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The Roads To Computer Literacy —The propagation of EDP specialists—

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No. 53

Japan Information Processing Development Center (JIPDEC) was established in 1967 with the support of the Government and related industrial circles. JIPDEC is a non-profit organization aimed at the promotion, research and development of information processing and information processing industries in Japan.

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IN-HOUSE EDUCATION AND TRAINING OF EDP PERSONNEL

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INTRODUCTION

Japanese companies are managed in a fashion peculiar to Japan. The typical Japanese company is run in a very paternalistic manner, being comprised of a variety of systems such as lifetime employment and seniority systems and having its own in-house enterprise union. Personnel training programs also reflect this multi-system approach, being implemented in ways that coincide with these various systems. The education and training of EDP personnel are no exceptions. In-house EDP training programs are usually devised and carried out in line with a company's basic employee training policies.

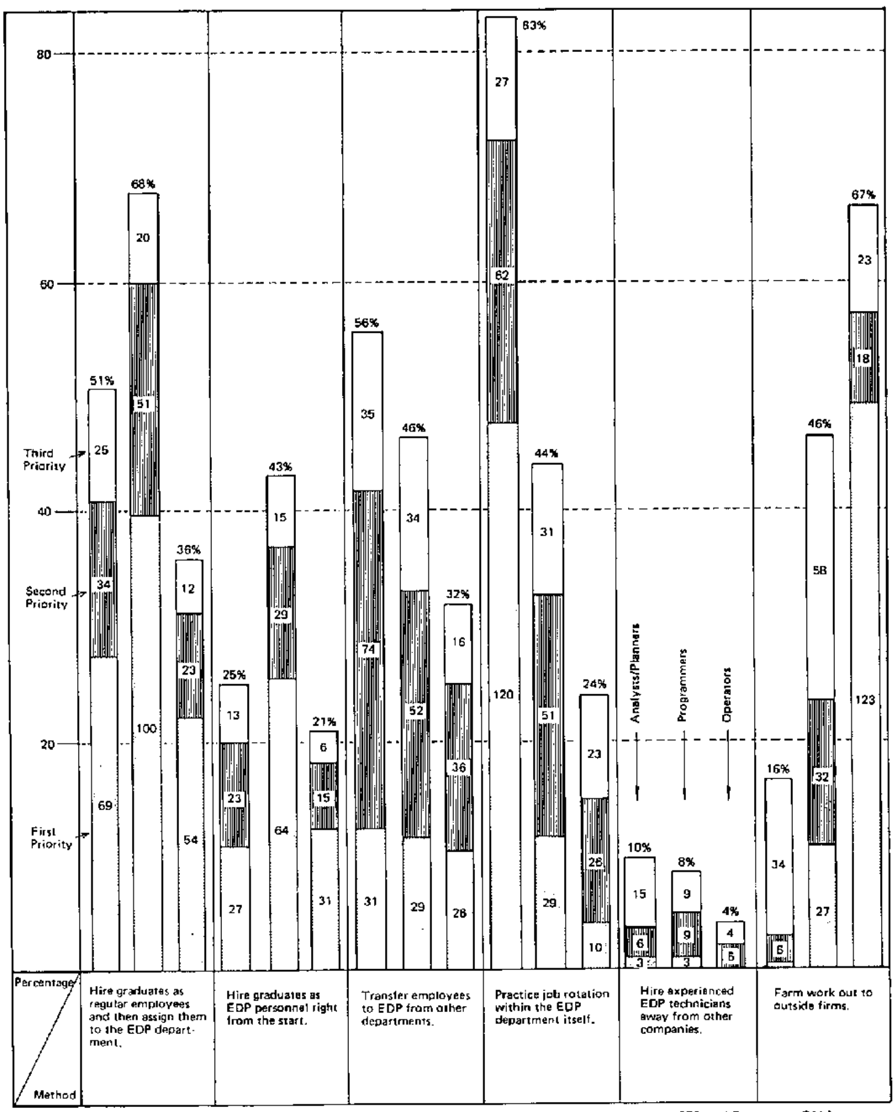
This article will begin by touching on the special nature of Japanese-style management and then proceed to describe just how education and training programs aimed at EDP personnel have developed within that particular style of management.

JAPANESE STYLE MANAGEMENT AND EMPLOYEE EDUCATION

Employee education at Japanese companies is generally carried out by adroitly incorporating various training programs into the peculiar style of management practiced at those companies. Most major Japanese enterprises adhere to a very paternalistic, family-like method of management. Based on this kind of paternalism, these companies have established lifetime employment systems, systems for promotions and salary increases based on worker seniority and a uniquely Japanese labor-management system consisting principally of enterprise unions. In line with these various systems, Japanese companies hire most of their employees straight out of junior and senior high schools and universities and set about educating them primarily via on-the-job training (OJT) and job rotation systems, an approach which ensures that human resources come up to company standards. This form of education and training applies to EDP personnel to a large extent as well.

Basic trends in the education and training of employees at Japanese companies can probably be condensed into four major areas. These are:

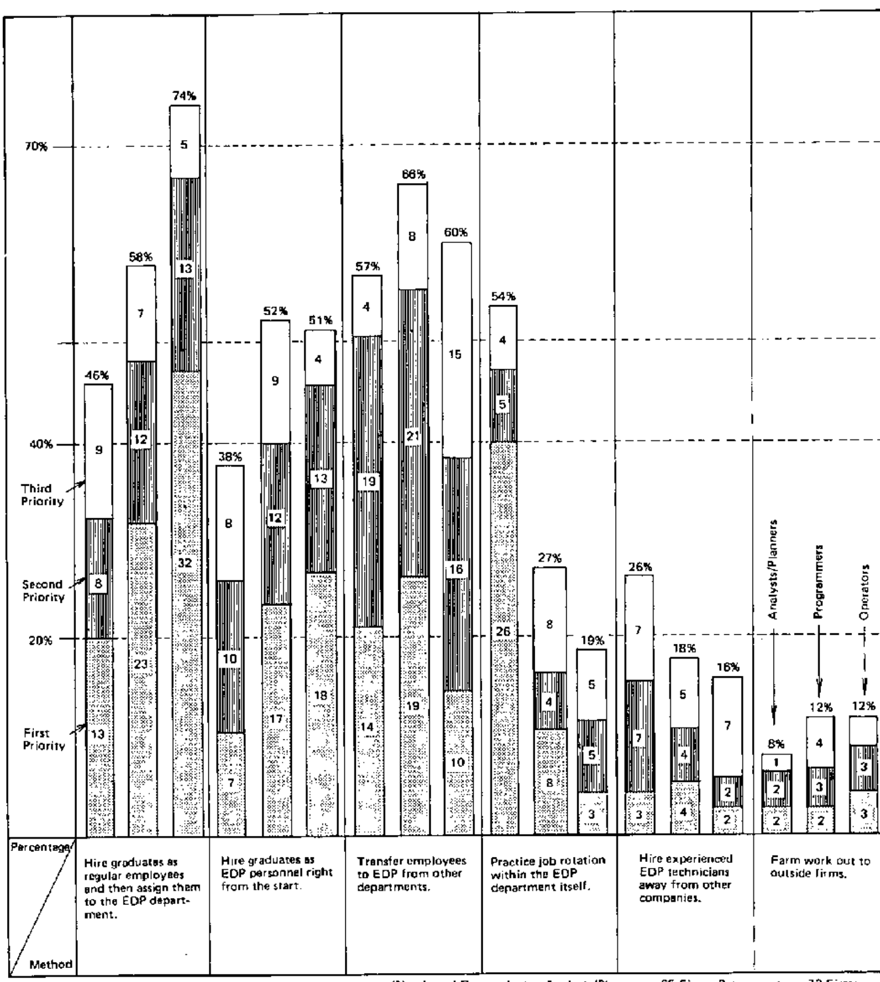
1) Employee education programs which emphasize the long-term nature of life-



(Number of Respondents: Analysts/Planners — 251; Programmers — 252; and Operators — 244.)

Source: See Footnote 1

Fig. 1. Methods Of Securing EDP Personnel At Companies Using IBM General Purpose Computer Systems



(Number of Respondents: Analysts/Planners – 65 Firms; Programmers – 73 Firms, and Operators – 68 Firms.)

Source: See Footnote 1

Fig. 2. Methods Of Securing EDP Personnel At Companies Using IBM Small-Scale Computer Systems

time employment security, i.e. the development of non-specialized, 'jack-of-all-trades' type employees;

2) Training based primarily on job rotation;

3) The cultivation of employees who meet with a company's own peculiar standards and characteristics; and

4) The development of personnel devoted heart and soul to the company.

METHODS OF SECURING EDP PERSONNEL

In spite of the fact that persons skilled in computer hardware and software are in strong demand, Japanese employment policies go a long way towards ensuring that a company is capable of securing and retaining sufficient computer-related talent. The practice of one company hiring experienced EDP personnel away from another company isn't very evident in Japan. Instead, the tendency here is to hire new employees straight out of school and assign them to the EDP department or reassign personnel from other departments within the company to positions in EDP. A lot of times a company will supplement its systems engineers with trained programmers, for example.

Following the oil shocks, Japanese enterprises found themselves in a period of stable economic growth as opposed to the high economic growth period they had enjoyed prior to those shocks. This sudden drop in growth tended to put a damper on new hiring. However, in the case of EDP personnel, the tendency to rely on the hiring of new graduates to fill out the ranks is as prevalent as ever. Firms related to the information processing industry aside, most companies hire EDP personnel as regular employees, not information processing specialists. Those enterprises not related to the information processing industry which do hire their EDP personnel on the basis of specialized skills right from the start are few and far between.

Figures 1 and 2 cite several examples of methods used by Japanese companies to secure EDP personnel. The figures appearing therein are the results of a questionnaire survey conducted in 1982 by the IBM User Society.

This type of survey is carried out every year by that Society and targets its own member companies [1]. These results were divided into two broad areas, those pertaining to users of general purpose systems (IBM 4330 or larger systems) and those of small-scale systems (users of IBM S/34, S/38 and S/7 systems). Figure 1 shows the results for general purpose system users and Figure 2, those for small-scale system users. Both of these figures indicate some of the various methods used by Japanese companies to secure and retain EDP personnel by job category: analyst/planner, programmer and operator. The questionnaires were filled in by the analyst/planners, programmers and operators at the various user companies and their responses were analyzed to determine which of the methods for securing EDP personnel were felt to be given the most priority at these respective companies. Methods felt to have the most priority are marked "first priority," those with the next most priority are marked "second priority" and those felt to be of the least priority are labelled "third priority." These figures also show the percentage of the total number of respondents by job category who replied to each query.

CAREERS VS JOB ROTATION

CAREERS

Most Japanese companies depend on the rotation of personnel from one job to another, one department to another, as the basis of their employee education and training programs. This means they are anything but specialist oriented. This fact is evident even for EDP personnel who require a high level of technical skills. In other words, the careers of EDP personnel in Japan aren't at all clear in most cases.

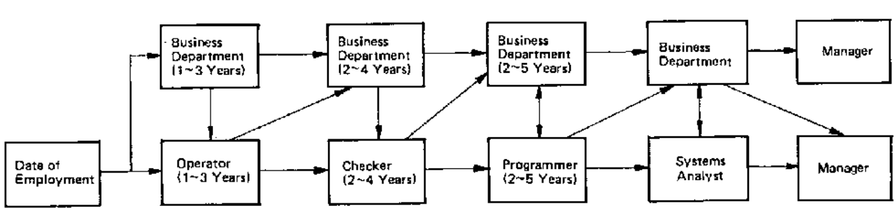
Japanese firms outside of those related to the information processing industry which currently have EDP career development schemes in place amount to a little better than 10% of the total. If we include those enterprises supposedly considering the establishment of such career schemes in future, this figure rises to only a little less than 20%. Moreover, only a very few of those companies that do currently offer their EDP personnel career opportunities back this up with any kind of regular education and training programs.

The situation in the information processing industry isn't much better, either. Companies directly related to the information processing industry which provide their EDP personnel with career development schemes total just a little better than 10% of all such companies. Those currently considering establishing such career schemes exceed 30%, however. Nevertheless, of those companies that already have such schemes in place, only one out of every five are actively supporting and promoting them.

ing them.

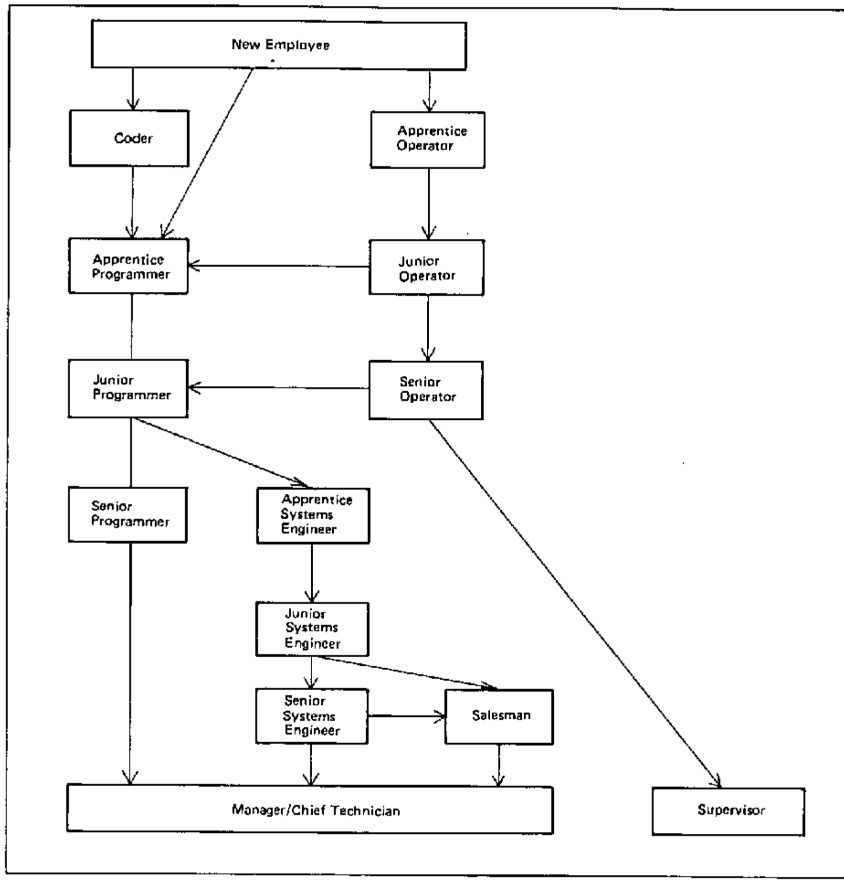
Figures 3 and 4 provide examples of EDP career development schemes currently in place at Japanese companies.

Example Of A Career Development Scheme For EDP Personnel In The Manufacturing Industry



Source: See Footnotes 2, 3.

Fig. 3. EDP Career Development Scheme At An Enterprise Not Related To The Information Processing Industry



Source: See Footnote 3

Fig. 4 EDP Career Development Scheme At An Information Processing Company

Figure 3 is an example of the kind of careers devised by companies in the manufacturing industry, while Figure 4 gives an example of a typical career development scheme found at companies in the information processing industry.

JOB ROTATION

The significance of job rotation at Japanese enterprises is great. The following six points attempt to summarize just how and why job rotation is so important.

1) Job rotation is extremely effective as a means of ensuring that company employees receive the diverse training necessary for them to contribute positively towards the company's operations until they reach the age of retirement;
2) It provides employees with multiple skills acquired through a variety of job experiences which go beyond a

single department or job category. In this way, the company knows it can count on its personnel to contribute towards its operations in a variety of ways in the long run;

3) New employees just entering a company have no special vocational aptitudes for the most part. For that reason, job rotation is the quickest and best way for the company to match its personnel up with the job that most suits them, thus building up their confidence and skill levels. By so doing the company develops employees capable of performing other jobs well, too;

4) Having employees do the same job over a long period of time has its drawbacks when it comes to trying to provide each worker with a job that he or she will feel is worth doing until retirement. It is necessary to provide the worker with a change of pace, a new challenge, to stimulate him by changing his job at appropriate intervals. Job rotation is just the answer to motivating and invigorating employees on a more or less regular basis;

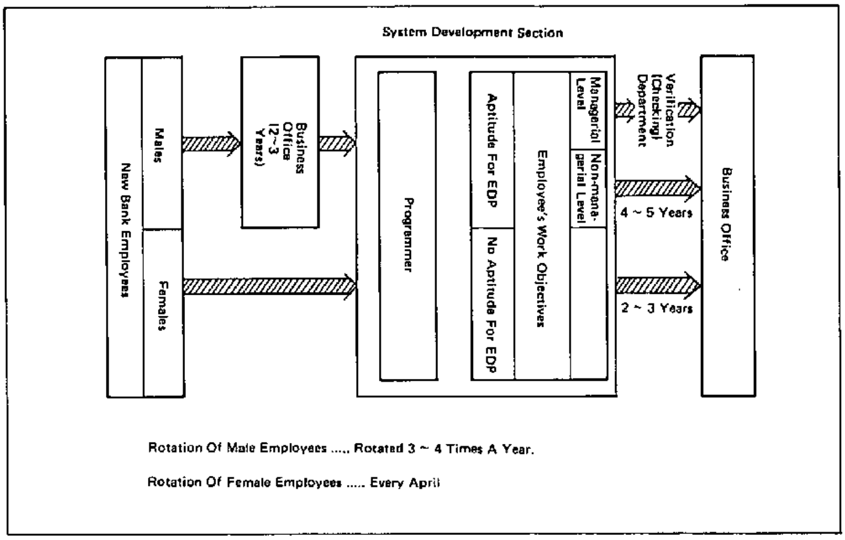
5) In addition to recharging the workers like this, it is also very important to energize the various worksites and overall organization itself occasionally. Job rotation plays a big role in this regard as well;

6) Performing the same job for long number of years can lead to worker complacency and even the perpetration of criminal acts such as the sale of company secrets. To avoid such a situation and assure companywide security it is very important to have workers change jobs regularly.

The above stated reasons should help clarify just why job rotation is considered an extremely significant aspect of personnel policies at Japanese companies.

Quite naturally, then, job rotation also applies to EDP personnel. However, with the low rate of economic growth being experienced by Japan lately, it's reached the point where many companies are being forced to reduce the number of their EDP personnel. Since layoffs are not the practice in Japan, these EDP technicians are being reassigned to jobs unrelated to their specialties, thus dislocating their career development. There are apprehensions that the situation could well lead to a drop in overall performance at many firms. The upshot is that increasing numbers of companies are finding it more and more difficult to carry out interdepartmental career-oriented job rotation.

An example of a typical interdepartmental job rotation system at a city bank is shown in Figure 5. Most Japanese city banks require that their male employees have experience working in one of their business offices. This goes for city bank EDP personnel as well. After putting in between two and three years doing regular banking chores at a business office somewhere, EDP personnel are then reassigned to the data processing department.



Source: See Footnote 3

Fig. 5. Job Rotation At A City Bank

EDUCATION OF EDP PERSONNEL

As is evident from the preceding discussion, Japanese companies aren't in the practice of hiring people based on their previously acquired knowledge or technical skills. Rather, they prefer for the most part to hire new employees straight out of school and then provide them with the job knowledge and technical skills necessary to perform a variety of tasks by means of a system of job rotation. The basically same approach is used when it comes to the education and training of EDP personnel as well.

When a new employee or someone from another department is first assigned to the EDP department, they begin computer training from the ground up. That is, they start out by receiving basic training on computer hardware and software, then advance through beginning, intermediate and advanced data processing training until they become full-fledged EDP technicians. The education and development of EDP personnel takes the form of OJT for the most part. However, there are quite a few companies that have regular group training programs to help employees acquire basic EDP knowledge and skills.

At this point we would like to introduce some actual examples of EDP personnel training programs in effect at both ordinary companies and those directly affiliated with the information processing industry.

EDP TRAINING SYSTEM AT A COMPANY OUTSIDE THE INFORMATION PROCESSING INDUSTRY

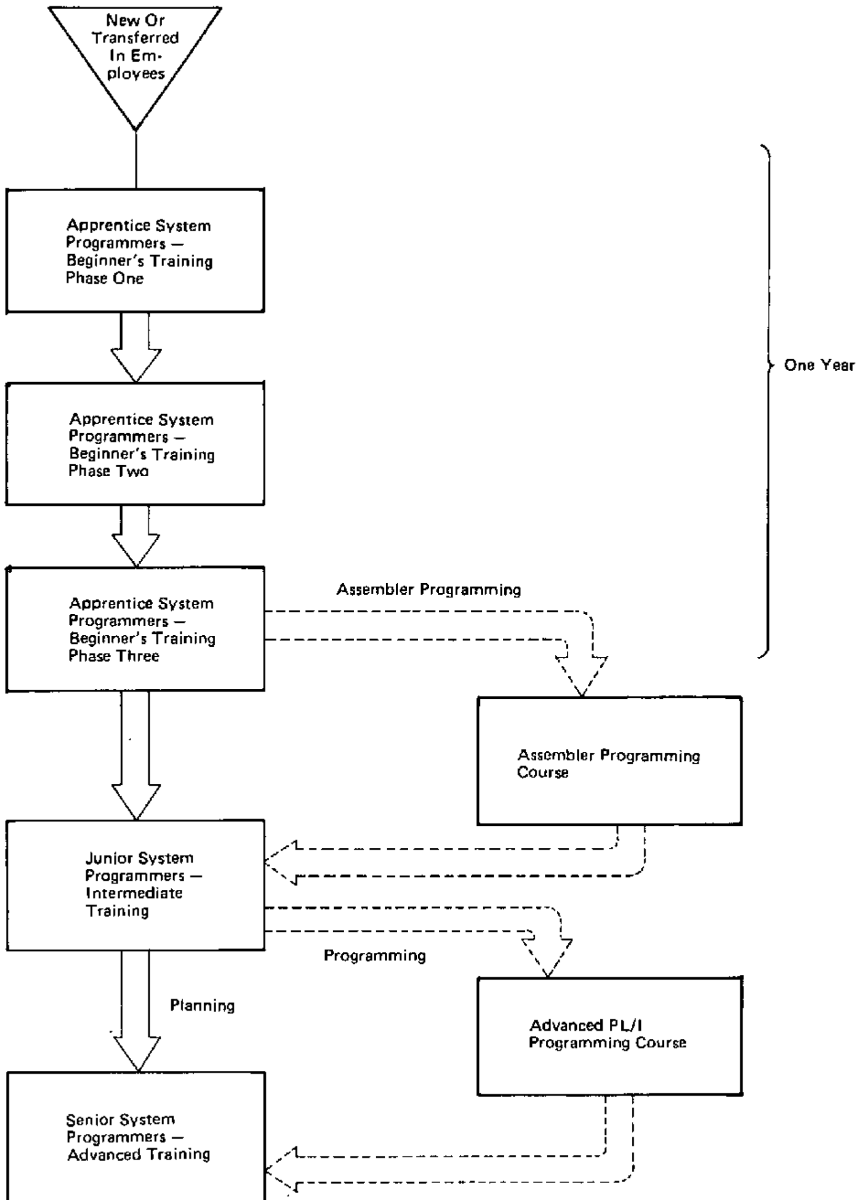
The example given here is an actual computer education program in effect at a certain Japanese gas company. The education and training system for EDP personnel at this company actually consists of two separate programs, one aimed at developing systems programmers and the other operators. We will present only the systems programmers' training program here.

Systems programmers are those individuals charged with developing programs and analyzing and designing systems. The training program for these technicians is divided into three levels: beginners, intermediate and advanced. Individuals receiving beginners training are known as apprentice systems programmers, those receiving intermediate training as junior systems programmers and advanced technicians are called senior systems programmers. Figure 6 outlines the overall education and training program for these systems programmers. As shown in that figure, apprentice systems programmers receive EDP systems training in three phases covering a period of one year. This training is the same for new employees as it is for those prior employees who transfer in from other departments. Intermediate training is carried out during the second year and advanced training comes in the third year following assignment to the EDP department.

In setting up this training program, the company determined what knowledge and skills would be necessary in accordance with the work criteria at each of the levels and then prepares curriculums based on those factors.

Figures 7 through 9 show the objectives, courses and specific course contents for each of the three levels of training. The boxes marked "Assembler Programming Course" and "Advanced PL/I Programming Course" in Figure 6 are explained as to course content in Figure 9.

Phase one of beginning level systems programmer training lasts roughly one month, during which time the apprentice systems programmers are provided with pretty much all the basic knowledge they'll need. After completing the instruction portion of phase one, the apprentice systems programmers are sent back to their various posts and given a series of simple jobs to carry out. By assisting their superiors at the worksite like this, the apprentice systems programmers gradually familiarize themselves with the type of work they will be involved in. Phase two of beginner training is designed to make good use of all the apprentice systems programmers learned during their first phase of instruction and OJT. This phase consists primarily of programmed instruction which the trainees can study on their own and at their own pace at the worksite. When necessary, they can get difficult to understand points cleared up for them on the spot by asking their superiors for explanations. Phase two of beginner training lasts about three



Source: See Footnote 2.

Fig. 6. Diagram of a Training Program for System Programmers

(1) Phase One of Beginner's Training for Apprentice Systems Programmers

To train new and transferred in EDP employees in the basics of EDP systems

No.	Training Courses	Course Contents	Training Materials/Aids
1	Company System and Data Processing	◦ History, workload and organization of the company's EDP Center.	"General Outline of the Company's EDP Center."
2	Fundamentals of Computers	◦ Computers and Creativity ◦ Data Expressions ◦ Data Storage Media ◦ Computers and Logic ◦ Computer Configurations ◦ Bit Record; Byte Block ◦ Magnetic Tape; Disks	Video tapes "Computers: A General Explanation." Introduction to IBM's 370 series
3	Operation Practice	◦ Fundamentals of computer operation	
4	Introduction to Flow Charts	◦ Methods of preparing flow charts ◦ Flow Charts and Logic	"Introduction to Flow Charting" Video tapes
5	Introduction to Decision	◦ Decision tables ◦ Nest loops	Video tapes
6	Basics of PL/I	◦ Definition of PL/I programs ◦ Principles of PL/I programs ◦ Data expressions ◦ Program execution and control ◦ I/O methods ◦ Processing exceptional conditions ◦ Subroutines and their functions ◦ General purpose macros for PL/I use ◦ Useful functions for program testing	Standard PL/I manual Workbook
7	Fundamentals of OS and JCL	◦ Relationship between operating systems and job control languages ◦ Computer operation ◦ How to prepare JCLs ◦ Program execution	Video tapes
8	Sequential Dataset Processing	◦ Maintenance, updating and deletion of files	Video tapes
9	PL/I Practice (I)	◦ Flow charting ◦ Coding	Video tapes
10	Standardization	◦ Importance of standardization ◦ In-house system of standardization (scope, contents)	OHP
11	General Purpose Program	◦ TDGEN, Sort/Merge, TMATE, TLIST, LIBCON	Standard manual Compilation of general purpose programs Examples of general purpose program usage
12	Introduction to System Design	◦ Procedures, specifications and codes for system preparation	"Fundamentals of System Design"
13	PL/I Practice (II)	◦ Testing	

(2) Phase Two of Beginner's Training for Apprentice Systems Programmers

To expand upon and strengthen phase one training

No.	Training Courses	Course Contents	Training Materials/Aids
1	Introduction to IBM's System 370 (Programmed Instruction [PI])	◦ Basic configuration of System 370 ◦ Data expressions and operations in System 370 ◦ I/O operations and devices ◦ Methods for organizing and processing files ◦ OS functions	"Introduction to System 370"
2	Introduction to Virtual Storage Systems	◦ What are virtual storage devices? ◦ Dynamic address translation (DAT) ◦ Control of real storage devices ◦ Program execution and paging	"Introduction To Virtual Storage Systems" Video tapes
3	Basic Rules For Utilizing OS/VS	◦ OS/VS functions and configurations ◦ JCL ◦ JES	"Basic Fules For Utilizing OS/VS"

(3) Phase Three of Beginner's Training for Apprentice Systems Programmers

To provide training in the preparation of programs using JCL and structured programming

No.	Training Courses	Course Contents	Training Materials/Aids
1	OS/VS Concepts	◦ OS/VS functions ◦ System Control Programming (SCP) ◦ JES	"Basic Rules For Utilizing OS/VS"
2	Linkage Editor Functions and Program Preparation	◦ Linkage editor functions ◦ Control statements	
3	JCL Practice	◦ Preparation of JCL for actual jobs	Standard practice problems
4	Structured Programming	◦ Control structure ◦ Structured programming in PL/I	Video tapes

Source: See Footnote 2

Fig. 7. Training Schedules For Apprentice Systems Programmers

(4) Intermediate Training For Junior Systems Programmers

To enable junior systems programmers to prepare program specifications from basic plans and to develop detailed designs from those

No.	Training Courses	Course Contents	Training Materials/Aids
1	System Design	1 Top-Down Design 2 I/O Voucher Design 3 Design of I/O media and record layouts 4 On-line file design and storage capacity estimates 5 Code design	Standard manual
2	Program Design	1 Structural design techniques 2 Specifications preparation 3 Decision table notation 4 NS chart 5 HIPO notation	Video tapes Standard manual
3	COSS	1 General outline of COSS 2 COSS operations	
4	Introduction to Data Bases	1 Data and storage structures 2 Data retrievel 3 Information Management System concepts	
5	Introduction to Data	1 Outline of data communication systems 2 Outline of communication circuits and their control	
6			

Source: See Footnote 2

Fig. 8. Training Schedule For Junior Systems Programmers

(5) Advanced Training for Senior Systems Programmers

To enable senior systems programmers to carry out their daily work in a smooth, efficient manner

No.	Training Courses	Course Contents	Training Materials/Aids
1	Management of Development and Maintenance Control	1 Work schedule management 2 Test management 3 Document control 4 Diagram and Network Control 5 Video tapes	Video tapes
2	Standardization and Its Employment	1 System standardization	
3	Data Protection	1 Data protection and system design	Standard manual
4	Walk-Through operations	1 Structured walk-through operations	Standard manual

(6) Advanced PL/I Programming Training

To train systems programmers in the effective use of PL/I compiler functions

No.	Training Courses	Course Contents	Training Materials/Aids
1	Advanced PL/I Programming	1 Ways of using pointer variables 2 Ways of handling IS files 3 Subroutines and their functions	
2	PL/I Preprocessors and Macros	1 Preprocessor functions 2 Preparation of PL/I macros	PL/I Programming Manual
3	Dump List Analysis	1 Methods for solving troublesome bugs 2 Analysis of PL/I dump lists	PL/I Programming Manual

(7) Assembler Programming Training

To train systems programmers in the assembler language, especially in-house standards and SP macros related to assembler programming

No.	Training Courses	Course Contents	Training Materials/Aids
1	In-house Standardization	1 Standard coding formats 2 Initialization and termination of program	"Tokyo Gas Assembler Programming Manual" Educational materials
2	Sequential Dataset Processing	1 Data control block (DCB) macros 2 OPEN/CLOSE 3 I/O procedures	
3	SP Macros		
4	Utilization of PL/I Subroutines		
5	Debugging	1 Additional uses of dumps	

Source: See Footnote 2

Fig. 9. Training Schedule for Senior Systems Programmers

months and is divided into the three different programmed instruction courses shown in Table 2 of Figure 7. Since the trainees mastered the basics during phase one of their training, the programmed instruction courses presented during phase two enable them to deepen their understanding of the field of systems programming. When phase two is over, the apprentice systems programmers move on to phase three of their training program. This phase is the finishing process for these individuals. It consists of five days of group instruction on such topics as operating systems/virtual storage (OS/VS), methods for utilizing linkage editors, practice using job control languages (JCL) and instruction on structured programming (See Table 3 of Figure 7.). JCL practice seesions, in particular, provide the apprentice systems programmer with actual hands-on experience in the utilization of JCL in accordance with in-house criteria and real job descriptions.

When the EDP trainee advances to the level of junior systems programmer, he receives intermediate level training primarily in the form of hands-on, learn-as-you-do type training centering around program design and the detailed design of systems. He is also introduced to the areas of data bases and data communication systems (See Figure 8.). Senior systems programmers receive training in the management of development and maintenance control, the standardization of systems and their operation and data protection. As senior systems program-

Curriculum		Beginner's Course	Intermediate Course	Advanced Course	Special Course
Experience		First Year	1 ~ 2 Years	3 ~ 4 Years	5 ~ 7 Years
Job Category	A	Basic Training	Junior Programmers	Senior Programmers Junior Systems Engineers	Systems Engineers
	B	Operation Practice	Junior Operators Senior Operators	Chief Operators Controllers	
Job Category A		· Basic knowledge of EDP systems · Knowledge of COBOL and FORTRAN · Basic knowledge of OS · Acquisition of various standardization techniques	· Completely familiar with COBOL, FORTRAN and Assembler. · Thorough understanding of program design. · Knowledge of systems design · Knowledge of documentation · Knowledge of utility programs · Basic uses of OS	· Data base design · Thorough understanding of systems design. · Knowledge of systems analysis · Complete familiarity with utility programs · Knowledge of terminal communication circuits · Thorough knowledge of documentation · Capable of managing and giving guidance · Complete understanding of OS	· Capable of efficiently analyzing and judging systems · Capable of managing programmers · Capable of managing data processors · Thorough knowledge of terminal communication circuits · Complete knowledge of information processing · Instructor level
Job Category B		· Basic knowledge of EDP systems · COBOL and FORTRAN · Fundamentals of OS · Fundamentals of machine operation	· Thorough understanding of machine operation · An understanding of operation manuals and job contents · Basic uses of OS · Efficient utilization of OS	· Complete knowledge of OS · Thorough understanding of the relationship between all work · Capable of managing and giving guidance · Acquisition of machine room operation techniques · Completely familiar with the entire system · Capable of judging machine efficiency · Knowledge of terminal communication circuits	· Capable of analyzing and effectively judging systems · Capable of managing operators · Capable of managing data processors · Thorough knowledge of data processing · Instructor level

Source: See Footnote 3

Fig. 10. Example Of The Levels And Contents Of A Training Program At A Data Processing Company

mers, these advanced-level technicians are trained to be able to carry out every-day EDP duties in a smooth and efficient manner (See Figure 9.).

Since PL/I is the principal programming language used at this company, when deemed necessary, it gives its systems programmers classes in "Advanced PL/I Programming" following completion of intermediate level training. This training focuses mainly on ways of writing PL/I macro instructions and preprocessor statements (See Table 6 Figure 9). A course in "Assembler Programming" is also given to those systems programmers put in charge of maintaining programs written in assembler (See Table 7 Figure 9.). The systems programmers take this assembler course following the completion of phase three of the beginning level of training.

The preceding has attempted to outline the education and training program for systems programmers at a gas company. However, since there are numerous companies which have programs similar to this, it might be taken as representative.

EDP TRAINING AT AN INFORMATION PROCESSING COMPANY

An example of an EDP education and training program found at an information processing company is shown in Figure 10. The company concerned is a major Japanese data processing service that offers software development and consulting services in addition to its main business of carrying out data processing on a consignment basis. It employs over 500 people in its EDP operations. Systems engineers and programmers account for roughly 300 of these employees, while operators number somewhere around 130 and checkers around 80.

As Figure 10 indicates, the education and training program at this company is broken down into four categories or courses, a beginner's course, intermediate course, advanced course and special course. These courses are further divided by job category into those for systems engineers and programmers (A) and those for operators (B). The contents of the various courses differ depending on the job category to which they apply.

All new employees are obligated to receive basic training in the beginner's courses. This goes for those individuals who have prior computer experience as well as those who do not, and for college as well as high school graduates. No incoming employee is exempted from the beginner's training courses. The instruction portion of these courses lasts four weeks, after which the trainees are given between three weeks and a month of actual computer operation practice.

After completing the beginner's course, the trainees are assigned to different departments within the company where their EDP training continues in accordance with the various courses available. Although certain of the subjects and areas covered in the intermediate and higher courses are taught within the company, most upper level training is carried out by sending the employees to special classes held outside the company (See Figure 10).

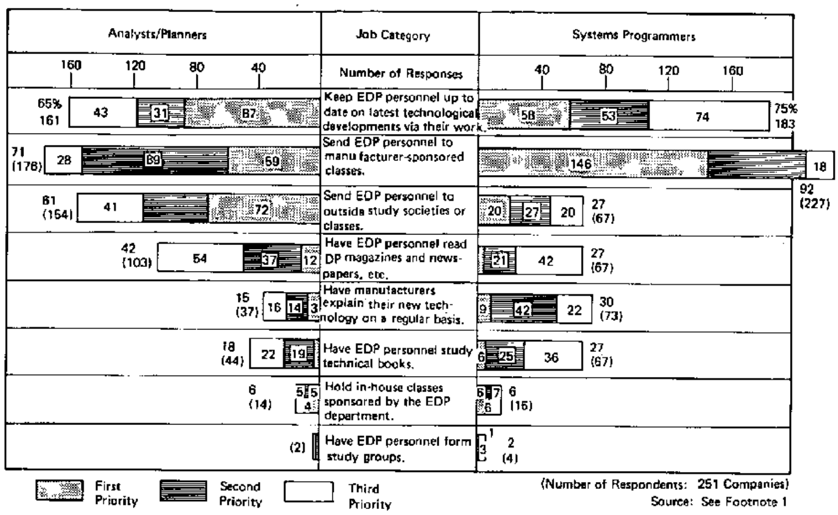


Fig. 11. Methods For Keeping EDP Personnel Up To Date On The Latest Developments In EDP Technology (Part 1)

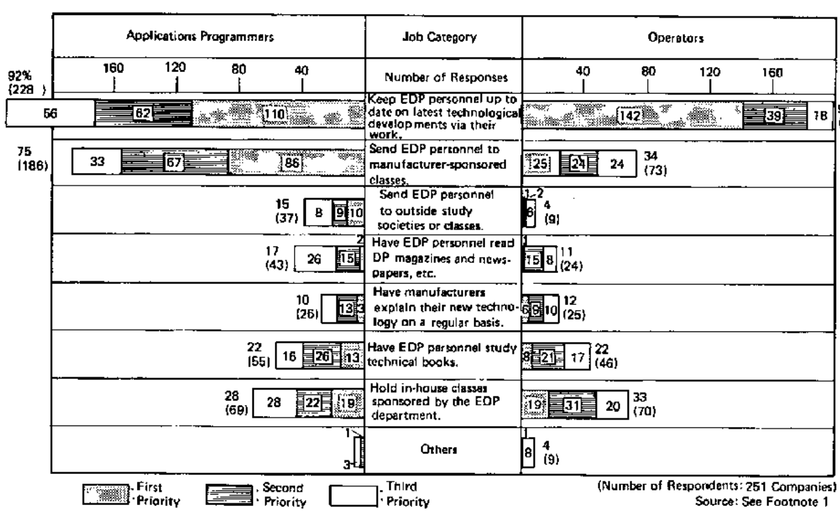


Fig. 12. Methods for Keeping EDP Personnel Up To Date On The Latest Developments In EDP Technology (Part 2)

METHODS FOR ACQUIRING THE LATEST TECHNICAL SKILLS AND KNOWLEDGE

Innovations in data processing technology are being developed at a remarkable pace. In order to keep abreast of these new developments, a company must constantly update the technical skills and knowledge of its EDP personnel. But just how do Japanese companies go about doing this? Well, a few answers to this are contained in Figures 11 and 12, which show the results of a study done on this topic. These results were calculated based on the total number of responses received to a questionnaire sent to some 251 companies currently using IBM general purpose computer systems.

The principal means of keeping EDP personnel up to date on the latest developments in information processing technology seems to be either through their work itself or by having them attend classes given by the manufacturers of this new technology. The pattern for this learning differs considerably according to the job category involved, however.

For analysts and planners it is necessary to include a third principal means of keeping them up to date, and that is having them join study societies and attend outside classes. As the bar graphs indicate, some 87 of the companies which responded to the questionnaire gave top priority to having their analysts/planners bring themselves up to date through their work, while 72 of these companies indicated they preferred having them attend outside classes and study society meetings.

When it comes to systems programmers, reliance on classes given by manufacturers of new EDP technology is extremely strong. Nearly 60 percent of the companies which responded to the survey, or 146 companies, gave top priority to manufacturer-sponsored classes to keep their systems programmers informed on the latest in technological developments. The second most popular means of updating systems programmers, so to speak, is via their work itself. None of the other methods cited for this job category were very noteworthy.

Applications programmers are kept up to date on new technological developments primarily via their work, and next by means of attending manufacturer's classes. The former method was given top priority by 110 of the respondents and the latter by 86. Combined, these two methods account for nearly 80 percent of the means available for keeping applications programmers informed of technological developments.

The majority of the respondents favored having their operators stay abreast of new technologies via their work. The actual number of companies that placed the most importance on this method for their operators came to a high 142 in all.

The above has been an attempt to point out how Japanese companies, both those directly related to the information processing industry and those not, systematize and institutionalize regular EDP education and training programs from basic through advanced levels. It was also intended to shed some light on the ways these same companies keep their EDP personnel up to date on the latest technological developments in the field.

FOOTNOTES

1. "Report On The Results Of A Questionnaire Survey Conducted By The IBM Study Society," Kanto IBM Study Society, November, 1982.
2. "Collection Of Reports On The Fifth DP Education Symposium," Information Processing Training, IBM, Japan Co., Ltd., October, 1980.
3. "Collection Of Reports On The Sixth DP Education Symposium," Information Processing Training, IBM, Japan Co., Ltd., September, 1981.
4. "Report On The Results of A. Study Into The Types Of Work Being Done By Senior Data Processing Technicians," Institute of Information Technology, Japan, March, 1982.

THE JAPANESE EDUCATIONAL SYSTEM

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INTRODUCTION

The following article is a very broad outline of the Japanese educational system. It is not intended as an in depth report or analysis of that system, but rather as an overview of education in Japan in general to provide the reader with a point of reference with which to better understand the other articles in this edition of the JIPDEC Report which deal specifically with data processing education and training programs currently in force in Japan.

The contents of this article are based almost entirely on an English-language report titled "OUTLINE OF EDUCATION IN JAPAN" put out in 1977 by the Science and International Affairs Bureau of the Japanese Ministry of Education, Science and Culture (MOMBUSHO).

PRINCIPLES OF EDUCATION IN JAPAN

Article 26 of the Japanese Constitution states that every child has an equal right to receive an education adapted to his abilities as the law shall provide, and every parent has the duty to see that children receive a basic education. It also states that compulsory education shall be free.

Basic national aims and principles concerning education in Japan are set forth in the Fundamental Law of Education enacted in 1947 in accordance with the spirit of the Constitution.

ORGANIZATION OF THE EDUCATION SYSTEM

The educational system in Japan is

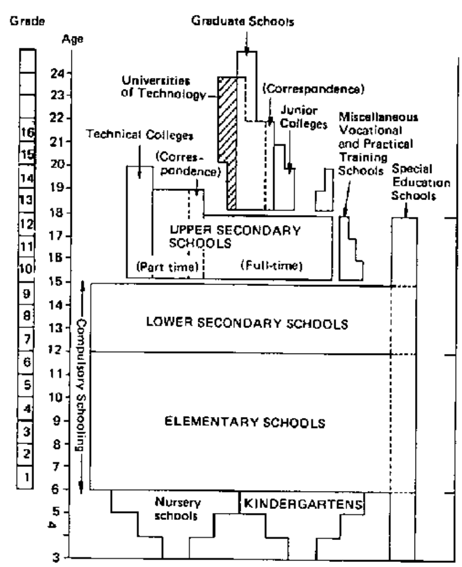

Fig. 1. Organization of Educational System

organized along much the same lines as those in western nations with children starting their formal, general education at the elementary school level, then progressing on to lower secondary (junior high) schools, upper secondary (senior high) schools and then to colleges or universities. This system also includes technical and other specialized and special training high schools and colleges, plus part-time and correspondence schools. In addition, there are nursery schools and kindergartens for pre-school children as well as schools for exceptional children suffering from physical and/or mental handicaps and other disorders (See Figure 1). All schools in Japan can be broadly categorized as either public, i.e. those run by national, prefectural or municipal authorities, or private. The major characteristics of each of these different types of educational institutions are briefly explained below.

NURSERY SCHOOLS AND KINDERGARTENS

While not part of the compulsory educational system, nursery schools and kindergartens for pre-school children nevertheless comprise a part of the formal education process for the majority of Japanese people.

Nursery schools cater to infants ages 1 to 5 inclusive who are in need of institutional care. Those children aged 3 or older who are enrolled in nursery schools receive instruction similar to that offered in the kindergartens.

Kindergartens aim at preparing preschool children mentally, physically and socially for their entrance into elementary schools by providing them with a sound educational environment. Kindergartens admit children ages 3, 4 and 5 and provide them with three-, two- or one-year courses, respectively. Although the majority of kindergartens come under the supervision of national and local educational authorities, they are most often privately controlled and operated.

ELEMENTARY SCHOOLS

All Japanese children having attained the age of 6 are required by law to attend a six-year elementary school. Elementary schools aim at furnishing children between the ages of 6 and 12 with general elementary educations adapted to their mental and physical abilities.

LOWER SECONDARY (JUNIOR HIGH) SCHOOLS

All children having completed elementary school education are required by law to continue on to a three-year lower secondary (junior high) school. They must attend these schools for three years or until the end of that school year during which they turn 15 years of age. Lower secondary schools provide children between the ages of 12 and 15 with general educations adapted to their mental and physical abilities and based on the education they received in elementary school.

UPPER SECONDARY (SENIOR HIGH) SCHOOLS

Any child having completed lower secondary school may go on to an upper secondary (senior high) school. Three types of upper secondary school programs are available in Japan: full-time, part-time and correspondence. Full-time courses last a maximum of three years, whereas part-time and correspondence courses can continue on for four or more years. Part-time programs can be further broken down into day and evening courses, the latter accounting for the majority of part-time courses.

Both part-time and correspondence students can earn diplomas equivalent to those awarded students who complete the requirements for full-time courses. Approximately 5.0% of the total number of upper secondary school students in Japan are enrolled in either a part-time or correspondence program.

Upper secondary school curriculums can be broadly divided into two categories: academic and vocational. Academic courses provide students with the general type of education necessary for them to gain entrance into institutions of higher learning or to find gainful employment in other than vocational fields.

Vocational courses can be classified into technical, commercial, agricultural, marine, domestic and fine arts, science and mathematics. These curriculums provide the kind of vocational or other specialized education required by those students who choose to pursue one or another of the various trades or occupations which fall into these categories.

UNIVERSITIES, JUNIOR AND TECHNICAL COLLEGES

There are more than 400 universities in Japan. In order to gain entrance to one of them, the prospective student must have completed upper secondary schooling or its equivalent and be able to pass a series of competitive entrance exams. All Japanese universities offer various four-year programs leading to bachlor's degrees (Medical and dental degrees require a minimum of six years of study.). Approximately one half of all Japanese universities also offer graduate school courses leading to master and doctorate degrees. On the average, two years of study beyond the bachlor's degree are necessary in order to earn a master's degree, and an additional three years to qualify for a doctorate degree (four years in the case of Doctor of Medicine and/or Dentistry degrees).

Junior colleges number over 500 in all and provide upper secondary school graduates with two- or three-year programs in a variety of fields. Most of the courses offered in junior colleges are in the humanities, social sciences and home economics and the credits acquired by completing these courses can be counted towards fulfilling the requirements for a bachelor's degree. The majority of the students enrolled at junior colleges in Japan are women.

The first technical colleges didn't appear in Japan until 1962. Unlike universities and junior colleges, admission to technical colleges requires only that the prospective student have completed lower secondary (junior high) school and scored a passing grade on either an achievement test or entrance examination. Technical colleges offer five year programs aimed primarily at the training of skilled technicians (Mercantile marine programs are usually 5.5 years long.). The courses available at the roughly 65 technical colleges in existence in Japan include mechanical, chemical, electrical and civil engineering, among others. Strictly speaking, those students who successfully complete the course requirements at a technical college are capable of applying for admittance to upper level study at universities.

SPECIAL TRAINING AND MISCELLANEOUS VOCATIONAL AND PRACTICAL TRAINING SCHOOLS

In addition to the regular upper secondary schools and institutions of higher learning described above, there are also numerous special vocational and training schools which fall outside the main stream of education in Japan, but which nevertheless are a part of the overall education system and play an important role in enabling all Japanese citizens to exercise their right to an equal education. The majority of the students enrolled in these schools are individuals who either chose not to take or failed to pass the competitive or achievement tests required for admission to regular upper secondary schools and institutions of higher learning.

These schools can be divided broadly into accredited special training schools supported by the government and miscellaneous vocational and practical training schools which are not accreditted. Accredited special training schools offer three curriculums: upper secondary, technical and general. All of these are designed to raise students' work capabilities as well as their general levels of education. Each course runs for a minimum of one year and must have at least 40 students enrolled per class. Admission requirements differ according to curriculum. For example, special training schools offering upper secondary curriculums require that prospective students have a lower secondary school education, while those offering technical curriculums require the successful completion of upper secondary schooling. Special training schools which offer general course curriculums have no specific admission requirements and are therefore open to anyone who wishes to attend. There are reported nearly 900 such accredited special training schools currently in operation in Japan, most of which are privately run.

Miscellaneous vocational and practical training schools not supported by the government and thus not accreditted, offer such courses as cooking, bookkeeping, typing, automobile repair and computer training for the most part. Admission to these schools usually requires only that the prospective student have completed lower secondary school, but in some cases, completion of upper secondary schooling is a necessity. Miscellaneous vocational and practical training schools are all privately operated and their respective courses are usually less than a year in duration.

SPECIAL EDUCATION SCHOOLS

Finally, there are number of schools in

Japan dedicated to providing special education to those children afflicted with physical and mental handicaps. These include schools for the deaf, dumb, blind, crippled and otherwise handicapped individuals.

ADMISSIONS

ADMISSION TO LOWER SECONDARY SCHOOLS

Municipal public lower secondary schools are obligated to admit any child who has completed an elementary education and resides within a designated school district. However, in the case of national public and private lower secondary schools, entrance examinations and other tests are given to prospective students as a means of keeping the numbers admitted within the bounds of the limited seats available.

ADMISSION TO UPPER SECONDARY SCHOOLS AND TECHNICAL COLLEGES

Although all those students having successfully completed lower secondary schooling are entitled to apply for admission to the upper secondary schools or technical colleges of their choice, only those who pass the required entrance exams or achievement tests can gain admittance. In the case of upper secondary schools and technical colleges run by municipal authorities, admission is based on the results obtained by applicants on achievement tests given by those authorities plus recommendations and reports provided by the applicants' lower secondary school principals. National and private upper secondary schools and technical colleges admit applicants on the basis of results obtained on entrance exams given by those institutions themselves.

As of April, 1976, 92.6% of all lower secondary school graduates in Japan went on to upper secondary schools or technical colleges.

ADMISSION TO JUNIOR COLLEGES AND UNIVERSITIES

Practically all junior colleges and universities in Japan are limited as to the number of new students they can admit each semester. Generally speaking, competitive entrance examinations given nationally by the Ministry of Education, Science and Culture, as well as others given by the colleges and universities themselves, serve to determine which applicants will be admitted and which will not. In many cases, the students' upper secondary school records are also taken into consideration.

At the end of the 1975/76 school year, 834 thousand students applied for admission to universities and junior colleges, out of which some 595 thousand or 71.4% were admitted. Of the successful applicants, roughly 160 thousand or 26.9% were students who had graduated upper secondary schools at least one year previous and who had presumably failed entrance exams one or more times before. The total number of successful applicants accounted for 33.9% of all upper secondary school graduates in 1976.

TOTAL NUMBER OF SCHOOLS AND STUDENTS

The total number of schools, colleges, universities and other institutions of learning in Japan as of May, 1976, amounted to over 63,000 in all. Total enrollment in these various schools and institutions was approximately 25.7 million, or 23% of the overall population of the country. Of the total number of enrolled students, 10.6 million were in elementary schools, 4.8 million in lower secondary schools, 4.4 million in upper secondary schools and 2.4 million in institutions of higher learning.

ENROLLMENT BY COURSE

Since around the turn of the century, the proportion of compulsory school age children enrolled in schools has always been close to 100%. The number of children completing compulsory level education and going on to higher secondary and college-level educations has risen remarkably since the early 1950's.

Student enrollment in upper secondary schools by type of courses and programs offered, i.e. full-time or part-time, is as shown in Figure 2. As indicated, roughly 64.5% of the total number of students attending full-time upper secondary schools as of May, 1976, were taking academic courses.

When it comes to universities, enrollment by course differs between the private universities and the public. For example, more than half of all private university students are enrolled in humanities and social science courses and approximately 1/3 in scientific courses such as natural sciences, technology, medicine and agricultural courses. Public university students, however, tend to favor scientific courses over humanities and social science courses, with as much as 48% of all public university students enrolled in the former and only about

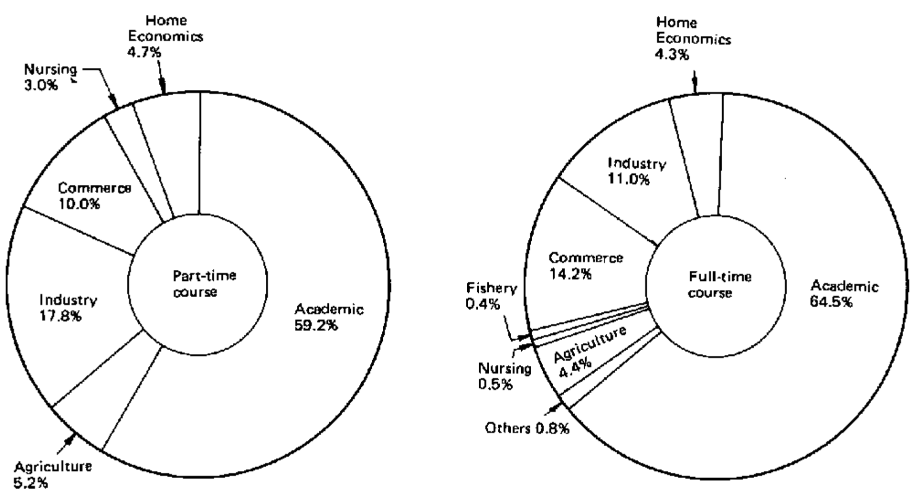

Fig. 2. Student Enrollment in Upper Secondary Schools by Type of Course and Program, May 1976

1/4 in the latter.

The majority of all junior college students in Japan are women, which may account for the fact that approximately 1/3 of all junior college students major in home economics. Another 1/5 of these students are taking humanities courses.

SCHOOL CURRICULUMS

ELEMENTARY AND SECONDARY SCHOOL CURRICULUMS

A Ministry of Education, Science and Culture ordinance titled "Enforcement Regulations for the School Education Law" sets forth the subjects to be offered and number of hours per school year that these subjects are to be taught in elementary and lower secondary schools. It also stipulates the subjects to be offered in upper secondary schools.

The basic framework for elementary and secondary school curriculums is outlined in a national directive called the "Course of Study." This Course of Study is compiled by the Ministry of Education, Science and Culture based on recommendations from the Curriculum Council, an advisory body to the Minister of Education, and provides curriculum planning guidelines for all three levels: elementary, lower and upper secondary schools. Each school is required to put together its own curriculums in accordance with the guidelines set forth in the Course of Study, taking local needs and characteristics into consideration.

Elementary and lower secondary schools, therefore, generally offer such subjects as Japanese language, social studies, mathematics, science, music, arts and crafts (elementary only), fine arts (lower secondary only), homemaking, physical education, industrial arts (lower secondary only), moral education, special (extra-curricular) activities and electives (lower secondary only).

Upper secondary school curriculums are also regulated by the Enforcement Regulations for the School Education Law and based on the guidelines set forth in the national Course of Study. As mentioned earlier, the curriculums for upper secondary schools can be broadly divided into academic and vocational courses. The vocational courses can be further broken down into specialized and non-specialized courses, the former consisting of technical, commercial, agricultural, fishery, home economics and nursing subjects and the latter of science-mathematics, music and fine arts, among others. Whatever the case, however, all upper secondary school students are required to take certain subjects. These are Japanese language, social studies, mathematics, science, health and physical education, fine arts and homemaking. In order to make upper secondary school curriculums better suited to a wider variety of needs, abilities and aptitudes, the Course of Study includes such electives as general mathematics, basic science, elementary and conversational English.

SCHOOL YEAR

The school year in Japan begins on April 1 and runs through March 31 of the following year. This school year is divided into three terms for all elementary and lower secondary schools as well as most upper secondary schools, with vacations coming between terms in August, December and March. Most universities and other institutions of higher learning opeate on a two-semester school year.

PUBLIC SCHOOL TEACHERS

Public school teachers in Japan are considered public officials and receive permanent tenure at the schools where they teach following a six month probation period.

Elementary and secondary school teachers are trained by means of teacher training courses offered at universities and junior colleges approved by the Ministry of Education, Science and Culture. Teaching certificates are awarded to all prospective teachers who have successfully completed the minimum number of credits in both teaching and professional subjects.

For the most part, elementary school teachers are assigned a homeroom class and are responsible for instructing the students in that class in all or most of their required subjects. Instruction in lower secondary schools is departmentalized to a large extent and in upper secondary schools is completely departmentalized with the majority of teachers specializing in just one subject.

ADMINISTRATION AND FINANCING OF THE EDUCATION SYSTEM

Administration of the education system in Japan is carried out on three distinct levels: national, prefectural and municipal. The central education authority in Japan is the Ministry of Education, Science and Culture, which is responsible for the integrated administration of national governmental services pertaining to the promotion and propagation of education at all levels.

Each prefecture in Japan, of which there are 47 in all, also has its own board of education in charge of handling all administrative matters dealing with education at the prefectural level. Each prefecture in turn is subdivided into a number of municipalities. The total number of municipalities in Japan is around 3,250 and each has its own board of education for the administration of all education-related matters at the local level.

The responsibility for financial support of public education is also shared by the national, prefectural and municipal governments, each providing its own educational activities from funds derived from its own taxes and other sources of revenue. No national, prefectural or municipal taxes are earmarked for specific governmental services. How much of total tax revenues should be allotted to educational services is left up to each level of government to decide for itself. In other words, there is no education tax per se in Japan.

During fiscal 1974/75, total public expenditures for education amounted to over 7 million yen, accounting for 6.2% of the national income and 21.3% of the net combined total of national, prefectural and municipal government expenditures. The proportion of total national government expenditures spent on education was 11.7% and that of combined prefectural and local government expenditures, 27.1%.

DATA PROCESSING EDUCATION AT THE HIGH SCHOOL LEVEL

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INTRODUCTION

At present, the brunt of data processing education employing computers as teaching aids is being carried out as part of the technical and commercial curriculums offered at the high school level in Japan. This type of education has yet to be formally adopted in the curriculums of academic high schools or at the junior high and elementary school levels. This article will, thus, deal primarily with data processing education at Japanese technical and commercial high schools.

POLICIES PROMOTING DATA PROCESSING EDUCATION

PROPOSAL FOR THE PROMOTION OF DATA PROCESSING EDUCATION

The biggest factor contributing to the advancement of data processing education in Japanese high schools to date has been the "Proposal For The Promotion Of Data Processing Education In High Schools" submitted to the Minister of Education, Science and Culture on December 3, 1969, by the Council for Science and Industrial Education (CSIE), an advisory body to that Minister.

PURPOSE AND MAIN POINTS OF THE PROPOSAL

This proposal consisted of a preamble, a five-part text and an attachment. The preamble stated, in effect, that the advancement of data processing education in Japan is a pressing concern that has a direct bearing on the social and economic progress as well as improvements in day-to-day living of this country. It went on to emphasize that the promotion of data processing education in high schools would be of vital importance to the overall advancement of such education. The text of the proposal was divided into five separate sections dealing with the objectives of data processing education at the high school level, curriculum adjustments that would be necessary to accommodate such courses, the establishment of model courses, teacher training and the facilities and equipment that would have to be provided to effectively implement data processing courses, respectively.

Among the objectives outlined in section one of the text of the proposal was the fostering of a basic understanding of, appropriate attitude toward and fundamental skills in data processing, not simply through the acquisition of knowledge related to this field, but via actual hands-on experience using computers to perform data processing jobs in the classroom.

Naturally, the goal was to implement data processing education in all high schools throughout Japan. However, to do this would require the installation of numerous computers and the training of sufficient numbers of teachers to conduct the courses. These prerequisites would take both time and money to realize. In the meantime, section three of the proposal called for the establishment of recommended or "model" courses as an interim measure. These courses, it was envisioned, would influence the conduct of other courses offered in the same school as well as those at other schools in the same region. In other words, establishing model data processing courses at schools which already had or could be easily equipped with the necessary facilities would serve to promote data processing education and related courses at the school concerned as well as at others in the same geographic area. Those schools offering such model data processing courses could then also serve as kinds of data processing education centers, that is, computer centers for the training of DP teachers in that area or region. In fact, the latter was one of the recommendations made in section five of the proposal.

The key to promoting any new form of education is training the necessary teachers to take charge of conducting those courses. Therefore, in addition to calling for the adoption of appropriate teacher training courses at universities and colleges in Japan, section four of the proposal recommended that teacher "re-education" or "re-training" programs be implemented until such time as the universities and colleges could begin to turn out qualified specialists in the field of DP education.

Section two of the proposal indicated various measures that would have to be taken to adjust existing high school curriculums to accommodate data processing education in academic as well as technical and commercial courses. It also recommended certain specific subjects for inclusion in model data processing courses. The type and amount of facilities and equipment necessary to actually implement these courses were described in section five of the proposal.

This in-depth proposal laid the foundations for administrative policies established beginning the following year which were aimed at realizing data processing education based on hands-on experience operating computers.

MEASURES AIMED AT ESTABLISHING DATA PROCESSING EDUCATION

The implementation of measures and policies based on this proposal came under the jurisdiction of the Vocational Education Division of the Elementary and Secondary Education Bureau (ESEB). Some of the policies to come out of that division are covered below.

1) Curriculum Adjustments

School curriculums for all elementary and secondary schools in Japan are prepared by the individual schools themselves in accordance with certain guidelines set forth in the "Course of Study," a guide to curriculum planning put out by the Ministry of Education, Science and Culture. By incorporating the main points of the previously described proposal for the promotion of data processing education into the Course of Study for upper secondary schools issued on October 15, 1970, the government made its position on data processing education clear and got the ball rolling on the adjustment of high school curriculums to accommodate new data processing courses.

Some of the ways this effected the courses and subjects that make up the various high school curriculums in Japan are described below.

a. Mathematics – Various new subjects were introduced into mathematics curriculums. These included the incorporation of such subjects as "General Mathematics" and "Mathematics IIA" in which classes (chapters) on "Computer Concepts and Flow Charts" were taught. "Applied Mathematics" was also added to these curriculums and covered such subject matter as "Computer Concepts And Numerical Computations" and "Operations Research."

b. Technical – New subjects adopted into technical curriculums included "Practice in Information Technology," "Programming," "Numerical Computations," "Systems Engineering," "Computer Hardware" and "Programming Theory." These new subjects were prepared as special information technology courses for inclusion in model data processing curriculums. Nevertheless, such subjects as "Programming" and "Numerical Computations," for example, were also incorporated into a number of other, existing technical courses. These included mechanics, electricity, electronics, architecture, civil engineering and industrial chemistry. This indicated that data processing subjects could indeed be incorporated into related technical fields.

c. Commercial – New data processing subjects created for commercial curriculums included "Management Mathematics," "Computer Concepts" and "Programming I and II." Among these, "Computer Concepts" and "Programming I" were expected to be studied in other commerical, business and management courses as well.

2) Provision Of Facilities And Equipment

Facilities and equipment for laboratory work and practical exercises in vocational education have always been subsidized by the national treasury in accordance with stipulations set forth in the Vocational Education Promotion Law. As a means of paving the way for such subsidies for data processing education as well, guidelines concerning the facilities and equipment for use in information technology and data processing courses were prescribed and communicated to prefectural and municipal authorities throughout Japan as of October 14, 1970.

a. Facilities – Guidelines concerning facilities for use in the information technology courses of technical curriculums were stipulated as programming, key punch and data processing rooms as well as an integrated information technology training room. For data processing courses incorporated into commercial curriculums, facilities such as bookkeeping, key punch and data processing rooms plus a programming-cum-business applications training room were called for. Total floor space involved was to be 540 m^2 for technical curriculum facilities and 580 m^2 for commercial curriculum facilities.

b. Equipment – Concerning the machinery itself, complete systems including a small-scale central processing unit (nowadays microcomputers would more than suffice), a high-speed tape reader, high-speed data punch and high-speed printer, were stipulated for use in both technical and commercial data processing courses. The configuration and size of the computers and peripheral equipment needed for each school was determined by the size and scope of the courses offered as well as that equipment's ability to efficiently handle large numbers of students. Ten key punch machines were provided for each information technology course and 15 such machines for each data processing course. The total cost of installing these machines came to roughly 54 million yen for the information technology courses and 43 million yen for the data processing courses.

c. Data Processing Education Centers – Guidelines were also drawn up for the establishment of data processing education centers at key schools in certain prefectures which would then serve as the computer centers and training locations for students and teachers alike from that school as well as others in the area.

The total floor space for these centers amounted to 865 m^2 and the cost of equipment came to 115 million yen. The latter included medium-scale CPUs complete with peripheral equipment and numerically-controlled machine tools.

d. Others – The Science Education Promotion Law was established primarily to foster education in science and mathematics. This law provided for government subsidizing of equipment for use in science and math programs similar to the subsidies made available under the Vocational Education Promotion Law mentioned earlier. Equipment covered by this law included computers and related machines, making possible the purchase of microcomputers for use in today's science and math programs.

3) Teacher Re-training Programs

The fiscal 1970 national budget for education included funds for the start of a data processing teacher's training course. Two DP training centers were set up, one in Tokyo and the other in Osaka, each capable of handling a maximum of 30 trainees at a time for a total of 60 teacher trainees per course nationwide. These courses initially lasted three months, but grew year by year until by 1973 the two training centers were offering five courses yearly to a total of 150 teacher trainees. Following 1973, however, this program gradually diminished in scale until today only the Tokyo training center still offers DP training to teachers, and then only two courses per year to a maximum of 60 teachers. Each course is now only two months in duration.

The teachers who have taken this DP training course to date have been instrumental in promoting data processing education at the data processing education centers as well as in the model information technology and data processing courses and other, existing courses in their respective schools.

4) Revisions To The "Standards For Vocational Education Facilities And Equipment" And The National "Course Of Study"

Japanese government "Standards For Vocational Education Facilities And Equipment," announced on April 30, 1965, and including the guidelines for facilities and equipment funding mentioned previously, were revised on December 21, 1976, together with other government and ministerial ordinances. The revision of the national "Course Of Study" guidelines for elementary and secondary curriculum planning were also announced thereafter on August 30, 1978. The main revisions made to these ordinances are outlined below.

a. New Standards For Vocational Education Facilities and Equipment – Prior to the revision of these guidelines, facilities and equipment standards for technical information technology courses and commercial data processing courses were stipulated separately. Following these revisions, facilities and equipment standards for these two courses were incorporated into one set of standards applicable to all information-related courses.

The scope of equipment purchases under the revised guidelines called for roughly 2.3 times the funds stipulated for technical information technology courses in the old standards or 122.51 million yen. The old standards set the limit at 54.13 million yen. The floor space for facilities utilized in the conduct of commercial data processing courses was also nearly doubled from the old dimensions of 580 m^2 to 1,090 m^2. Standards pertaining to the operation of these facilities and equipment were also made more flexible.

b. New Course Of Study – Revisions made to the Course of Study can be classified into those pertaining to mathematics, technical and commercial curriculums.

1) Mathematics – In addition to making Applied Mathematics into a technical subject called "Mathematical Sciences in Technology," the new Course of Study also stipulated that Mathematics II and III be taught in each field.
2) Technical – Subjects pertaining to information technology and related courses were revised to include Information Technology I, II and III and Systems Technology as well as Practical Exercise classes. The contents of the above mentioned Mathematical Sciences in Technology course was revised to include classes on "Forecasting And Planning" plus "Information and Control," while classes on "Management and Automation" were incor-

porated into a course called "Fundamentals of Industry." This has enabled all the students enrolled in every technical course to get a basic education in data processing.

3) Commercial – Subjects created earlier for inclusion in the data processing courses of commercial curriculums were revised and limited to consist of "Data Processing I," "Data Processing II" and "Management Mathematics." Moreover, Data Processing I was included in all commercial courses.

SAMPLE CURRICULUMS

Examples of typical curriculums put together for technical information technology courses and commercial data processing courses can be seen in Table 1. Asterisks (*) indicate required subjects.

Table 1. Sample Curriculum For An "Information Technology Course"

Area	Subject	Number of Credits Per School Year			Total Credits
		I	II	III	
Japanese Language	Japanese I	2*	2*		4
	Japanese II			2	2
Social Studies	Contemporary Society		2*	2*	4
Mathematics	Mathematics I	4*			4
	Basic Analytics		2	2	4
Science	Science I	4*			4
	Physics		2	2	4
Health and Physical Education	Physical Education	3*	2*	2*	7
	Health			2*	2
Fine Arts	Music I				
	Fine Arts I		2*		2
	Handicrafts I				
	Calligraphy I				
Foreign Languages	English I	2	2	2	6
Total Academic Credits		15	14	14	43
Technical	Fundamentals of Technology	4*			4
	Workshops	3*	6*	8*	17
	Drafting	2			2
	Mathematical Sciences In Technology	2*	2*	2*	6
	Information Technology I	4*	2		6
	Information Technology II		4	2	6
	Information Technology III				
	Systems Engineering		2	4	6
	Electronics I				
	Automatic Process Control				
Total Technical Credits		15	16	16	47
Total Academic and Technical Credits		30	30	30	90
Homeroom and Required Club Activities		2*	2*	2*	6
Total Credits		32	32	32	96

Sample Curriculum For A "Data Processing Course"

Area	Subject	Number of Credits Per School Year			Total Credits
		I	II	III	
Japanese Language	Japanese I	4*			4
	Japanese II		4		4
Social Studies	Contemporary Society	2*	2*		4
	World History or Geography			4	4
Mathematics	Mathematics I	4*			4
	Mathematics II		2	2	4
Science	Science I	4*			4
Health and Physical Education	Physical Education	2*	2*	3*	7
	Health			2*	2
Fine Arts	Music I Fine Arts I Handicrafts I Calligraphy I		2*	2	4
Foreign Languages	English I	4	2		6
	English II		4	4	8
Total Academic Credits		20	18	17	55
Commercial	Commercial Economics I	3*			3
	Bookkeeping and Accounting I	3*			3
	Practical Business Computations	2*	2*		4
	Data Processing I	2*	2*		4
	General Business Training		2*	2*	4
	Bookkeeping and Accounting II		4		4
	Data Processing II		2	5	7
	Commercial Law			3*	3
	(Electives)			3	3
Total Commercial Credits		10	12	13	35
Total Academic and Commercial Credits		30	30	30	90
Homeroom and Required Club Activities		2*	2*	2*	6
Total Credits		32	32	32	96

The number of credits awarded for subjects other than required ones differ according to the school.

DATA PROCESSING EDUCATION TODAY

Technical and commercial high schools today are energetically introducing information technology and data processing courses into their curriculums in line with the revisions made to the national Course of Study and Standards For Vocational Education Facilities And Equipment and in concert with Japan's progress towards an information society. Practically all of these schools currently have some kind of data processing education program in force.

MODEL CURRICULUMS

The creation of model data processing

curriculums and data processing education centers have played a big role in helping get data processing education started in most of the technical and commercial high schools of Japan.

As of May, 1982, 120 such high schools nationwide had established either information technology or data processing courses, making for an average of 2.6 schools per prefecture with one or the other type of data processing education program in force. The growth rate for the establishment of such courses slowed to a near halt for a time, but has once again picked up momentum.

Data processing education centers are located in 36 of Japan's 47 prefectures. This means that the percentage of such centers established throughout Japan is roughly 77%. This figure approaches the numbers called for in the plans laid down for the creation of such centers starting in 1970.

The utilization of computers in the conduct of data processing education has proceeded apace with the establishment of model curriculums and data processing education centers. In fact, there were a total of nearly 4,000 computers installed at public and private technical high schools in Japan as of May, 1982. Of these, some 3,500 were microcomputers, with minicomputers, small- and medium-scale computers accounting for the remaining 500 machines. Since there are some 627 technical high schools which belong to the All Japan Technical High School Principals Association, a group which encompasses all technical high schools nationwide, the number of installed computers works out to an average of about six per school. The number of computers installed in commercial high schools throughout Japan is considered to be roughly equivalent to the numbers recorded for technical high schools. Thus, the total number of computers in utilization at technical and commercial high schools in Japan can be estimated at around 8,000 units.

The Science Education Promotion Law cited earlier has opened the way for the introduction of microcomputers and minicomputers into those high schools which offer only academic curriculums as well. However, this introduction process is rather slow getting off the ground. The private academic high schools have begun to show an interest in the installation and utilization of computers in recent years, and it is expected that the public schools will follow suit before too much longer.

RESULTS OF DATA PROCESSING EDUCATION

It goes without saying that the determination of the results of an education program should be based on a variety of viewpoints and a considerably long time scale, but for the time being we feel safe in pointing out the following several examples.

First of all, those individuals who successfully completed either an information technology or data processing model course while in high school have found employment in the hardware, software development and/or technical service divisions of computer and other manufacturing firms, banks, securities firms and a variety of distribution houses.

Another result of introducing data processing courses into high school curriculums has been the establishment of preparatory examinations by the All Japan Technical High School Principals Association for those students who wish to earn a second-class rating in the Ministry of International Trade and Industry (MITI) sponsored "Certified Data Processing Examination."

The inclusion of a programming contest for high school students as one of the events in Japan's annual Information Month activities can be cited as yet another result of data processing education in high schools. These contests are participated in by students from technical. commercial and academic high schools as well as first, second and third year students in technical colleges. The top prize in this contest was awarded to a FORTRAN-to-COBOL Conversion program in 1980, an Automatic Logical Circuit Design program in 1981 and a New Club Members' Training program in 1982.

In line with the latter, the student who won the 1980 programming contest here in Japan put together a program for typewriter training and entered it in the high school programming tournament of the TC 3 International Federation of Information Processing (IFIP) world meeting held in Louzanne, Switzerland, in July, 1981.

EDUCATIONAL RESEARCH ACTIVITIES

An All Japan Information Technology Education Research Society has been organized by the teachers involved in data processing education programs at technical high schools. This society is made up of a total of 273 member schools and is affiliated with two regional research societies in the Kanto and Tohoku regions of Japan. Japanese commercial high schools also have a nationwide Data Processing Education Research Society which holds national and regional meetings every year. In addition, there is the Data Processing Education Center Leadership Council started by teachers associated with the various Data Processing Education Centers located throughout Japan. This council also holds a national meeting once a year.

In future, these various research societies should try to engage in data processing-related educational research activities in cooperation with Japanese information processing societies which belong to the IFIP.

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1. One 50 minute class is equal to one credit hour and a 35 credit hour per school year course earns the student one credit (This system coincides with the guidelines set forth in the "Course of Study.").
2. The sample curriculums shown above were put together on the basis of a 32 credit hour (standard) school week. These hours are subject to change according to the locale and/or school involved (as per guidelines set forth in the "Course of Study").
3. A student must have successfully completed 80 or more credit hours in order to graduate high school and homeroom and club activities are considered an essential part of these hours (Course of Study).

DATA PROCESSING EDUCATION AT UNIVERSITIES

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INTRODUCTION

This report deals primarily with data processing education programs at Japanese universities. It also touches briefly on similar education programs in place at junior and technical colleges as well. The report starts off with a rather in-depth description of the history of data processing education in Japan, then moves on to discuss programs offered at data processing departments[1)] at Japanese colleges and universities and winds up by presenting some examples of data processing courses available to all students at specific universities.

National and private colleges and universities in Japan differ considerably as to how they are run and financed. For example, with the exception of a certain amount of research funds, all financing for national universities comes from the government. The overall budgets as well as the establishment of new departments and augmentation of teaching staffs at national universities are decided by the national government based on its assessment of requests received from those institutions. In the case of privately-run universities, however, expenditures are paid principally from the individual earnings of those institutions, with decisions as to how those monies are spent resting with their administrators. Of course, there are also instances where a private university will receive financial assistance in the form of subsidies from the government. Furthermore, even private universities must receive the approval of the Ministry of Education, Science and Culture before they can establish new departments.

HISTORY OF DATA PROCESSING EDUCATION IN JAPAN

Instruction on digital computers was first introduced into the curriculums of Japanese universities during the late

1) For our purposes here, we will be refering to those departments at universities which offer courses related to information science and computer engineering as Data Processing Departments. The reasons for this will be explained in more detail later in the texts while there are also those departments offering such courses which tend to emphasize administrative science, we will not deal at any length with those here.

1950's. That was about the time when research into digital computers in Japan was getting into full swing and computers built at universities and research centers were first being put into operation. Education programs were started by the pioneers in this field who were engaged in the actual research and development of these computers. Those education programs were initially designed to train the users of these early trial manufactured computers, but before too long lecture and lab courses were founded for the university student as well. The Management Engineering Department at Keio University and the Administrative Science Department of Konan University, both founded in 1959, were organized for the development of early computer applications.

The production of computers by Japanese manufacturers increased considerably during the early 1960's. As these machines began to find their way into the universities, so did introductory courses on computers. The computing capabilities of universities at that time, however, were extremely poor. Since most of the computers installed on the campuses were primarily for research purposes, students had little or no real access to them.

As the 1960's drew to a close, the Japanese information industry began to grow at a phenomenal pace and computers came into use in almost every field of social endeavor. In anticipation of the increase in demand for data processing specialists that would come about as a result of this, national policies were drawn up to deal with the problem of educating these individuals.

The Ministry of Education, Science and Culture established the Information

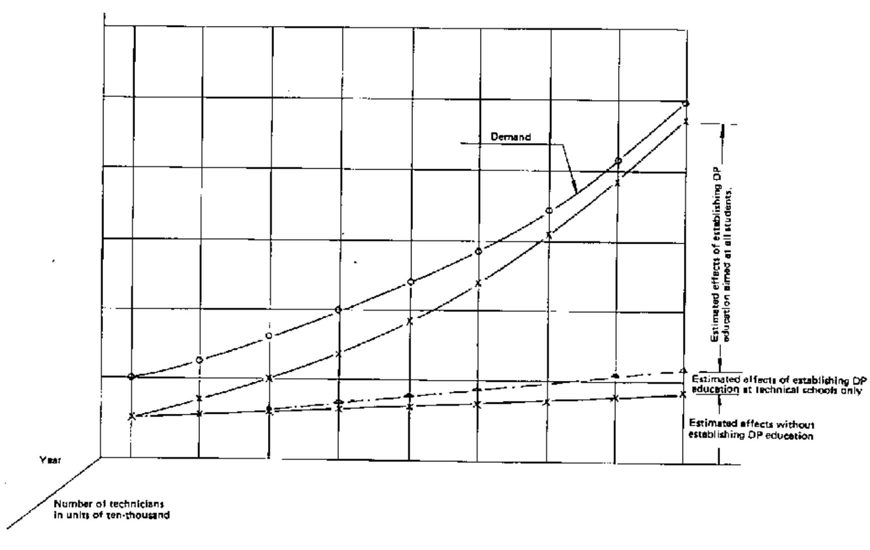

Fig. 1. Supply And Demand For Data Processing Technicians (Programmers and Systems Engineers)

Processing Education Council (Professor Jiro Yamauchi, Chairman) in May, 1969, and put it in charge of coming up with policies aimed at promoting data processing education in Japan. This council submitted a final report titled "Fundamental Concepts for the Promotion of Data Processing Education," [1] together with a series of accompanying reports to the Ministry of Education, Science and Culture in May, 1972. Some of the main points brought out in this report are listed below.

i) The demand for data processing specialists (programmers and systems engineers) was estimated to reach 50 thousand by 1980 (See Figure 1);

ii) In order to deal with this situation, it was proposed that professional as well as general data processing education programs be jointly promoted; and

iii) A number of specific measures necessary to accomplish this were spelled out.

The professional data processing education program mentioned therein was aimed at training the researchers, engineers and educators necessary to carry out basic research and development work on computer hardware and software, and as such was designed to increase the level of Japan's information industry. The general data processing education program, however, was seen as a means of providing all secondary and college students, regardless of their majors, with basic instruction on and training in the use of computers so as to build up a national foundation for the effective utilization of computers in all fields. Or as the proposal contained in the report stated, the general data processing education program should have as its goal "...making students aware of the possibilities and limitations of data processing and preparing them to take up the challenge of ushering in the information age of the future." In other words, this program was seen as widening the base for computer applications by advocating that the ability to use computers was akin to a second form of literacy.

This report had a considerable influence, both directly and indirectly, on the later development of data processing education programs within the framework of Japan's school education system.

The following, then, is an outline of some of the major factors related to the development of data processing education in Japan from the start of the 1970's until today, especially as those developments manifested themselves in the universities and technical colleges.

ESTABLISHMENT OF DATA PROCESSING DEPARTMENTS IN THE SCIENCE AND ENGINEERING SCHOOLS OF UNIVERSITIES

Beginning in 1970, data processing departments were created in the science and engineering schools of Japanese national universities. By 1982, the number of such departments had reached 28 in all nationwide. Graduate courses were set up within these departments, and some even established doctorate courses as well. Furthermore, the field of information processing technology was consider-

Table 1. Data Processing Departments And Graduate Courses Established At Science And Engineering Schools Of National And Private Universities And The Number Of Students Capable Of Entering Those Departments/Courses
— Number Of Students In Parenthesis —

		1970	1976	1981
Data Processing Departments	National Universities	5 (234)	23 (755)	28 (1,005)
	Private Universities	2 (120)	6 (415)	6 (415)
	Total	7 (355)	29 (1,170)	34 (1,420)
Master's Courses	National University	0 (0)	15 (242)	32 (426)
	Private Universities	0 (0)	1 (8)	3 (34)
	Total	0 (0)	16 (250)	35 (460)
Doctorate Courses	National Universities	0 (0)	10 (79)	12 (89)
	Private Universities	0 (0)	1 (4)	3 (21)
	Total	0 (0)	11 (83)	15 (110)

ed interdisciplinary and special graduate courses aimed at students from a variety of majors were established at six major national universities. During this same period, six data processing departments and three special data processing graduate courses were established at certain private universities.

Transitions in the number of these courses and the students enrolled in them are shown in Table 1.

Special budgets were also approved to install medium-scale computer systems at the data processing departments of national universities for use by the students during the course of their studies.

ESTABLISHMENT OF DATA PROCESSING EDUCATION CENTERS

As pointed out earlier, computers were installed at Japanese universities beginning in the early 1960's, but these were limited solely to research work. In fact, it was difficult to make these machines available to students at that time. Thus, in order to promote data processing education aimed at all students, data processing education centers were founded at national universities beginning around 1972. These centers were equipped with large-scale computer systems and staffed with full-time teachers so as to make data processing education available to all the students enrolled in those universities. By 1982, these types of centers had been established at 10 national universities.

Data processing centers which possessed functions similar to these education centers were also set up at a number of other national universities.

In the case of the private universities, a system whereby they could obtain financial assistance from the government for a part of the monies necessary to complete their computer facilities was put into effect in 1974.

DATA PROCESSING EDUCATION FOR ALL STUDENTS

As a result of strengthened computer facilities and a heightened awareness of the need for data processing education, numerous departments in nearly all the schools of Japanese universities beginning with the school of science and engineering and continuing on to the schools of economics, commerce, law, literature, education and medicine, expanded and improved, both quantitatively and qualitatively, instruction in the field of data processing. This type of education doesn't consist solely of introductory courses by any means. It has become quite normal for students to utilize computers in the arrangement of experimental data, statistical analysis, theoretical calculations and simulations in the course of their studies in the various areas of specialization within each department. Quite a few students also operate the computers installed at their universities to research information related to their graduation theses.

The importance of including subjects related to computer and information processing technology into the curriculums of departments which have been closely related to data processing such as electronic, communication and administrative engineering as well as applied mathematics, has increased considerably. These departments are thus contributing greatly to the supply of data processing specialists in Japan.

The Ministry of Education, Science and Culture also established a data processing training system for university instructors in 1970. Under this system, university instructors receive training in information processing technology and techniques for about one year. This training is conducted separately from the instructors regular duties and is carried out in Japan. As of 1982, a total of about 200 university instructors had completed this special training course.

DATA PROCESSING EDUCATION AT JUNIOR COLLEGES

Education programs related to computer hardware and software are being strengthened at technically-oriented junior colleges. Six such junior colleges have already established new data processing departments. Minicomputers were installed at all nationally-operated technical junior colleges during the 1970's.

Software education programs are also being incorporated into certain departments at economic and commercial junior colleges, and special software curriculums have already been established at three such institutions.

Table 2. Example Of The Curriculum Employed In The Intensive Data Processing Training Course For Technical College Teachers (1982)

(Figures in parentheses indicate the number of credits per course. One credit is equivalent to three classroom hours.)

Computers

Large-scale Computers	(2)
Introduction To Compilers	(1)
Microcomputers	(6)
Operating Systems	(1)
Formula Manipulation	(1)
Application Programming (PL/I)	(1)
Operating Systems And Procedures Of IIT Computers	(1)
Applied Technology	
Numerical Analysis	(3)
Simulation	(2)
Networking	(2)
Multivariate Analysis	(3)
Finite Element Method	(3)
Database Systems	(1)
Class Scheduling	(1)
CAD	(1)
Robotics/Mechatronics	(1)
Education	
Data Processing Education	(1)
Educational Engineering And The Development Of Lively Lessons.	(1)

Research

PL/I Arithmetic

Numerical Analysis

Simulation

Multivariate Analysis I

Multivariate Analysis II

Simulation

Microcomputer

Class Scheduling program Preparation

(One research theme is selected from among the above).

This curriculum consists of 32 units in all, only two of which (courses marked with an asterisk*) represent required courses. All other courses (30 units) are electives. Teacher trainees can take up to 20 units worth of courses including required courses. The rest of their time is spent on research work.

DATA PROCESSING EDUCATION AT TECHNICAL COLLEGES

Beginning in 1971, small-scale computers for education purposes were gradually introduced into technical colleges and introductory courses on computers opened. The requirements for establishing technical colleges were revised in 1976 and among those revisions were stipulations stating that two-credit data processing courses be included in all curriculums.

Special data processing curriculums were also set up at five such technical colleges.

Technical college teachers have been receiving training in data processing since 1971 in the form of an intensive four-week course implemented by the Institute of Information Technology, Japan, at the request of the Minstry of Education, Science and Culture expressly for that purpose. As of 1982, 464 some teachers at technical colleges in Japan had taken this course. This works out to roughly 12% of all the technical college teachers in Japan. Table 2 presents an example of the contents of this special training course.

DATA PROCESSING DEPARTMENTS IN THE SCIENCE AND ENGINEERING SCHOOLS OF UNIVERSITIES TODAY

The data processing departments established in schools of science and engineering at today's universities go under various names. The majority of these are referred to as the "Department of Information Engineering," but other prominent titles include "Department of Information Science and Engineering" and "Department of Computer Science." For our purposes here, as well as for the sake of simplicity, let's refer to these departments as "Data Processing Departments." The profusion of different names used to refer to data processing departments at Japanese universities reflects the subtle differences in emphasis placed on the education and research programs carried out at those respective departments. The reasons for these subtle differences can be attributed to the different conditions existing at those universities when these departments were established.

Since the field of information processing technology is interdisciplinary in nature, one can expect to find a variety of curriculums in place at the faculty level. By the same token, even with such a variety of curriculums, it's a pretty safe bet that there are also considerable points of similarity between them since they all deal specifically with data processing. In order to make this point clear, let's take a brief look at the results of a study I made into this matter in 1980 [2]. That study was carried out by investigating the curriculums then currently in place at 24 data processing departments.

POINTS IN COMMON

Table 3 shows the names of representative lecture courses given by various of the 24 data processing departments studied as well as the number of departments giving such courses. No hard and

Table 3. Typical Data Processing Courses

Courses	Number of DP Departments Offering These Courses		Number of DP Departments Offering Equivalent Courses	
	Required	Elective	Required	Elective
Discrete structure	10	3		1
Numerical analysis	7	10		
Information theory	2	14	2	1
Automata theory		6		3
Automata theory and formal language theory	1	4		1
Formal language theory		4		2
Theory of algorithms		2		3
Artificial intelligence		2		2
Pattern recognition		7		1
Introduction to programming/Principles of programming	4	3		
Programming language	6	10		
Compiler construction		5		2
Operating systems	5	1		
Systems programming	3	8		1
Data structure	2	5		4
Data base		1		
Software engineering		2		4
Introduction to computer organization	3	5	1	
Digital logic/Logical design	7	7		1
Computer architecture/Computer organization	3	11		3
Data transmission and computer network	2	8		3
Electronics/Electronic circuits	10	7		1
Control system theory	5	10	2	
Computer appreciation course	3	2		
Systems engineering	2	9		
Mathematics for programming		6	1	
Operations research		6	1	
Simulation		5		

fast conclusions can be drawn from these results alone, but it seems that the curriculums offered by data processing departments in Japan have been influenced to a good degree by a computer science curriculum prepared by the Association of Computer Machinery (ACM) in 1968.

SPECIAL FEATURES OF INDIVIDUAL DEPARTMENTS

The lecture courses offered in the curriculums of data processing departments can be broken down into several categories. Let's tentatively make those catagories i) Fundamental Mathematics, ii) Fundamental Theories of Computer Science, iii) Software Technology, iv) Hardware Technology, v) Fundamentals of Electronic and Communication Engineering, vi) Fundamentals of Natural Science and Engineering, vii) Systems Engineering and Administrative Science and viii) Artificial Intelligence. The proportion of credits accounted for by each category vis-a-vis the total number of credits for special subjects offered by each department are expressed in graph form in Figure 2a, b and c. When these proportions were worked out, laboratory subjects were excluded from the calculations. For reference purposes, however, a bar graph showing the proportion of lecture subjects to lab subjects has been prepared.

As Figure 2 indicates, these curriculums can be classified into 5 distinct forms:

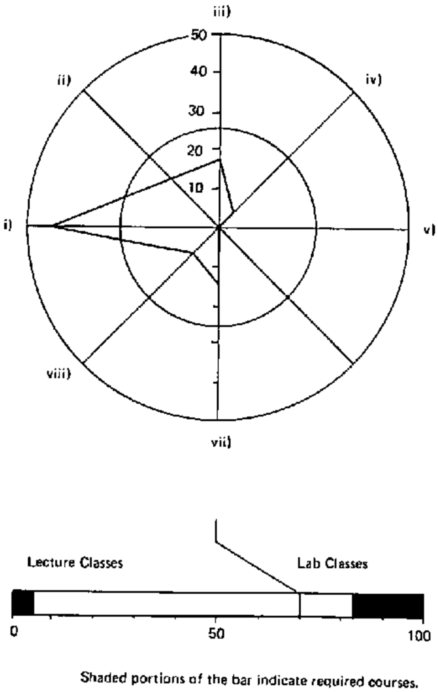

Fig. 2a. Way of Reading Figures 2b and 2c

- M – Emphasis placed on fundamental mathematics;
- E – Emphasis placed on electronic and communication engineering;
- H – Stress is on hardware technology;
- S – Emphasis is placed on software technology; and
- D – Stress is on systems engineering and administrative science.

However, among these are those forms such as E6 and E7 which might be appropriately referred to as ES and EM forms, respectively.

As stated previously, the expenses involved in installing medium-scale computer systems at the data processing departments of national universities for use in the education of students enrolled in those departments is provided by the Ministry of Education, Science and Culture. If we compare these expenses with the equipment and operating expenses of departments other than those in the schools of engineering we see that they are fairly high. The capabilities of the computers installed via such government funding differ considerably according to the time when they were purchased. For example, operation speeds vary from 0.2 to 1 MIPS, main storage capacity from 0.25 to 4 MB and disk file capacity ranges anywhere from 100 to 1,200 MB. The new systems purchased as replacements in recent years are time sharing systems (TSS) with between 40 and 50 terminals per system. These have greatly improved the situation for software education. These systems are capable of running FORTRAN, PL/1, and COBOL as well as PASCAL and LISP.

Due to the fact that information processing technology is developing at such a rapid rate, it's become necessary to constantly check the contents of curriculums at the undergraduates level. It is extremely important that universities offer complete, up-to-date curriculums in order to turn out high quality data processing specialists.

The employment situation for graduates of data processing departments was looked into by a study conducted in 1980 [3]. The results of that study are presented in Table 4. The demand for software specialists from fields other than the information industry, especially the field of manufacturing, has been increasing in line with the spread of microprocessors in recent years.

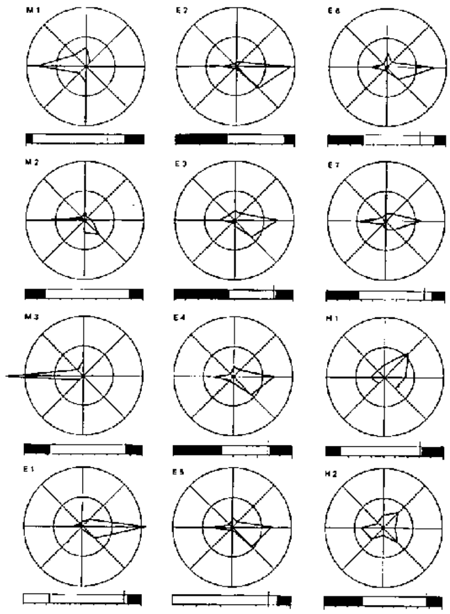

Fig. 2 b

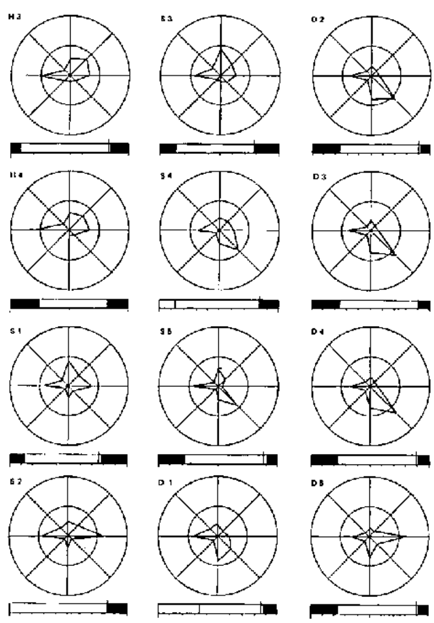

Fig. 2 C

Table 4. Employment Situation By Industry For Graduates Of Data Processing Departments Of Science And Engineering Schools At National Universities (1974 – 1980)

Type Of Industry	Holders Of Undergraduate Degrees	Holders Of Graduate Degrees (Master And Doctorate)	Total
Government Service And Public Corporations	270 (5.0%)	156 (13.3%)	426 (6.4%)
Field Of Education (University and Technical High School Teachers)	67 (1.2)	89 (7.6)	156 (2.4)
Computer Manufacturers	580 (10.7)	322 (27.4)	902 (13.6)
Manufacturers Of Computer-Related Equipment	228 (4.2)	55 (4.7)	283 (4.3)
Electrical/Electronic Machinery Manufacturers	497 (9.2)	177 (15.0)	674 (10.2)
Software Houses	702 (12.9)	38 (3.2)	740 (11.2)
Data Processing Service Companies	518 (9.5)	20 (1.7)	538 (8.1)
General Primary and Secondary Industries	493 (9.1)	107 (9.0)	600 (9.1)
General Tertiary Industries	816 (15.0)	49 (4.2)	865 (13.1)
Others	217 (4.0)	32 (2.7)	249 (3.8)
Those Going On To Higher Education	1,042 (19.2)	132 (11.2)	1,174 (17.8)
Total	5,430 (100.0)	1,177 (100.0)	6,607 (100.0)

DATA PROCESSING EDUCATION FOR ALL STUDENTS

Information processing education for all students is being carried out at quite a few universities in Japan. The way in which this education is being presented differs with each university, however. By way of example, the data processing programs at three representative Japanese universities – Tokyo University, Tsukuba University and Keio University – are outlined below.

TOKYO UNIVERSITY

The most representative of Japan's national universities has to be Tokyo University. Tokyo University has been actively promoting data processing education for all its students from the time it was first realized that this type of education was necessary. That program has been expanded and improved ever since the university established its education-oriented computer center in 1972. This educational computer center offers computing capabilities to Tokyo University students, while lecture courses and teaching are left up to the various schools and departments within the university. There are some 13,000 undergraduates enrolled at Tokyo University. Statistics on the utilization of this center for the academic year from April, 1981 to March, 1982 are shown in Table 5 [4]. There are also statistics compiled on the kinds and utilization ratio of the various programming languages used at this center during the 1982 summer school session. These statistics were arrived at by calculating the number of jobs in which a certain language was used and then finding what percentage of the total number of jobs executed during that session this accounted for. The results showed that FORTRAN was used for 86.5% of the jobs run, BASIC for 6.8%, PASCAL for 4.1%, LISP for 2.0% and the remainder more or less equally divided among COBOL, PL/I and APL. The computer

Table 5. Statistics On Utilization Of Tokyo University's Educational Computer Center By School For The Academic Year From April '81 to March '82. (Taken from p.55 of Tokyo University Educational Computer Center Report No. 20, October 1982.)

1981 Academic Year

NOTE: Uppermost of the pairs of figures given above show utilization during the first half of the school year (April to September, 1981) and the bottom figures indicate that for the latter half of the school year (October, 1981 to March, 1982).

Faculty	Total Enrollment	Number Of Processing Runs			Processing Time (Minutes)			TSS Online Time (Minutes)	Number Of Printouts
		Total	Batch	TSS	Total	Batch	TSS		
School Of Law	200	0 5,695	0 1,926	0 3,769	0 150	0 29	0 121	0 80,846	0 13,014
School Of Medicine	244	549 6,500	318 4,189	231 1,311	141 199	28 100	113 99	4,680 52,911	2,636 27,401
School Of Engineering	2,734	34,576 40,187	29,485 23,336	5,091 16,851	6,769 5,545	4,642 2,981	2,127 2,564	91,642 498,823	161,826 161,528
School Of Literature	291	7,453 5,344	5,876 2,698	1,677 2,646	1,302 525	698 179	604 346	33,613 68,672	37,985 30,470
School Of Science	595	14,961 15,010	13,191 8,815	1,770 6,205	7,267 2,102	5,780 1,097	1,487 1,005	42,806 198,908	94,598 71,826
School Of Agriculture	602	1,139 12,821	640 8,726	499 4,095	474 815	155 381	319 434	10,619 114,812	4,687 67,847
School Of Economics	399	861 11,919	345 4,596	516 7,323	494 762	194 189	300 573	24,094 211,077	5,730 32,475
School Of Liberal Arts	2,839	7,756 15,736	6,222 13,004	1,534 2,732	1,765 815	1,304 559	461 256	29,007 63,703	39,609 66,654
School Of Education	90	1,332 2,671	1,285 2,238	47 433	174 248	143 231	31 17	1,259 14,551	7,139 30,597
School Of Pharmacy	60	1,477 428	935 46	542 382	424 63	235 9	189 54	9,833 7,124	9,958 456
(Research Institute)	52	0 156	0 7	0 149	0 10	0 0	0 10	0 3,248	0 72
Total	8,106	70,104 115,477	58,297 69,581	11,807 45,896	18,810 11,234	18,170 6,755	5,631 5,479	247,553 1,311,427	360,168 502,268

Table 6. Data Processing Education For All Tsukuba University Students – Computer Utilization By School Or Department During 1979

Cluster	College	Semester	Number Of Students	Number Of Classes	Accumulated Utilization Per Student Per Semester				
					TSS Utilization	Number Of Batch Operations	CPU Time	Elapsed Time	Numer Of Printouts
First Cluster of Colleges	Humanities	3	129	3	32.0	15.5	3 35	14 00	78.6
	Social Sciences	1	78	2	27.4	17.2	2 45	13 20	79.4
	Natural Sciences	2	205	4	43.8	33.2	12 7	25 19	219.2
Second Cluster of Colleges	Comparative Culture	3	74	2	17.8	25.9	5 10	27 41	124.6
	Human Sciences	1	122	3	26.4	13.4	5 11	12 51	67.9
	Biological Sciences	2	82	2	40.2	34.8	5 39	21 42	175.5
	Agriculture And Forestry	2	126	3	42.6	31.4	5 48	21 52	166.8
Third Cluster of Colleges	Socio-Economic Planning	1	120	3	37.4	29.0	20 46	21 34	173.6
	Information Sciences	1	84	2	37.0	36.7	32 10	25 59	238.2
	Engineering Sciences	1	148	4	42.0	32.4	10 34	22 24	169.8
School Of Medicine		2	103	2	26.8	23.0	5 24	14 59	174.2
School Of Health And Physical Education		3	240	5	28.2	13.2	2 16	11 9	61.1
School Of Art And Design		3	74	2	25.0	10.0	3 10	14 53	72.4

* Figures shown in these two lines reflect computer utilization carried out during "Data Processing Practice" classes.

system installed at this center consists of a CPU capable of operating at a speed of 4.4 MIPS, 8 MB of main storage capacity and 3,810 MB of file storage capacity and offers both cafeteria-style batch processing as well as a time sharing system. Of the roughly 150 TSS terminals connected to this system, about 80 are distributed throughout the various schools or faculties of the university.

TSUKUBA UNIVERSITY

Tsukuba University is a new kind of national university founded in 1974. All first year students at this university study data processing as one of their required subjects. The data processing course is composed of both lecture and laboratory classes. The lecture classes are titled "Introduction to Information Science," and cover such topics as the need and motivation for data processing, algorithms, data processing equipment, the principles of executing FORTRAN programs and the capabilities and limitations of computers. Topics on operating systems, artificial intelligence and laboratory automation are also offered for students with certain majors. Classes on the actual operation of computers make use of TSS terminals linked to a computer system designated especially for education purposes installed at the university's computer center. Programming is done primarily in FORTRAN. Statistics on the jobs run on this system during 1979 are presented in Table 6 [5].

KEIO UNIVERSITY

Keio University is one of the oldest and most prestigious of the private universities in Japan. It was also one of the first such universities to make data processing education available to all of its students. At Keio University, teaching all of the students in each of that university's faculties about data processing is the responsibility of the full- and part-time staff who run the Institute of Information Science. Table 7 shows the data processing courses established at this university during the 1981–82 academic year as well as the number of students who enrolled in each course. The percentage of students taking these courses by faculty worked out to 28.3% from the Science and Engineering School, 17.9% from the Business School, 3.4% from the School of Political Science, 4.8% from the School of Law, 8.3% from the School of Literature and 1.4% from the various other schools combined. The total number of undergraduates enrolled at Keio University is 24,000, and the number of these students taking data processing courses is increasing rapidly each year. The total number of students who took such courses from 1975 through 1982 are shown in Table 8. Actual hands-on computer operation is carried out at the university's computer center. The computer system installed there offers both cafeteria-style batch processing and TSS [6].

CONCLUDING REMARKS

The above described data processing education programs in place in Japan's higher education system have come about

Table 7. Data Processing Courses Offered at Keio University During The Academic Year 1980—81 and The Number of Students Enrolled in Each

1. Elementary Courses	
1-1 Computer Science	1,645
1.2 Data Processing	211
2. Intermediate Courses	
2-1 Advanced Computer Programming and Algorithms	
APL	7
Assembler	15
Pascal	31
2-2 Symbol Manipulation	
LISP	17
SNOBOL and ICON	10
3. Advanced Courses	
3-1 Application of Information Processing	
Numerical Analysis	28
Mathematical Programming	24
Data Analysis and Statistics	22
Simulation	52
Econometrics	91
Computer Graphics	28
3-1 Special Topics in Computer Science	
Computer Systems	35
Operating Systems	25
System Programming and Language Processors	8
Management Information Systems	79
Information Retrieval	29
Design of Microcomputer Systems	28
3-3 Information Science	
Theory of Programming	1
Software Engineering	6
Theory on Data Structure	9
Theory on Algolithms	12
(Total	2,413)

Table 8. Student Enrollment In Data Processing Courses At Keio University Between 1975 And 1982

Academic Year	Elementary Courses	Intermediate Courses	Advanced Courses	Total
1975—76	911	11	103	1,025
1976—77	967	54	203	1,224
1977—78	1,092	50	258	1,400
1978—79	1,022	70	208	1,300
1979—80	1,169	42	237	1,448
1980—81	1,429	66	322	1,817
1981—82	1,856	80	477	2,413

partly by plan and partly as a natural course of events in line with the progress of computer technology, the information industry and informationalization in general in this country. It can be said that these education programs have produced some fairly good results and have met with the needs of Japanese society. However, it is also a fact that this country's data processing needs are increasing both quantitatively as well as qualitatively. This in turn means that it will be necessary for Japanese universities and schools to make even greater efforts in future to fulfill these burgeoning information needs.

The following points are considered to be some of the merits of data processing education in Japan:

M1 – The basic level of learning in mathematics and natural sciences is comparatively higher now for science and engineering as well as other students;

M2 – With the proliferation of computers, the number of individuals capable of effectively utilizing them has increased considerably.

Some of the drawbacks of this type of education are summed up as follows:

D1 – Generally speaking, Japanese aren't used to using typewriters and thus aren't familiar with input devices that use keyboards;

D2 – The input and output of data in Japanese is difficult.

The first drawback listed above (D1) doesn't seem all that much of a problem for the younger generations of Japanese students who are readily picking up the knack of using keyboards. Also, with recent advances in technology, the second demerit (D2) is gradually being overcome.

One of the major tasks in future will probably be the strengthening of data processing education for students other than those enrolled in science and engineering programs in consideration of advances in office automation, while at the same time expanding and improving on the contents of such education for science and engineering majors in line with the spread of microprocessor technology. Furthermore, the need for continuous education and retraining of individuals in the field of data processing technology is being advocated, but Japanese institutions of higher learning are contributing very little towards this kind of education. One of the reasons for this has to do with Japanese employment practices and another with the fact that the Japanese education system is still fairly inflexible and not open to the working man and woman. It will be necessary for Japanese universities and schools to contribute more towards education for working people in future as well.

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COMPUTER EDUCATION IN TECHNICAL SCHOOLS

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LEGISLATION REGARDING TECNICAL SCHOOLS

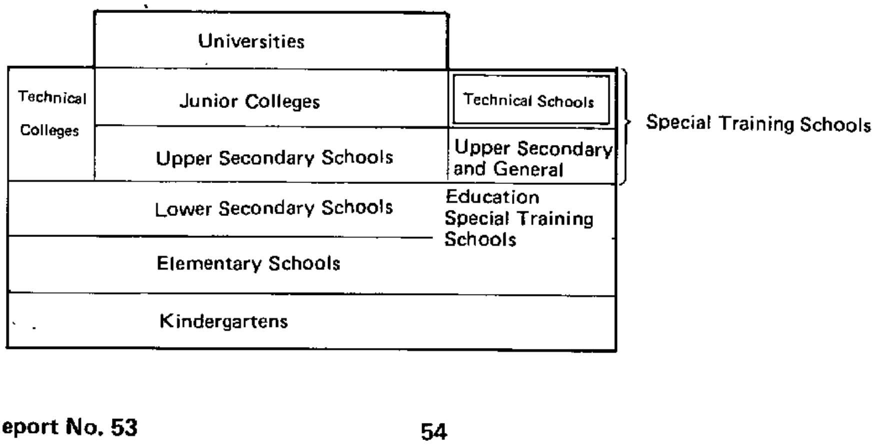
A general outline of Japan's education system is presented in the second article of this edition of JIPDEC Report. In order to help the reader gain a clear understanding of the points to be made in this article, however, I would like to begin by describing the legislative foundations and distinguishing characteristics of technical schools in Japan.

Paragraph 2 of Section 82 of the School Education Law provides for "Special Training Schools" which fall outside those regular educational institutions cited in Section 1 of that Law (eg. kindergartens, elementary schools, lower and upper secondary (junior and senior high) schools, junior colleges and universities, technical colleges, as well as special education schools for the blind, deaf and otherwise physically or mentally handicapped), and which provide organized education aimed at improving students' vocational abilities as well as their general level of education. Paragraph 3 of Section 82 stipulates that these special training schools offer one of three types of curriculums: upper secondary, technical or general.

The technical schools described in this article are those special training schools which offer technical curriculums (See Figure 1).

Admission to technical schools in Japan requires that the prospective student have graduated from an upper

Fig. 1. The Position Of Special Training Schools (Technical Schools) In Japan's Education System



secondary school. The minimum number of mandatory class hours per school year is 800 and graduation takes anywhere from one to three years (The majority of established curriculums take two years to complete.). Completion of a course of study at a technical school is equivalent to having graduated from a two-year junior college.

DEVELOPMENT OF COMPUTER-ORIENTED TECHNICAL SCHOOLS

FROM MISCELLANEOUS VOCATIONAL SCHOOLS TO ACCREDITED TECHNICAL SCHOOLS

Information processing and related industries arose in Japan during the period of high economic growth experienced in the mid-60's. Information processing technicians had to be trained in a hurry to meet the demands of the changing society.

As a result, Japan founded its first "Computer School" in October, 1966, to provide a systematized education to prospective information processing technicians that differed from the short-term, one-shot training programs offered at a hodge-podge of vocational and practical training schools up to then. From 1967 on, a number of these kinds of schools were established throughout Japan, until by the early 1970's there were some 50 such schools nationwide.

Nevertheless, during this period these schools were still stipulated as "Miscellaneous Vocational And Practical Training Schools" by the School Education Law and the requirements for their establishment were all but none-existent. These schools weren't very well regarded by the general public at that time either.

In 1976, the "Special Training School Law" was enacted which provided certification as accredited technical schools to all those miscellaneous vocational and practical training schools which met with certain prescribed qualifications. In this way, technically-oriented schools established after the enactment of this legislation as well as those which had managed to pull themselves up by their own bootstraps from the status of a miscellaneous vocational and/or practical training school became accreditted technical schools. As of January, 1983, there were some 43 such accreditted technical schools in existence in Japan (This is less than the number of such schools registered during the early 70's. The reason for this is that those vocational and practical training schools which couldn't meet the qualifications required to gain certification had no choice but to close their doors while other, new schools sprang up and either succeeded or failed in their wake.) (See Figure 2).

Furthermore, with the appearance and development of office automation (OA) there has been a wave of new OA-oriented schools opened in Japan as well.

METHODS OF ESTABLISHMENT

Computer schools established to date can be classified as follows:

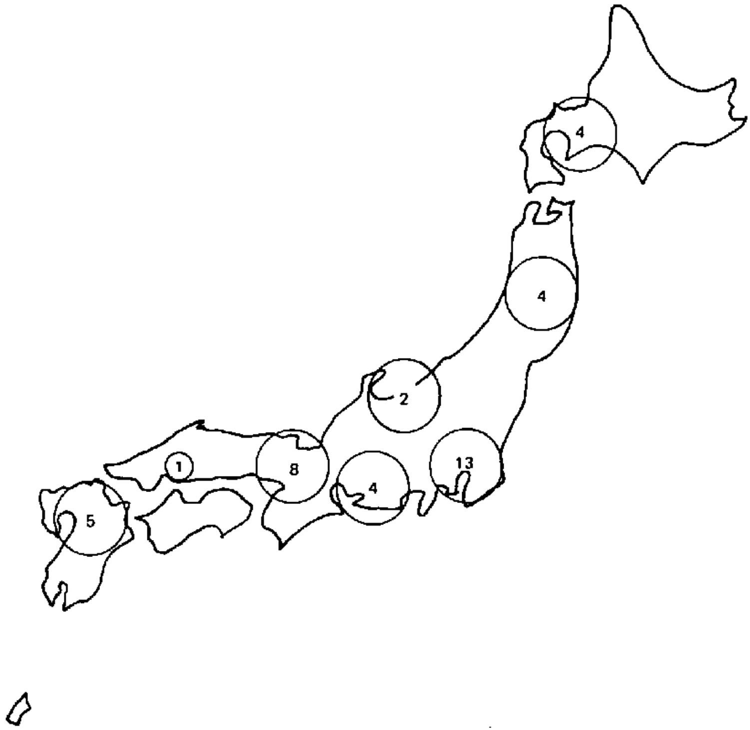


Fig. 2. Distribution Of Computer-Oriented Technical Schools In Japan

i) There are 19 electronics engineering schools which also offer data processing (software) and information technology (hardware) courses;

ii) Six commercial schools have established data processing courses in addition to their regular commercial courses;

iii) There are 13 schools founded specifically for the purpose of providing instruction in either data processing or information technology;

iv) One major computer manufacturer has also opened a school specializing in data processing and information technology courses; and

v) There are currently three other computer-oriented schools which still fall into the category of miscellaneous vocational and practical training schools.

(NOTE: There are numerous other schools which haven't set up data processing and/or information technology courses per se, but rather have incorporated computer-related subjects into their existing curriculums. The total number of such schools hasn't been recorded yet, however.

ORIGINAL CURRICULUMS

Sections 8 and 9 of legislation dealing with official requirements for the establishment of special training schools stipulates that the technical subjects offered at such schools must be at a level higher than those available in upper secondary schools and should be specialized enough in nature to warrant their being taught at a special training school. This legislation also provides that at least 80 percent of the total number of class hours at special training schools offering technical curriculums be devoted to technical subjects.

Each school is expected to put together its own original curriculum based on the requirements set forth in the above described legislation. There are no established means for these schools to exchange information and opinions concerning their particular curriculums at present. Moreover, the size, number of installed computers, experience and teaching force of the various schools in operation today differ greatly from school to school.

NATIONAL CERTIFIED DATA PROCESSING EXAMINATION

The Certified Data Processing Examination given by MITI every year provides a fixed standard upon which computer schools can base the goals of their computer education programs and then be evaluated as to the suitability of those programs. The curriculums and teaching methods employed by all of these schools thus reflect and attempt to incorporate the points brought out and emphasized by this yearly qualification exam.

Some schools recommend (require) that this examination be taken by all their students, while others leave the decision of taking or not taking the exam up to the individual student himself.

CASE HISTORY

The following is an outline of the data processing education program in place at the Nippon Electronics Engineering College (NEEC).

NEEC was founded in the Kamata district of Tokyo in 1947 as a school specializing in electronics engineering courses such as television technology. It continued to operate in this fashion until 1966, when it became the first technical school in Japan to incorporate special courses dealing with data processing and information technology into its curriculum. NEEC has since served as a leader in this field, setting an example for other such schools to follow.

There are 13 different technical courses as well as six fine arts courses offered at NEEC and it boasts some 8,000 students, making it the largest technical school in Japan.

TRAINING EQUIPMENT

When it first established its data processing courses, NEEC purchased the latest domestically-produced computers available on the market and has emphasized the importance of actual hands-on experience using computers in the study of programming and machine operation techniques ever since. At present the College has 225 TSS terminals hooked up to two large-scale host computers to ensure that all of its students get ample

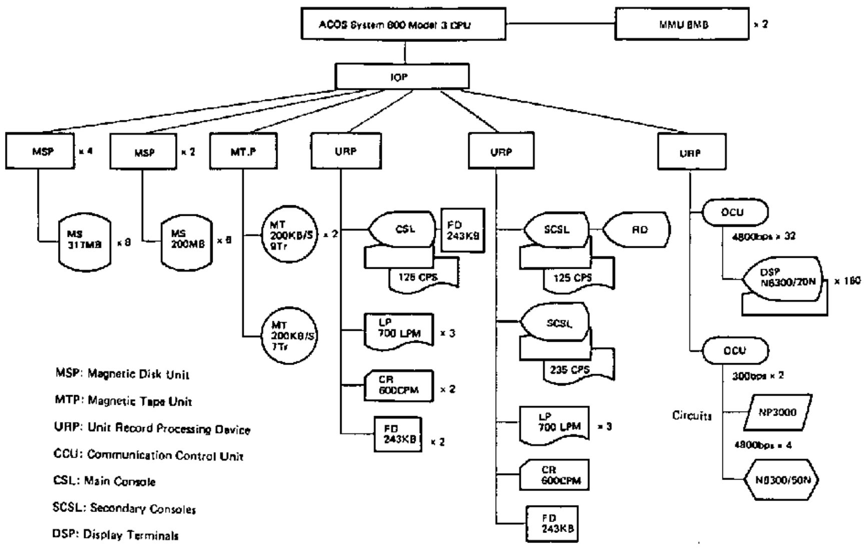


Diagram of the No. 4 System Configuration

Fig. 3: Hardware Configuration

Software	Description
COBOL	A business language translation system used in the COBOL I, COBOL II and COBOL Practice classes.
FORTRANEX	A technical computation language translation system used in the FORTRAN and FORTRAN Practice classes.
COMPANION	A machine level programming practice system used in the Introduction to Assembler course.
ATSS	An interactive Time Sharing System used in programming practice sessions to write, debug and test run programs.
FDSYSIN	A system for writing, debugging and test running programs in the batch mode. FDSYSIN inputs programs to the system which have been transferred to floppy disks from OCR sheets by means of OCRs.
MCSYSIN	MCSYSIN inputs programs coded on mark-sensing cards to the system via card reading devices.

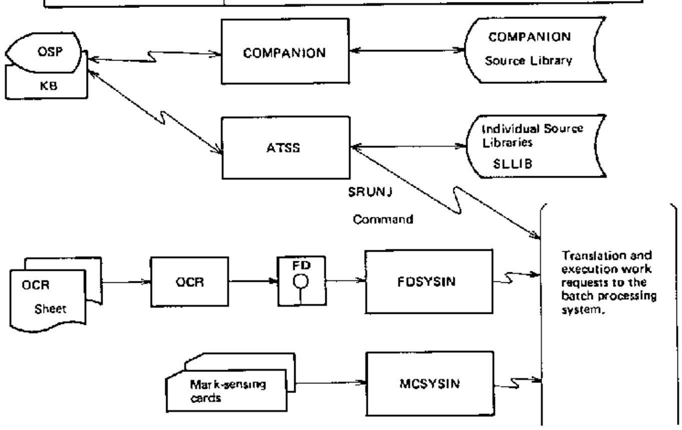
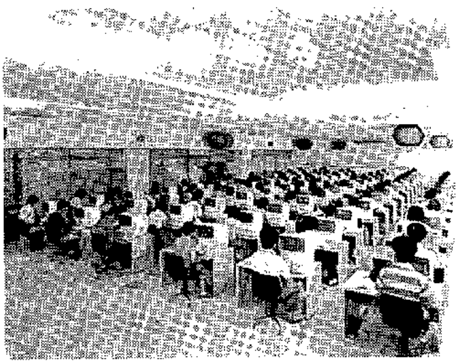


Fig. 4. Software

time practicing programming on the machines.



The type and number of machines currently being utilized in NEEC's programming courses consist of 160 ACOS System 800/IV terminals and 65 ACOS System 550 terminals. The programming languages capable of being used are COBOL, FORTRAN, PL/I, BASIC, PASCAL, HPL and the assembler language CAP-X, which appears in the problems contained on the Certified Data Processing Examination given by MITI annually.

Other equipment currently installed at the school for use in machine operation practice consists of six NEAC MS50 units and six OCR units for entering programs written by students into the system.

Source programs written by the students during their programming classes are prepared by hand on special sheets or documents capable of being read by the OCR machines. The OCR sheets containing the students programs are submitted to the instructors at the end of the programming class and are entered onto floppy disks by means of the OCRs and immediately registered in the computer system. The students can then call up the source programs they wrote earlier and have them displayed on one of the 225 TSS terminals for debugging and execution. This system has proved remarkably effective in teaching students how to program computers.

In addition to their hands-on experience with the TSS terminals during programming practice classes, the students also have a chance to use the six MS50 machines as part of their machine operation instruction. This enables them to master the basic skills necessary for a computer operator. At the end of the first year of instruction, each student is given a particular problem to solve on his own using the machines he's been practicing on. His skills as an operator are evaluated at this time.

These computers and their peripheral equipment are controlled by the Computer Center. Full-time Computer Center personnel are in charge of planning, managing and maintaining this equipment in line with the progress of the various courses.

The configuration of the ACOS System 800/IV system and the various software being utilized in this and the ACOS System 550 system are as shown in Figures 3 and 4.

CURRICULUMS

There are one-year as well as two-year data processing courses offered at NEEC, but the majority of these courses are two years in duration.

During the first year of the two-year course, emphasis is placed on acquainting the students with stored program computers and having them learn COBOL programming techniques and machine operation skills.

The second year of study consists of classes on computer systems and applications as well as a wide variety of related subjects.

The first-year data processing curriculum is composed of the following subjects taught for the number of class hours indicated.

TECHNICAL SUBJECTS	CLASS HOURS
Introduction To Computers	60
Introduction To Systems	30
Introduction To Assembler	30
Flow Charts	60
Hardware	60
Operating Systems I	60
Operation I, II	120
Data Communications	60
COBOL I, II	240

GENERAL SUBJECTS	CLASS HOURS
Mathematics I	60
Statistics I	60
Bookkeeping I, II	120
English I, II	120
History Of Social Development	60

Data processing subjects for the second year of study and the number of class hours for each are as shown below.

REQUIRED SUBJECTS	CLASS HOURS
Systems Design I	60
Operating Systems II	60
Operations Research I	60
FORTRAN	60
Computer Applications	60
Programming Practice	60
Economics I	60
Management I	60
English III	60

ELECTIVE SUBJECTS	CLASS HOURS
Mathematics II	60
Statistics II	60
Set Theories	60
Algorithms	60
Demand Forecasting	60
Simulation	60
Social Studies	60
English IV	60
Cost Price Computations	60
Systems Design II	60
Microcomputers	60
Information Science	60

Students may freely select those electives they wish to take from among the subjects offered. Graduation is dependent upon the students' abilities to pass a series of final examinations.

PROBLEMS FROM THE STANDPOINT OF INSTRUCTION

(1) Teaching Programming Techniques

Recent improvements in software productivity have brought about major changes in programming techniques. New trends represented by structured programming techniques, for example, are continuing to have a big influence on the way programming courses are taught at technical schools.

These new trends are zealously being studied, put into their proper perspectives and then introduced into technical school data processing curriculums in the form of regular courses. Unlike the program development and maintenance systems in operation at various enterprises, however, programming research at the school level is just getting underway. If technical schools hope to achieve worthwhile results in the teaching of programming techniques they are going to have to improve their research efforts in this area.

(2) Student Abilities

Admittance to technical schools does not require an entrance examination. Rather, the schools attempt to evaluate the abilities of each prospective student based on his or her upper secondary school record. Naturally, qualitative differences exist between and among the various upper secondary schools from which these students graduated. Also, just the fact that those students applying to technical schools either didn't wish to go on to university or couldn't gain entrance to one makes for considerable problems when trying to determine whether or not they are suited for a technical education. Another key point regarding admissions to technical schools has to do with the fact that privately run schools can't afford to let their attendance drop below a certain level for fear of falling into financial difficulties. The upshot of this vicious cycle of poorly motivated students on the one hand and the need to fulfill attendance requirements on the part of the schools on the other makes for a situation where the abilities of the students enrolled in the same class may vary widely and dropout rates become a considerable problem. The present situation is one where only about 80% of the students entering technical schools are capable of graduating. For this reason, the respective roles of research and guidance occupy extremely important positions within the education programs offered by technical schools. However, there are not pat remedies for solving these problems and all technical schools in Japan consider them major issues.

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