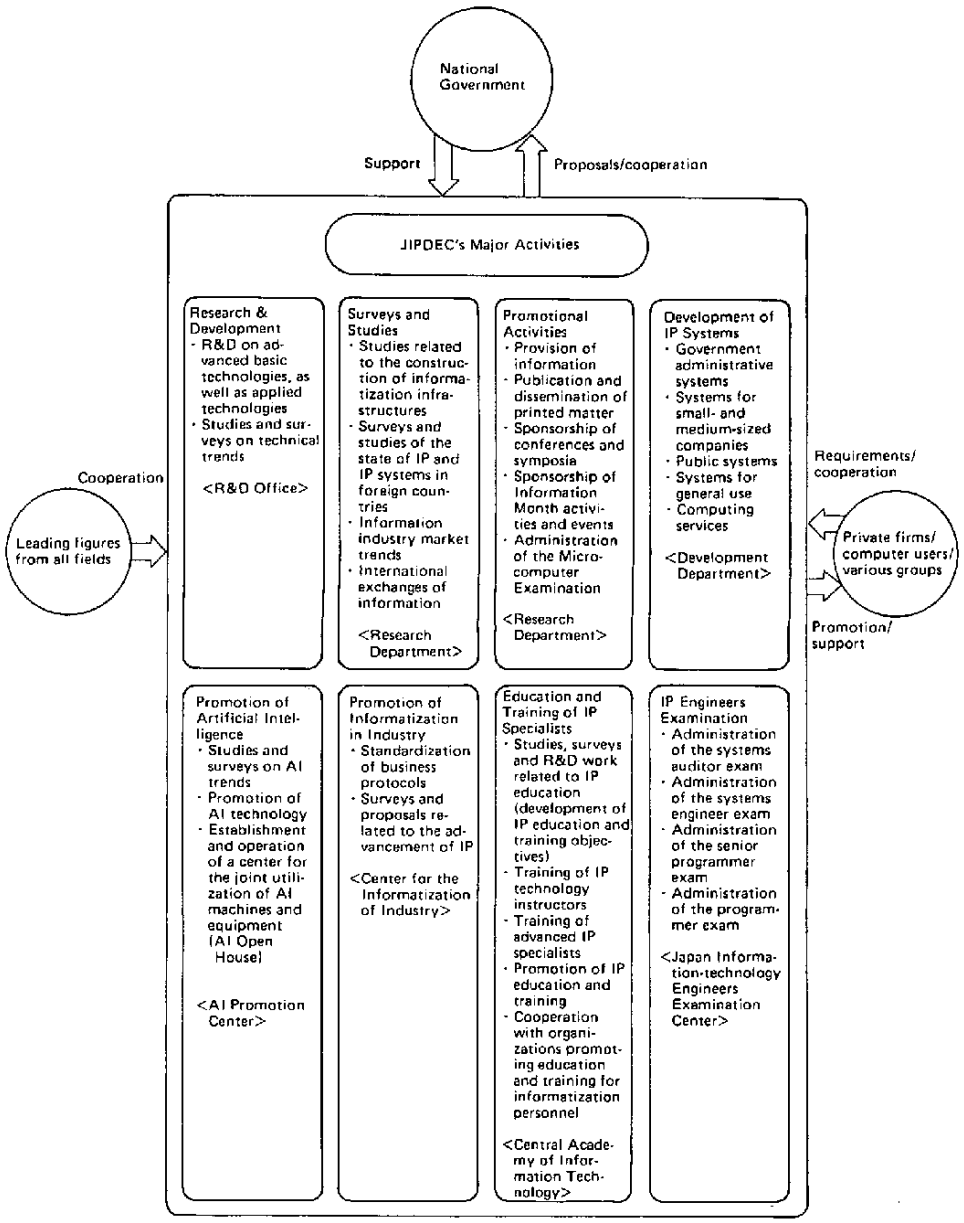


Figure 1. JIPDEC's Major Activities

detailed explanation of each of these five major activities is provided below.

R&D Work On Business Protocols

CII has been studying the criteria for existing Japanese protocols (J, Zengin and CAT protocols) since 1985, and has been pushing ahead with research on standard business protocols. The Center carried out studies during fiscal 1986 on a movement in the United States to standardize business protocols.

CII is also studying ways of unifying the codes so essential to standardized business protocols. Research in this area is focused on the manufacturing industry, for which CII drafted a proposal for a system of standard product codes in fiscal 1986.

Studying User-oriented Problems To Enhance Network Systems

CII has established a user's group comprised of leading users of data communications systems. This user's group serves as a forum for its members to discuss problems (i.e. different equipment, systems and services) with representatives of the information industry and to study concrete measures for dealing with these problems and thus enhancing their network systems. In April, 1987, CII also established an open systems interconnection (OSI) user's group for the purpose of dealing with the need to integrate and mutually interconnect various types of information-related equipment and machines. The OSI user's group discusses methods for practicalizing OSI standards, and the opinions and ideas put forth by this group concerning OSI reflect those of OSI users in general. This group is in the process of creating a system for the cooperative promotion of OSI, one which will benefit users and manufacturers alike.

Studying Systems Suitability By Industry

CII carries out wide-ranging studies on information system needs and trends on an industry-by-industry basis, and analyzes its findings to come up with a general picture of the current state of informatization in industry. The Center also selects specific industries and studies the directions that informatization is taking in each of them from a long-term point of view. CII then uses the results of analyses of various systems-building problems associated with these industries informatization schemes to support their efforts at network construction. During fiscal 1986, CII supported the construction of value-added networks (VAN) in the machinery and tools industries, plus studied and analyzed the types of network systems that should be built for the printing, cement, financial, furniture and synthetic fiber industries. In future, CII plans to support the construction of jointly-operated industry network systems.

Studying Legislative Problems of Network Systems In Industry

The conduct of electronic business transactions using network systems that interconnect different companies raises a variety of problems incapable of being handled by conventional business practices and/or legislation. CII has thus been systematically reviewing legal problems arising from electronic business transactions, and has been studying the legal problems for users of VAN services from the standpoints of operational criteria and utilization agreements. In fiscal 1986, the Center carried out a questionnaire survey of 316 VAN vendors and 400 industrial users to determine the current state and future trends of VAN utilization in Japanese industry.

Promoting Informatization In Industry

As part of its activities designed to promote informatization in industry, CII publishes a monthly "Industry Informatization Index." This index provides the titles, sources and a brief outline of major articles written on informatization trends in industry. The subjects dealt with in the articles selected include those related to government policies and legislation affecting industry; in-house and inter-company online network systems; database services; point of sales (POS) systems; and information technologies and systems equipment.

CII also publishes a quarterly report titled "Industry and Information." This report covers such topics as industry and government informatization policies, and the activities of CII during the past quarter.

Other promotional activities include the sponsoring of an annual industry informatization seminar aimed at industry groups, managers and entrepreneurs. These seminars deal with themes concerning the results of various information-related research projects and serve as a forum for introducing examples of informatization in industry. This year's seminar was held for two days from September 28–29, 1987 and dealt with the theme "New Developments in Data Communications Systems – Network Strategies and the Impact of OSI."

ICOT-JIPDEC AI CENTER

Founding Of The AI Center

Artificial intelligence (AI) technology is attracting considerable interest as a new information technology for use in the development of information systems and software. Interest in expert systems that make use of knowledge bases and inference functions is especially keen. Industrial and corporate groups are establishing AI societies and engaging in research on software development tools, while individual companies are moving from the development of prototype expert systems to the construction of practical, commercial systems. The number of firms engaged in the development and sale of AI tools is rapidly increasing, and we should see the formation of an AI

industry in Japan before too much longer.

Under these circumstances, JIPDEC and the Institute for New Generation Computer Technology (ICOT), with the support and guidance of the Ministry of International Trade and Industry (MITI), jointly established in April 1986 the ICOT-JIPDEC AI Center for the promotion and spread of AI technology. ICOT and JIPDEC each set up offices within their respective organizations to carry out the work of the ICOT-JIPDEC AI Center. In April of this year (1987), JIPDEC expanded this office, creating an AI Promotion Center with enhanced work requirements and capabilities.

AI Vision Survey

During fiscal 1986, the ICOT-JIPDEC AI Center estimated AI demend for the next ten years, put together an AI technology manual, and compiled these into an "AI Vision" survey report.

Definition of AI

In the AI Vision survey report, industrial-use AI is defined as that technology which analyzes the knowledge and judgement capabilities of humans and puts these capabilities to good use in computer environments.

Technologies essential to AI and its applications

A number of technologies are essential for the support of AI, including search procedures, knowledge representation, problem solving methods and knowledge acquisition and learning. Research and development of computer technologies required to represent AI on computers, such as programming languages (Prolog, Lisp, etc.), computer architectures and programming methodologies, are also essential to the development of AI. At present, AI is being applied to such fields as expert systems, intelligent robots, natural language understanding, voice recognition, image recognition, automatic programming and man-machine interface systems.

AI vision

By 1995, the demand for AI software for all of Japanese industry is expected to reach 4,800 billion yen, of which the AI software market for the information services industries is seen as reaching 660 billion yen. The market in Japan for AI hardware is expected to reach 890 billion yen by that time. The overall demand for AI in Japan is therefore seen as reaching 5,700 billion yen by the year 1995. These figures were calculated based on an annual 3.5% growth in GNP between now and then (See Table 1). Of the various applications to which AI technology is being put, interest in expert systems seems to be the greatest. A number of prototype systems are expected to be test operated within the next year or two, and these should be ready for commercialization within five years. Quite a few companies are also testing natural language understanding systems,

Table 1. AI Market In Japan By 1995

(Estimated figures)

Year	AI Software Demand (Industry-wide)	AI Software Market (Information Services Industry)	AI Hardware Market	AI Market (Software + Hardware)
1985	199 billion yen (0.07%)	25 billion yen	68 billion yen	93 billion yen
1990	960 billion yen (0.28%)	130 billion yen	250 billion yen	380 billion yen
1995	4,800 billion yen (1.2%)	660 billion yen	890 billion yen	5,700 billion yen
Average Annual Rate of Growth Between 1985—95	38%	39%	29%	33%

(Note: The figures given in this table are all estimates, and have been rounded off to the nearest two digits. Figures in parentheses indicate percentage of GNP.)

which are expected to be commercialized in another 5—6 years.

AI Open House

In October 1987, the ICOT-JIPDEC AI Center founded the "AI Open House" as a place where AI users and software houses engaged in the development of AI software can come to make joint use of AI tools (See Figure 2).

Firms that manufacture and sell AI hardware and software will be asked to display certain of their hardware at the AI Open House. These AI-related machines will then be made available to interested parties for use in R&D on AI tools. The ICOT-JIPDEC AI Center is currently contacting both Japanese and foreign-capital firms to ask their cooperation and participation in the AI Open House. Somewhere between 10—15 different AI machines, including the sequential inference machine (PSI) created as a result of work on the Fifth Generation Computer Systems Project, are scheduled to be displayed. The AI Open House will commence operation as soon as most of the equipment has been gathered together, which is expected to be sometime in December, 1987.

Only those firms that are registered members of the ICOT-JIPDEC AI Center will be eligible to use the AI machines and equipment displayed at the AI Open House. These tools will be available free of charge for a specified period of time so that users can learn their functions and how they are used, and evaluate these AI machines in accordance with their own development needs.

Those parties interested in utilizing these tools in their development work will, for a fee, be able to take advantage of a special users' membership system. Membership in this special group will

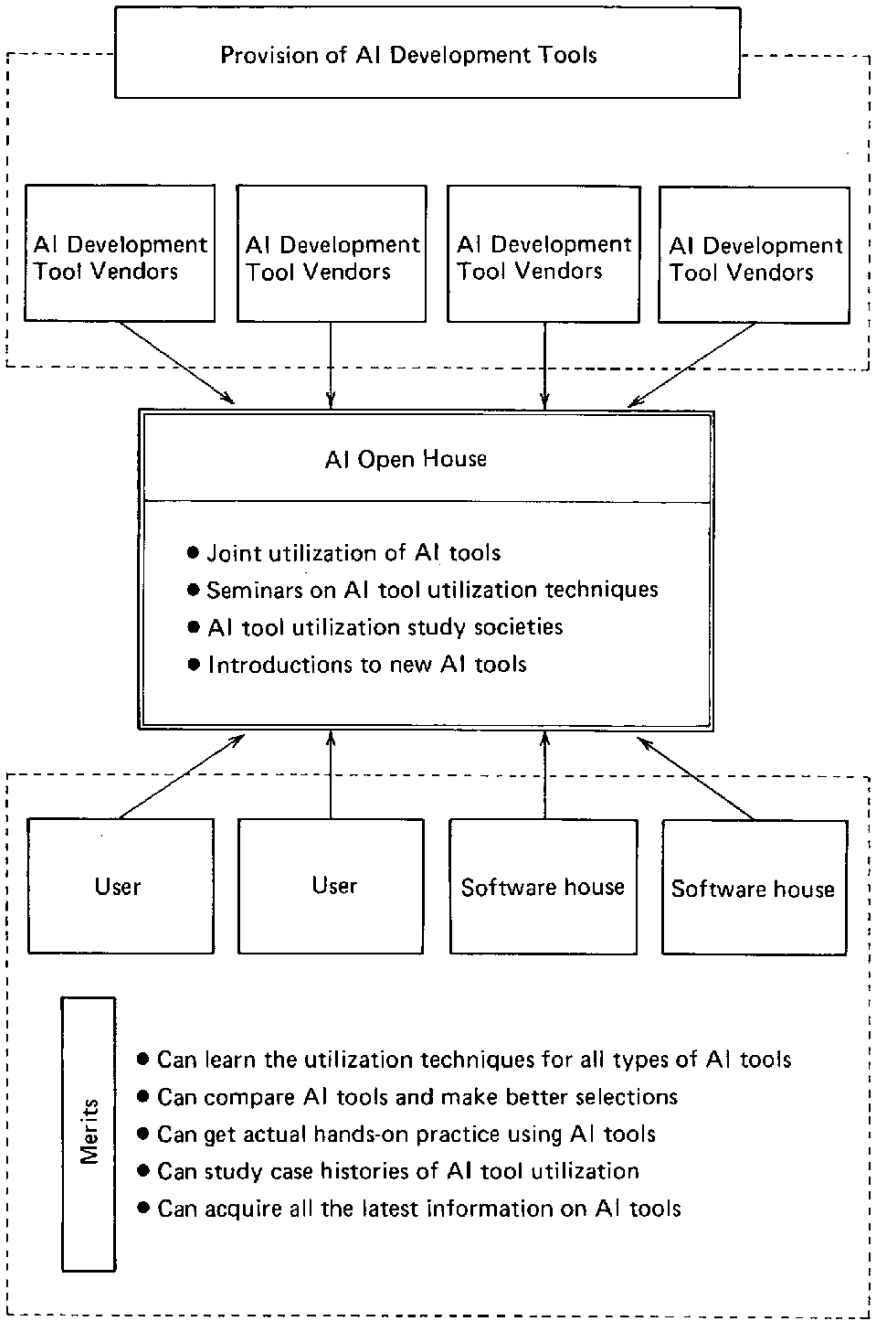


Figure 2. AI Open House Scheme

enable members to utilize any tool on display for as long as they desire in order to acquire high-level development techniques and/or to conduct in-depth research.

The ICOT-JIPDEC AI Center will sponsor on an ongoing basis explanation and research meetings and seminars on the functions, utilization techniques and sample usage of all AI tools displayed at the AI open House.

AI Network

To promote the mutual exchange of information and personnel interaction among AI Center members and AI researchers, in July, 1987 the ICOT-JIPDEC AI Center established the AI Network, a personal computer-based teleconferencing system. This AI Network system enables the exchange of electronic mail, the holding of teleconferences on specific topics of interest, and the communication of information on AI products and AI-related reports and events. Utilization of the AI Network by ICOT-JIPDEC AI Center members is limited to one name per member, and is free of charge.

Table 2. Breakdown Of AI Center User Members By Industry

Industry	No. of Members
Engineering	23
Foodstuffs/textiles	3
Publishing/printing	18
Chemicals/petroleum	9
Glass/cement	1
Steel/metals	8
Electric machinery	27
Machinery	22
Transportation machinery	6
Wholesale/retail/trade	13
Finance/securities/insurance	3
Transportation/telecommunications	5
Electricity/gas	4
Services	19
Educational institutes	3
National/municipal governments	5
Groups	12
Others	6
Total	187

AI Center Members

The ICOT-JIPDEC AI Center has adopted a membership system to promote the spread of AI technology and related enterprises. Any organization, be it an industry group or an individual

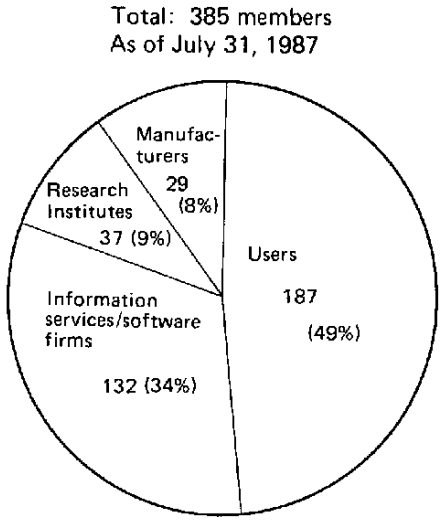


Figure 3. Ratio Of Users To Other Categories Of AI Center Members

company, is eligible to apply for membership. Membership is free. As of July 31, 1987, the ICOT-JIPDEC AI Center had a total of 385 members. Of these, 187 or roughly 49% of the total were users. This was followed by 132 (34%) information services vendors (including software houses), 37 (9%) universities and research institutes and 29 (8%) computer manufacturers (See Table 2 and Figure 3).

CENTRAL ACADEMY OF INFORMATION TECHNOLOGY

Background

The education, training and securing of information processing specialists is imperative in order to ensure that the information revolution proceeds ahead smoothly in Japan.

In April 1987, the Informatization and Personnel Measures Subcommittee of the Information Industry Committee, which comes under the Ministry of International Trade and Industry's Industrial Structure Council, forecast that Japan would find itself short some 970,000 information engineers by the year 2000, and proposed the promotion of an information university program as one means of educating and training the needed personnel.

On June 1, 1987, under the guidance of MITI, JIPDEC reorganized the Institute of Information Technology (IIT), renaming it the Central Academy of Information Technology (CAIT). In addition to being responsible for promoting plans for the establishment of an information university, CAIT is also tasked with a new mission of serving as the core organization for the creation and implementation of information processing-related education and training programs in Japan.

Objectives And Roles

As the central agency for information processing-related education and training in Japan, CAIT's activities are quite broad in scope, and include finding solutions to various educational and training problems.

CAIT puts considerable weight on personnel education activities, particularly as they relate to the cultivation of instructors for information-oriented vocational schools and the training of advanced information processing specialists. The Academy is also actively engaged in establishing a place for information engineers in industry in accordance with the requirements for such engineers, and in promoting the development of educational and training materials and conducting other education-related survey, research and development activities (See Figure 4).

Major Activities

Research on information processing-related education

CAIT is tasked with carrying out a variety of different surveys and studies, both inside and outside of Japan, related to the educational needs of information

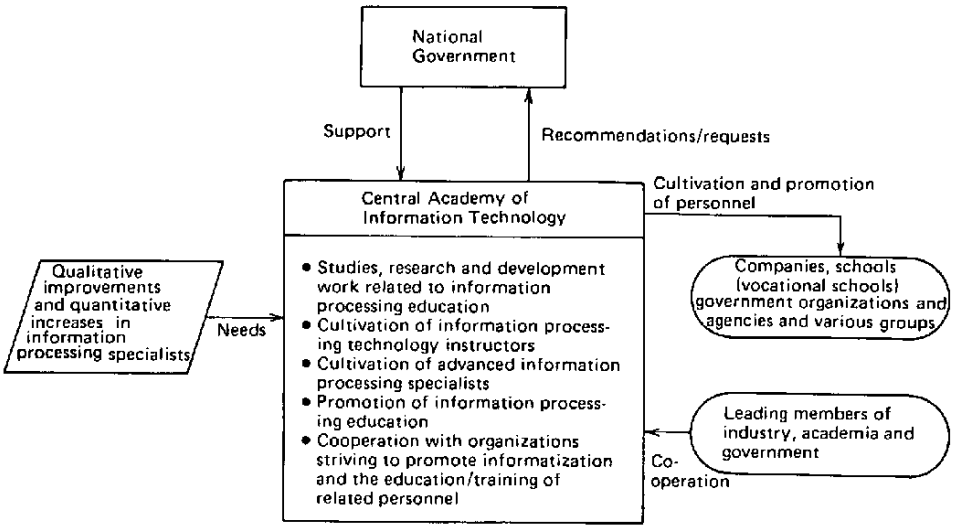


Figure 4. CAIT Objectives And Functions

engineers and technicians and the current state of educational and training opportunities available to them. The Academy must also define what information processing specialists are in accordance with the requirements that will be levied on them by an advanced information society. The research and development of educational policies and standardized texts, and studies into computer-assisted instruction (CAI) programs are also major tasks of CAIT. Finally, CAIT is responsible for researching effective educational methodologies and techniques, especially skills development techniques and technical aptitude tests.

Cultivation of information technology instructors

CAIT offers six different courses aimed at training information processing instructors for special information-oriented vocational schools. These courses are: 1) A course on teaching information processing; 2) a course on teaching methods designed to increase educational effectiveness; 3) a systems development and operation course; 4) an information processing and computers course; 5) a course on information processing systems; and 6) other courses related to information processing.

CAIT also trains instructors tasked with teaching information processing courses within the corporate environment.

Training of advanced information processing specialists

CAIT offers a variety of courses designed specifically to train advanced information processing specialists. Certain courses are geared towards specific types of information engineers.

For example, there are the applications engineering course, the network engineering course, the production engineering course and the systems auditor course. Four additional courses are currently being developed and should be available by fiscal 1988. These are a technical engineering course, a development engineering course, a knowledge engineering course and a database engineering course.

These new courses are to be subdivided into a number of lessons, each of which will be presented in the form of a lecture. These lectures will then be reviewed later at times convenient to the students.

CAIT also offers courses designed to study specific topics or subjects. These include an expert systems course, an information systems security and risk analysis course, a CAD/CAM course, and a numerical analysis course.

Other training offered by CAIT includes seminars given by foreign scholars and/or specialists on themes of current interest.

Promotion of information processing education

CAIT engages in a number of activities designed to promote the spread of information processing education and training in Japan. These activities include the administering of education programs designed to promote informatization at small- and medium-sized businesses; activities geared toward promoting informatization in outlying regions of Japan; the sponsoring of lectures and seminars designed to enlighten people on the need for information processing education and training; the dissemination of educational quidelines and standardized texts for information specialists; and the publication of public relations materials.

CURRENT NEWS

OCR-BASED MACHINE TRANSLATION SYSTEM BY OKI

Oki Electric Industrials Co., Ltd. has developed a Japanese-English machine translation system that employs an optical character reader (OCR). Japanese handwritten text and printed matter input into the OCR are output in English in either text or voice format. Compared to old keyboard input systems, the Oki OCR-based machine translation system is extremely easy to operate. This system is also opening the way for the development of a machine translation network that can readily translate required texts in one location and transmit those translations to other locations using data communications lines.

NTT ENTERS THE EDUCATION BUSINESS

Nippon Telegraph and Telephone Corporation (NTT) announced its cooperation with 15 other firms, including Nippon Steel Corporation and Nippon Shinpan Co., Ltd., to found a new education-oriented firm called NTT Learning Systems. In addition to developing and marketing in-house educational software that has been attracting the interest of Japan's major corporations lately, this new company will also serve as an outlet for the sale of a computer-assisted instruction (CAI) system developed by NTT for in-house research use. This is the first time NTT has ventured into the education field. First-year sales for the new company are expected to reach 1 billion yen.

FUJITSU TO TAKE PART IN X/OPEN PROJECT

Fujitsu Limited has announced its intention to be the first Japanese firm to participate in the X/OPEN Project, a project being carried out primarily by European computer manufacturers for the purpose of standardizing software. By taking part in this international project, Fujitsu hopes to have its ideas and thinking in this field incorporated into future standards, and to gain a foothold for the development of sales strategies aimed at the European market. The company also hopes the X/OPEN project will mark the beginning of information and personnel exchanges related to the Software Industrialized Generator and Maintenance Aids (SIGMA)

Project being carried out in Japan with the support of the Ministry of International Trade and Industry (MITI).

MITSUBISHI ELECTRIC SUCCESSFULLY TESTS NEW OPTICAL MEMORY TECHNOLOGY

Mitsubishi Electric Corporation's Central Research Laboratory was the first in the world to successfully test a new optical memory technology capable of stacking one hundred (100) pieces of information in one spot. This new technology enables 100 pieces of information ("Os" and "Is") to be recorded and read from a single location on a thin, high polymer film by striking that film with light of different wavelengths. Mitsubishi's successful test of this technology proves that it is possible to pack the equivalent of 40,000 pages of newspaper information into a one (1) centimeter square space. This success marks the first step toward the realization of the ultimate "molecular memory" device. Mitsubishi's next goal is to achieve ten-times the memory capacity exhibited in its recent test. That is, by expanding the wavelength domain of the light used to record the information on the high polymer film, it should be possible to record one thousand (1,000) pieces of information in the same location.

TOSHIBA ANNOUNCES ENTRY INTO VAN BUSINESS

Toshiba Corporation recently announced that it plans to use the large-scale network system it has constructed to date to enter the value-added network (VAN) business in earnest. Since October 1986, Toshiba has been operating the "Toshiba Group VAN (TG-VAN)" for members of the Toshiba group. The firm now intends to open this VAN system to outside users as well. Toshiba expects to achieve VAN sales of 20 billion yen within three-year's time, including revenues gained from the sale of terminal equipment. Three types of services are to be offered: 1) basic packet-switched communications services; 2) value-added services such as file transmission and database access services; and 3) information processing services, such as accounting and sales management system services.

NTT BREAKS INTO THE IC CARD BUSINESS

Nippon Telegraph and Telephone Corporation (NTT) has started up an integrated circuit (IC) card business. IC cards are the next generation in plastic cards, and NTT has joined up with Union Credit (UC) Corporation and seven banking houses, including Daiichi Kangyo, to enter this business. Starting in March, 1987, NTT issued multi-purpose IC cards to 3,200 personnel in its data communications division and had them use these cards to perform cashing and credit transactions, to enter and exit restricted areas, to purchase meals in the company's cafeteria and as prepaid cards. By August 1987, this trial period had proven the IC cards to be highly reliable, and NTT began issuing them on a commercial basis.

SECURITY-CONSCIOUS FIRMS OPT FOR DUAL ROUTING

More and more Japanese firms are opting for dual-routed dedicated telecommunications lines as a means of preventing in-house communication stoppages due to accidents and/or malfunctions. Increasing numbers of companies are making use of large-capacity, high-speed digital communications systems to handle their telephone and facsimile communications, and to provide them with image and computer data communications capabilities. The move toward dual-routed lines stems from these firms' efforts to make their communications systems as secure as possible. A total of 200 companies have already applied to Nippon Telegraph and Telephone Corporation (NTT) to have their telecom lines duplexed. This trend could give impetus to the reinforcement of in-house networks in future. Firms utilizing the dedicated lines of Japan Telecom and two other new telecom firms as backup communications systems are also on the increase.

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