chemical information flow, ACS policy on collaboration with other organizations, some new initiatives and approaches to information access, the international border issues, information communities, and international networks. I would hope in our discussions that we could approach a better understanding of what the challenges are for the New International Chemical Information Order and how to resolve the challenges in the future. I recommend that we begin with an in-depth analysis of the problems, including defining scientific and technical information flow. Also, we should continuously seek to assure that government regulations do not further impede this international information flow or create unnecessary barriers. And we should seek through model provisions or model contracts to guarantee continuous access to the databases involved. We should also strongly urge countries to participate in the orderly development of new international laws, standards, rules, values, and just ethical issues for all the shareholders in this chemical information community.

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Factors Involved in Japan's Contribution to International Chemical Information Activities: Present Status and Prospect[†]

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This paper reviews the current status of information activities in Japan, describes the policies and the projects related to information at the government level, identifies difficulties and problems that hinder the transborder flow of scientific and technical information, and discusses how these difficulties have been or are being solved. A speculative picture is given on the ultimate worldwide information system.

INTRODUCTION

The scope of the present paper will consist of three parts. In the first part, a brief review is given of the present status of Japanese information activities and information policies and projects mainly at the government level. The second part will depict the difficulties and the problems that confronted the Japanese information community during the past two decades. The state may be described as chaotic. As the policies and projects are gradually implemented, we will see that some sort of new order will be emerging out of the present more or less chaotic state. The second part will also describe how the problems have been or will be solved. Finally, some speculation will be made to predict the nature of the ultimate chemical information system that a research chemist will want to use. A proposal will be presented as to how such a system may be constructed and maintained.

Japan is an underdeveloped country in terms of organizing information systems. Like other developing countries, major activities are being conducted by government initiative, although the private sector constitutes the largest user community of international information services. Therefore, the discussion will be confined mainly to the projects and activities at the government level.

There are three major ministries or agencies of the Japanese government that are involved in the scientific and technical information activities.

The Ministry of Education, Science and Culture (MESC) directly operates the National Center for Scientific Information System (NACSIS), which was established on April 1, 1986, and supervises the administration of the national and private universities and academic societies.

The Science and Technology Agency (STA) directly operates Japn Information Center for Science and Technology (JICST) and has some influence on general national policy on information through the Council of Science and Technology, which is chaired by the prime minister.

The Ministry of International Trade and Industry (MITI) is responsible for all activities related to patents and trademarks and operates through the Japan Patent Office (JPO) and the Japan Patent Information Organization (JAPIO).

The present status, policy, and projects of these ministries will be discussed in turn.

PRESENT STATUS, POLICY, AND PROJECTS AT GOVERNMENT LEVEL

MESC. The Ministry of Education, Science and Culture runs about 100 national universities with numerous research institutes and supervises all private universities and academic societies and associations to which the ministry also gives some financial support. MESC's information plan has three objectives: (1) library automation and online library service through a national computer network; (2) database service, bibliographic and factual, for academia; and (3) promotion of database building at universities, research institutes, and academic societies under MESC's supervision.

To achieve those objectives, MESC has set up the National Center for Scientific Information System (NACSIS) for li-

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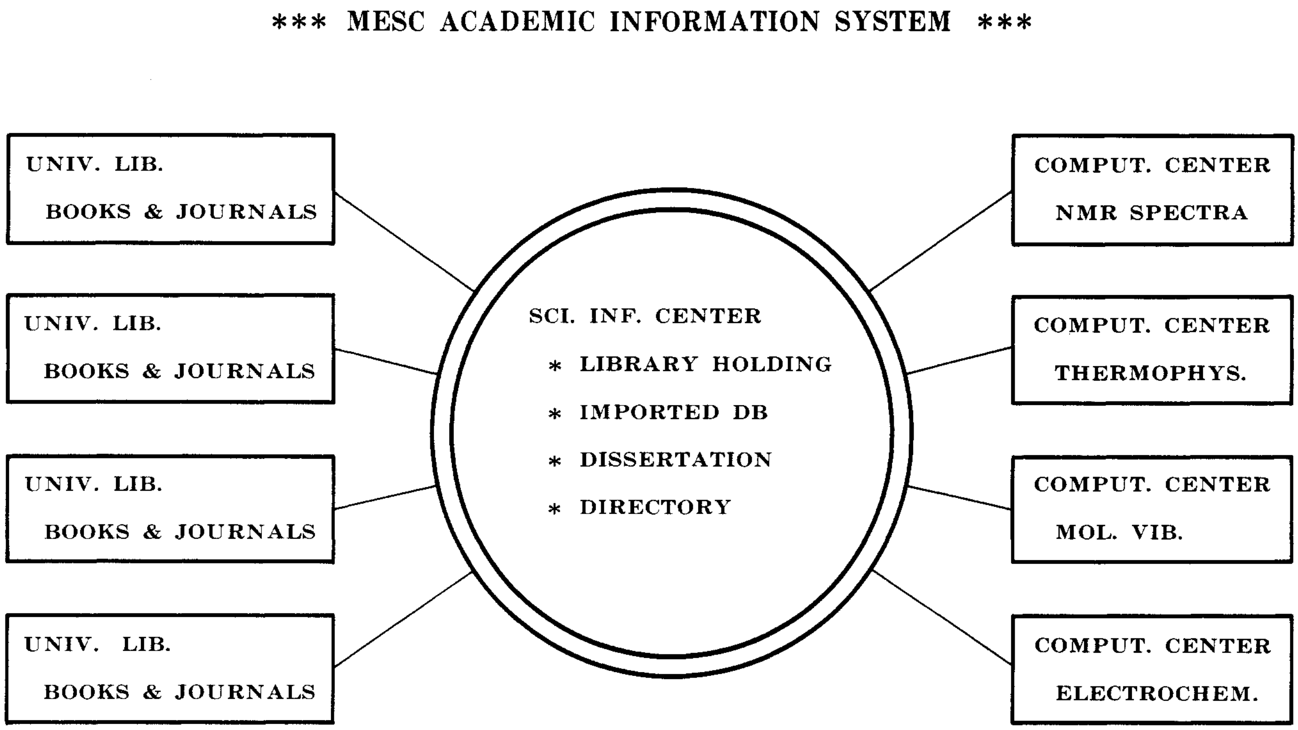

Figure 1. Structure of National Information System at the Ministry of Education, Science and Culture (MESC).

brary automation and database service. MESC also encourages and subsidizes database building at universities and academic societies. MESC's information system may be pictured as in Figure 1. Major university libraries have been networked for automation of library operations by building a large single file at the Center for all library holdings at those universities. It will allow all academic staff and students to use the library services online through the network.

Ten large computation centers at national universities are, at present, separately servicing a number of databases through the academic network. Those databases include major bibliographic databases such as CA Search, BIOSIS, and INSPEC, some numeric databases such as Cambridge Crystal Data and Protein Data Bank of Brookhaven, and also quite a few factual databases produced at those universities. The network will be upgraded, and university computers will be linked to the national center. Some of the databases now at universities will be transferred to NACSIS, whereas others will remain at universities for the sake of easy maintenance and updating.

In the chemical discipline, a recent survey shows that there are some 50 chemistry-oriented databases, both bibliographic and factual, produced by research people and supported by the university computation centers. Some of these are listed in Table I; about 25 of them are being serviced routinely, the rest being in preparation. There are some interesting database systems like the automatic organic structure determination listed at the bottom of the Table I, which provides a small number of candidate structures consistent with the spectroscopic (mass, infrared, etc.) data input from a user's terminal.

Some of these files were made available internationally on the exchange basis, but the online service is accessible only by academic staff and students at present. However, there was a policy change at MESC about the availability, which will be discussed below.

STA/JICST. STA and JICST have three major projects: (1) JOIS service of Japanese databases, JICST file on science and technology, mass spectra database, clearinghouse, etc.; (2) STN Tokyo Service Center, servicing an English-language file of Japanese scientific and technical literature, and others; and (3) compound information databank system. JOIS is a public online service for a number of imported databases, such as CA Search and Medlars, and a Japanese-language database called the JICST file which adds about 500 000 records annually. The files on JOIS also include a numeric file on mass spectra produced by the Mass-Spectral Analytical Society and a clearinghouse file that contains information on the ongoing research projects at government research institutes. The second project of STA and JICST is to install the Tokyo Service Center of STN International. JICST began production of an English-language version of the Japanese literature of scientific and technical information in 1985, with annual updates of about 160 000 bibliographic citations. It will be serviced on JOIS as of October 1986 and also will become the first Japanese database offered to the public worldwide through STN International.

The third project of STA is the construction of a databank system that, from the user's viewpoint, will look very similar to CIS, the Chemical Information System made by EPA and NIH. The component databases are shown in Table II. This 6-year project, called Networked Compound Information System, has been in development by STA and its collaborating organizations since 1981, using about $11 million. The system works differently from CIS, the feature of the system being

Table I. Some Databases of MESC Organizations

Bibliographic	
chemistry of tritium	muscle biochemistry
mass spectroscopy	quantum chemistry
meeting proceedings	Japanese chemical literature
Factual	
^{13}C NMR	infrared spectra
base sequence in DNA	electron energy, inner shell
heat of mixing	electrochemistry
nuclear quadrupole resonance	liquid–vapor equilibrium
protein structure	ion-selective electrodes
solvent extraction	mineral dressing, refining
Software and Data	
estimation of physical properties	
heterogeneous catalysis design	
automatic structure determination, organic	

Table II. Components of STA Compound Information Bank

database	producer
material dictionary	JICST, JAICI
spectra (IR, mass, NMR)	Natl Chem Lab for Ind
biology	Natl Inst Hygienic Sci
hazards and safety	STA, JETOC
environment	Natl Pollution Lab, EPA
thermophysical properties	JICST Product Dev Sci Inst
biochemistry	Natl Foods Res Inst
drug	Jap. Pharm Inf Center

in the design of the material registry system. The system will be put into service in 1987 and will become part of the JOIS service in 1989.

MITI. MITI, being one of the largest ministries, has three major organizations under its supervision, i.e., the Japan Patent Office, the Japan Patent Information Organization, and the Database Promotion Center.

The Japan Patent Office is now investigating ways to exchange patent data with U.S. and European patent offices. The data-exchange project is related to the "paperless" patent handling system which is also being developed. The actual work is carried out at JAPIO, which itself services the PATOLIS file that contains detailed information on Japanese patents, trademarks, and logo designs in Japanese characters filed since 1955. The total number of records accumulated so far amounts to 8 million. JAPIO was founded in October 1985 by reorganizing the JAPATIC. JAPIO has an agreement with INPADOC for input into and use of the INPADOC file. While the PATOLIS file is built in the Japanese language, JAPIO also publishes English-language abstracts which almost corresponds to the PATOLIS file of Japanese-language patents and which is serviced through a U.S. vendor. This English-language file contains more than 1 million records. JAPIO also stores all the published patent and trademark documents in the form of optical disks for retrieval, which will be serviced from 1987.

To encourage and promote the building of useful databases, MITI established Database Promotion Center in 1984 and, by way of the center, MITI subsidizes any organization in the public as well as private sectors. This has just begun, and it is too early to even mention the effect of such subsidies.

The activities at those three major Japanese government ministries and their information activities appear almost independent of one another because each ministry has its own infrastructure of divisions of bureaus responsible for information activities, policy, and plan implementation and mechanism.

CHAOS AND ORDER

When there were no computer-assisted information activities, there was a reasonable order. Printed services were distributed to any organization or individual who needed them without difficulty and without any need of preparation on the side of the users. In Japan, chaos developed as products of advanced information technology were imported because there was too much to digest when little preparation had been made to do so. The Japanese information community was simply too busy absorbing the large quantity of information and knowledge that flowed in like an avalanche. The slow response to the rapid flow of products of innovative information technology was one of the reasons why Japan has not been able to contribute much to the rest of the world with regard to computerized chemical information. The second reason, which is related to the first, was the lack of preparedness in information science on the basic side and in computer handling of information and telecommunications on the practical side. The third was the difficulty in developing the technique of processing the Japanese language. To elaborate on this point, it has been only several years since the microcomputers that have the required language capability and that may be used as intelligent terminals became available for a reasonable price. Besides the hardware problems, there is the difficult problem of converting printed Japanese-language information into an English-language computer file. The Japanese language is probably the worst language a computer has ever encountered. Progress is, nevertheless, being made toward practical machine-aided translation. Although its state of the art is still primitive, the technique was improved considerably during the past several years and, after some 10 years, it may become a usable means for translating Japanese-language abstracts into English. In addition to all this, there was virtually no working coordination among government policies and projects.

However, we begin to see that within each ministry of the government some sort of order is emerging. Only interministry order or coordination is lacking. The Japanese government is now committed to make substantial investment on the database production, especially factual databases. The countrywide information networks are being implemented by MESC and STA and, as the technique develops, those networks may be linked to each other in the future.

MESC recently changed its policy and has made an important decision that their databases may be licensed to others outside the academic community, including foreign organizations, in the form of magnetic tapes. The terms and conditions are being discussed by the Scientific Information Subcommittee at MESC. This change in policy is a result of the amendments to the copyright law which were enacted at the 1985 National Diet Sessions. Even before the policy was changed, Japan Association for International Chemical Information (JAICI) had broken the ice by offering one of the MESC databases outside Japan on an experimental basis.

This change in policy at MESC will enhance the international flow of information to a large extent, although it will be in the form of licensing the files they produce. Participation of JICST in STN International is another step to promote the transborder flow of information. On the technical side, the problems related to handling Japanese characters were solved by using 2 bytes per character and developing the 24-dot printers for a low price. Machine translation is under way, and the technique of heterogeneous networking will be a target of joint development by major computer companies. In fact, preliminary discussion along this line by four computer companies, Fujitsu, Hitachi, NEC, and IBM, has already begun.

Different ministries have different missions. The officials use this as an excuse as to why they do not intend to integrate the similar activities at different ministries into a single mission. There are liaison conferences held regularly among the ministries where the officials make presentations about the plans, discuss the overlap that may exist, and try to make adjustments. Therefore, they usually have good reasons when there is an overlap in the plans. Under such boundary conditions, the relationship is essentially that of competition rather than cooperation to look for unification with regard to information activities. Compromise will have to be made to the effect that in quite general terms a fair competition helps to keep our society vital and cannot be avoided after all.

ULTIMATE CHEMICAL INFORMATION SYSTEM

Finally let us think about the information system a research scientist would want in order to help carry out research work in an efficient way. In short, it will consist of a number of factual and textual databases and associated software packages for using them. The total system will be a coherent, integrated system through telecommunications network as depicted in Figure 2 and must be backed up by a group of subsystems, for example, Data Service, Abstracting Center, Library

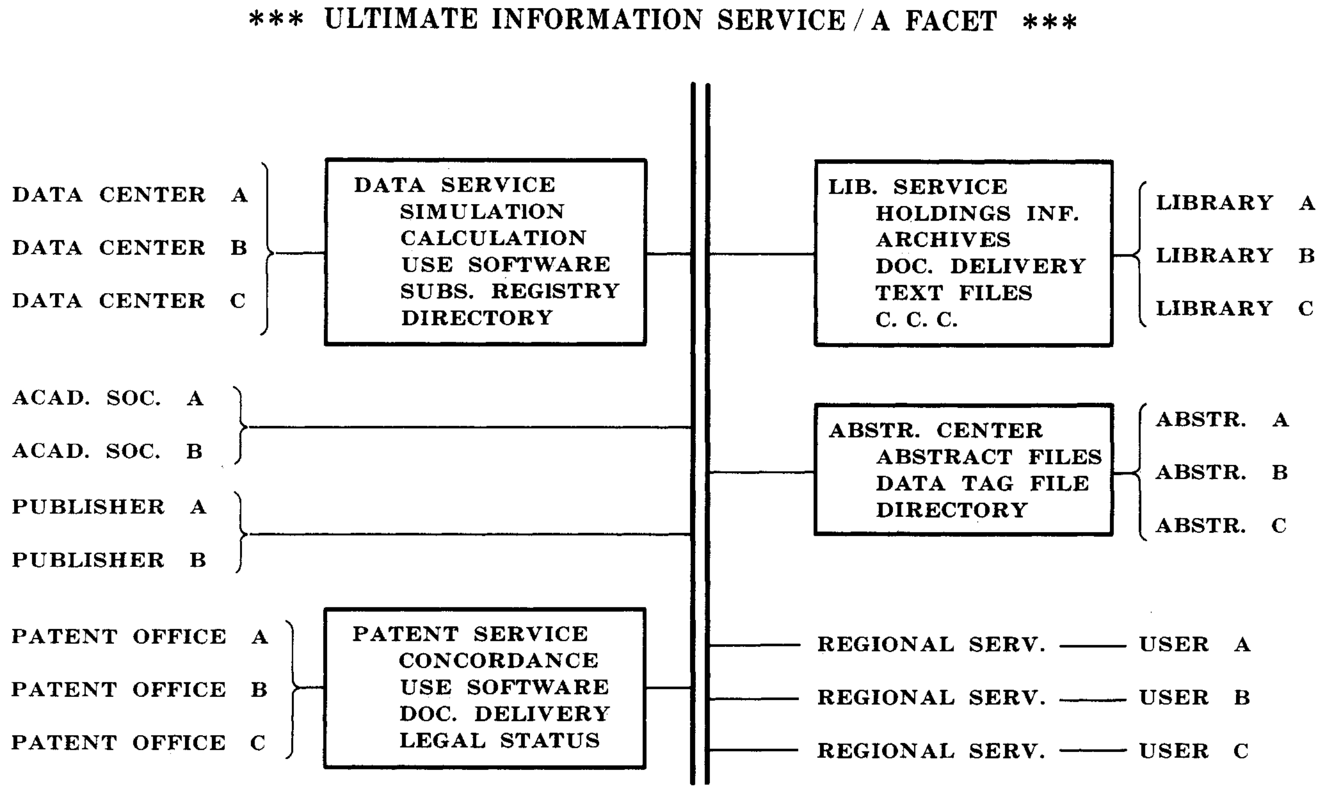

Figure 2. Proposed ultimate information system in which various organizations are networked internationally.

Service, Patent Service, and Regional User Service Centers. There will be discipline-oriented data centers where factual databases will be built and maintained by using the facilities provided by the Data Service where various utility software and files are ready for use. Academic societies will use the system for receiving, refereeing, and editing the papers submitted by research people and producing the primary journals. These will be serviced as full-text files. Some commercial publishers may also want to use the system in a similar way. Patent offices of various countries and international bodies will use the system for exchanging patent data, examining the applications, and filing the patent documents. A comprehensive patent service organization will be needed to prepare concordance data, supply necessary coordination, and format the data for user service. World libraries will join through the Library Service organization to prepare aggregate files of library holdings, provide document delivery, and operate a CCC type of service. Bibliographic secondary information, processed at each discipline-oriented abstracting service, will be integrated at the Abstracting Center, where a directory file, data tag file, etc. will be built. Finally, there will be a number of regional service centers, to which individual users are linked, that process user requests and questions, maintain user records, and route specific questions to appropriate organizations. It should be noted that the system illustrated in Figure 2 represents only an idealized picture; the actual system would be far more complicated.

If a user is a synthetic chemist, he/she would want to know the best reagent to do the job under specified conditions, using a work station on his/her laboratory bench. The chemist would logon to the regional center to which he/she belongs and use either the Abstracting Center files to retrieve the bibliographic information or the Data Service files for direct guidance. The chemist may want to get a photocopy of the original articles through the Library Service.

The question then is how to build and maintain such a system. It is almost apparent that research scientists must cooperate in it because it requires expert knowledge to acquire or extract hard data and to evaluate them for input into the data file at a Data Center. Information specialists must work to maintain the supporting systems and coordinate the input from a large number of scientists residing at remote places in the world into a single file of that discipline. Distributed online input and edit systems and a data-transfer mechanism of a high level will be needed. Hard data may also be input directly from measuring instruments.

Scientific papers will be submitted electronically, reviewed on a referee's terminal, and if accepted, put into the database for online searching and retrieval.

Attempts and effort toward this end are being made. An example is the case of earthquake information. In Japan, the data obtained from geological observation and measurements at remote stations are transferred in real time to the Earthquake Research Institute of the University of Tokyo and then transmitted to the center in the United States, where the database is built and used by researchers worldwide.

It does not seem practical to do all such services from a single information center, but a number of mission-oriented and discipline-oriented centers will have to be networked. Here, national borders will have to disappear because ideally all data that are produced will be transferred only electronically; therefore, the system cannot be operated in one country isolated from the data produced in other countries. File building is an extremely expensive operation, especially for factual data, even if we ignore the time and labor on the side of the research scientists. In order for such a big system to be economically viable, cooperation among relevant organizations, either for-profit or not-for-profit, will be inevitable. It will also be the only way possible for us to be able to provide an answer to a search question for a price comparable to the price of a flask.

There will be competition even at such a stage but, to be optimistic, the competition will be between the disciplines and missions and not between the systems.