ARTICLES

Keeping Up with Japanese Chemical Technology at Chemical Abstracts Service[1]

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Chemical Abstracts Service (CAS) has been covering the complete Japanese chemical science and technology literature in a consistent, accurate, and timely manner since 1907. During the past 2 decades, Japanese contributions to chemical technology have increased steadily and rapidly so that today nearly 11% of the world's journal literature cited by CAS originates in Japan. In addition, 50.5% of all basic chemical patent disclosures abstracted and indexed by CAS in 1983 represent the results of research performed in Japan. Editorial processing for CAS is handled both in Japan and in the Columbus offices by subject experts proficient in the Japanese language. Lack of familiarity with the Japanese language is not only the scientific community's prime constraint in utilizing the original information but also the challenge to CAS in covering the Japanese journal and patent literature.

INTRODUCTION

Recently in hearings organized by a Subcommittee of the Science and Technology Committee of the U.S. House of Representatives concern was expressed about the failure of American industry to tap the increasing store of Japanese technology and research results.[2] This failure may be due to Japanese scientific and technical information not being easily and readily available in the U.S.

This paper details how one major abstracting service, Chemical Abstracts Service (CAS), handles the difficult task of reporting the Japanese technological advances in the scientific disciplines of chemistry and chemical engineering. In all, CAS staff monitors some 12 000 scientific and technical periodicals from 133 nations, patents and patent applications published by 26 nations and two international bodies, as well as conference proceedings, dissertations, reports, and books from around the world. In 1983, the staff prepared 451 753 English-language abstracts and 3.3 million controlled-vocabulary subject index entries. In addition, CAS identified through the *Patent Index* 95 811 equivalent patents.

GROWTH OF JAPANESE CHEMICAL TECHNOLOGY

The major contribution of Japan's scientific and technical research to the body of chemical knowledge becomes evident when one examines the sources of the chemical journal literature abstracted by CAS in 1983. As shown in Figure 1, 12 nations accounted for 85.3% of the world's published chemical research, exclusive of the patent literature, with the U.S. (27%), U.S.S.R. (17%), and Japan (10.6%) leading the way.

CAS has abstracted and indexed Japanese chemistry and chemical engineering literature since 1907. The *Journal of the College of Science, Imperial University of Tokyo* and the *Memoirs of the College of Engineering, Kyoto Imperial University* were among the first journals covered by *Chemical Abstracts* (CA). CAS acquires the Japanese literature directly from the academic, commercial, and governmental organizations that publish it. Acquisition is by paid and/or complimentary subscriptions and exchanges. Most of this material is provided to CAS as page proof or first copy off the press. All are forwarded by air mail to CAS Columbus offices.

Table I reflects the growth in the number of Japanese journals covered since 1907, both in absolute number and as percent of total journals covered. It is significant that, immediately upon cessation of hostilities between the U.S. and Japan in 1945, General Douglas MacArthur, through the Scientific and Technical Division of the Army, was personally instrumental in making arrangements that enabled CA to resume promptly and to extend its coverage of the Japanese journal literature.

Table I. Japanese Journals Covered by CA (1907-1983)

year	no. of journals	% of total journals covered	year	no. of journals	% of total journals covered
1907	4	0.8	1961	760	8.8
1918	13	1.7	1971	907	7.9
1926	42	3.4	1974	1088	7.7
1936	151	5.5	1978	1536	12.6
1946	188	4.4	1983	1478	14.5
1956	437	6.2			

Table II. Abstracts of Japanese Papers in CA (1951-1983)

	work performed in Japan		papers in Japanese	
year	no. of papers	% of total papers	no. of papers	% of total papers
1951	4609	9.1	NA[a]	NA
1956	8112	10.4	NA	NA
1961	10413	8.8	7455	6.3
1966	11629	6.4	5633	3.1
1972	21934	7.9	10834	3.9
1977	28646	8.2	13095	3.8
1982	38739	10.2	16048	4.2
1983	39484	10.6	16264	4.4

[a] NA, not available.

Over the past 3 decades, the number of scientific papers (journal articles, conference papers, and reports) resulting from Japanese research has increased steadily and rapidly. As shown in Table II, by 1983 there were nearly 40 000 papers reporting work performed in Japan, accounting for 10.6% of all the papers cited in CA; however, less than half of these papers were published in the Japanese language.

Figure 2 shows that while English is the foremost language of chemistry, Japanese is currently the third most widely used.[3] The other major foreign languages include Russian, German, Chinese, and French.

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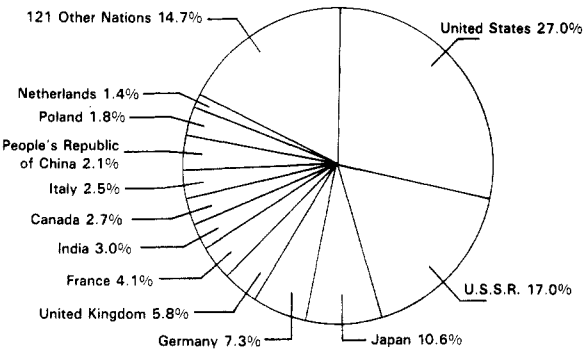

Figure 1. Sources of the world's chemical journal literature abstracted by CA in 1983.

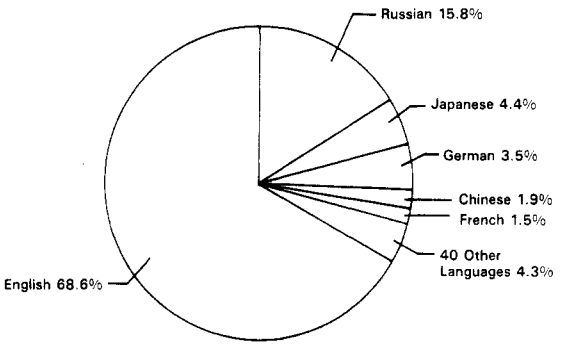

Figure 2. Languages of the world's chemical journal literature abstracted by CA in 1983.

Table III. Sources of Papers Abstracted in CA (1962–1983)[a]

	%				
nation	1962	1966	1972	1977	1983
U.S.	28.4	30.0	28.0	25.9	27.0
U.S.S.R.	23.0	21.3	24.0	23.2	17.0
Japan	6.9	6.4	7.9	8.2	10.6
U.K.	8.6	6.8	6.4	6.2	5.8
Germany	8.5	6.8	6.2	7.2	7.3
France	4.8	5.0	4.4	4.2	4.1
others	19.8	23.7	23.1	25.1	28.2

[a] Based on the country of research.

The relative percent of scientific papers abstracted in CA over the past 20 years that originated in each of the largest industrial nations is given in Table III. The percent originating in Japan has risen steadily, while the share emanating from some of the other large industrial nations has declined somewhat during the period. The data shown for Germany include contributions from both the Federal Republic of Germany and the German Democratic Republic, with the former accounting for about 6.2% and the latter 1.1% for 1983. While the Soviet Union continues to lead foreign contributors, there has been a dramatic reduction in the percentage of the Russian contribution over the past 6 years. The cause of this reduction is speculative. It has been suggested that the concepts of strong control and reduction of research expenditures may have adversely affected the free flow of information beyond the U.S.S.R. borders.[4] It is also evident that developing countries are making an ever greater contribution to the total world journal literature.

Although the growth of Japanese scientific papers has been impressive, it is the Japanese patents that more dramatically reflect the growth of Japanese chemical and chemical engineering research. The first Japanese patent abstracts appeared in the 1918 issues of CA. By 1935, CA contained 112 Japanese patent abstracts, 0.6% of the total patents abstracted. Table IV shows the growth in the number of Japanese patents abstracted by CA in the past half century, particularly since the early 1970s. The 36 640 Japanese patent documents abstracted in 1983 represent nearly 49% of the total 74 948 basic patents abstracted. Basic patent documents are those that contain the first disclosure of an invention. CAS also cited in the 1983 *Patent Index* an additional 28 848 Japanese patents as equivalents. An equivalent patent document contains essentially the same information as a previously abstracted earlier disclosure (basic patent) for the same invention.[5] About half of these Japanese equivalents describe Japanese inventions that were first disclosed in the Western patent literature.

Table IV. Abstracts of Japanese Patents in CA (1935–1983)

year	basic patents	% of total patents abstracted
1935	112	0.6
1945	0	0.0
1955	910	9.1
1965	1 767	6.0
1970	5 069	11.8
1975	27 546	40.4
1980	26 919	43.4
1982	33 495	47.3
1983	36 640	48.9

Table V. Abstracts of Patented Japanese Research in CA (1976–1983)

year	basic patents	% of total patents abstracted
1976	28 508	42.4
1980	28 447	45.9
1982	35 978	50.8
1983	39 188	52.3

Table VI. Japanese Patents Issued 1971–1983 (All Subjects)

year	Tokkyo Koho	Kokai Tokkyo Koho	total
1971	44 000	8 000	52 000
1975	43 600	161 600	205 200
1981	54 700	169 900	224 600
1982	62 040	212 900	274 940
1983	58 920	225 800	284 720

Since companies do not necessarily disclose or seek patent protection first in their own country, a better measure of the growth of Japanese chemical research during the past decade is reflected in Table V, which gives the number of basic patents abstracted by CAS resulting from Japanese research regardless of the country where the basic patent was issued. For the past 2 years, over half of the world's patented chemical research emanated from Japan. By comparison, the U.S. ranked second with 13.4%.

The 550% increase in the number of Japanese patent documents abstracted annually between 1970 and 1975 (Table IV) resulted from a change in the Japanese patent law, which allowed publication of *unexamined* applications (*Kokai Tokkyo Koho*) in addition to regular, *examined* applications (*Tokkyo Koho*). The number of examined patent applications on all subjects issued annually as patents has grown from about 44 000 in 1971 to about 60 000 today; in addition, the Japanese patent office now publishes over 225 000 unexamined applications each year (Table VI).

When the Japanese patent law was changed, CAS had to gear up rapidly to handle the sudden, vast increase in the volume of potentially valuable Japanese-language documents. CAS now handles this material in a timely manner, partly through arrangements with Japanese associates who help in abstracting and indexing the Japanese patent literature.

COOPERATION WITH JAPAN

There are four sources of CAS abstracts for the Japanese literature. In-house professional analysts in Columbus prepare

80% of the abstracts and index entries. A professional input center, organized recently in Japan under the auspices of the Japan Association for International Chemical Information (JAICI), provided CAS with some 2000 patent abstracts and corresponding index entries in 1983 and contributed nearly 10 000 patent abstracts in 1984. The remaining input is provided by two volunteer abstracting teams in Osaka and Kyoto, Japan.

Overall, CAS finds the Japanese very cooperative and works particularly closely with the staff of JAICI. This group was organized by Japanese scientific societies and chemical industry specifically to cooperate with the American Chemical Society (ACS) on matters related to exchange and dissemination of chemical information. JAICI also serves as the agent for marketing and distributing CAS services.

The principal challenge to CAS in covering the Japanese scientific and technological literature of chemistry, particularly the patent literature, and the prime constraint on the U.S. research-user community in utilizing the original information are one and the same—the Japanese language. While translation is not employed throughout the editorial process, without Japanese language skill to accompany knowledge of subject matter, the editorial work could not be accomplished. Bilingual comprehension is a necessary tool employed from the evaluator and selector of the literature to the document analysts and other editorial staff who produce the bibliographic citations, the abstracts, and the index entries.

An operation related to translation, yet distinctly different, is transliteration—the conversion of Japanese author names and geographic locations in the Japanese character set into readable Roman characters. For the Japanese language there are extant at least three systems of character Romanization—Hepburn, Kunrei-shiki, and Nippon-shiki. A modified Hepburn system is used by CAS as well as almost universally in Japan and abroad. The Hepburn system also forms the basis for the current ANSI standard.

THE CA ABSTRACT—A COMMUNICATIONS LINK

The purpose of the CA abstract is to alert and to inform; it is not intended as a substitute for the original writing. At the same time, CA's in-depth, thorough indexing is designed to help locate and retrieve the pertinent, findings-oriented abstract. For the researcher–user, whose scientific curiosity was piqued by the CA abstract and who now seeks the full document for details, CAS provides two routes of document accessibility.

The *CAS Source Index* is a bibliographic information reference for the nearly 60 000 scientific publications covered by CAS over the past 78 years. A total of 364 of the world's major resource libraries, 69 of which are located in 28 foreign countries (four in Japan), share the information on their holdings with the user community through this index.

Document accessibility is further enhanced by the CAS Document Delivery Service, which makes available complete articles, patents, technical reports, or other documents cited in CAS publications since 1975 (for Russian documents since 1970) and to which CAS itself has access. CAS pays the copyright fee or loans the original article if no copying arrangement exists. Patents, it is to be noted, are not copyrighted.

Thus, the abstract, with its bibliographic and technical information retrieval power, is all the more useful in serving as the bridge between the users and the generators of knowledge. Unfortunately, in the case of Japanese scientific and technical literature, this communication link is severely constrained by the language deterrent. While the Japanese patent is the most requested patent document in the CAS Document Delivery Service, the percent of total requests is far below what would be expected from the number of total abstracts of Japanese patents. By comparison, the second (European) and third (German) most requested patent documents show the expected relationship between requests and numbers of abstracts. Some users prefer to wait until a patent equivalent to the desired Japanese document, but in a language that they can more readily read, is disclosed and reported in the CA *Patent Index*.

Areas of chemistry and chemical engineering in which CAS users evidence greatest interest in or demand for Japanese scientific and technical information include electric phenomena (semiconductors), organic substances including photographic materials and compositions, pharmaceuticals, and polymers. Not unexpectedly, this user demand for information parallels the areas of most significant contribution of Japanese research to chemical science and technology. These are electric phenomena, photography, metals and alloys, and plastics.

COVERAGE OF JAPANESE CHEMICAL TECHNOLOGY

CAS is as comprehensive in its coverage of Japanese publications in chemistry as any organization in the West. However, that coverage is not absolutely complete. In recent years, information not covered by CAS but relevant to chemistry or chemical engineering, such as Japanese dissertations or government reports, may have been added to the database of the Japan Information Center for Science and Technology (JICST), the Japanese national abstracting and indexing service. CAS anticipates the full cooperation of JAICI and JICST in ensuring the comprehensive coverage of the Japanese literature in CA.

The JICST database covers Japanese documents in all areas of science and technology. Some of these documents probably are not covered in any Western database. However, the Japanese are not consciously attempting to prevent access to this information from outside Japan. JICST offers its database to the public through an online information service (JOIS), and there are no restrictions imposed by the Japanese on access to that service. Nevertheless, in order to use JOIS, one must be aware that the service exists, know how to access the service through the public value-added networks, have computer terminals capable of handling the Japanese character set, and, again, know how to search in the Japanese language. These constitute a formidable de facto barrier to access by scientists and engineers outside Japan.

While the JICST printed service, whose predecessor was *Nippon Kagaku Soran* (*Complete Chemical Abstracts of Japan*), is the major abstracting service in chemistry in Japan, there is another one, *Kagaku Shoho*, a biweekly current-awareness publication produced by JAICI. It also has a computer-readable version, which is in the English language.

RECOMMENDATIONS FOR THE FUTURE

At the U.S. Congressional hearings mentioned earlier, CAS along with other interested organizations and individuals provided testimony. The CAS Director of International Programs, James V. Seals, stated that the "U.S. government can act to improve our access to scientific and technical information from international sources, and in particular from Japan. This would require that a national policy be adopted to encourage the U.S. information community in its efforts and to foster international cooperation between U.S. organizations engaged in information activities and their counterparts in other countries, similar to the situation that exists in Japan, West Germany, and other industrial European nations."

SUMMARY

Growth of the scientific and technical literature based on research performed in Japan has been significant in the last

15 years. Access to this information is provided by Western information services such as Chemical Abstracts Service as well as by various groups in Japan.

REFERENCES AND NOTES

(1) Presented at the Conference on Japanese Scientific and Technical Information, MIT-Japan Science and Technology Program/Japan Society of Boston, Boston, MA, April 6, 1984.
(2) U.S. Congress House Committee on Science and Technology "The Availability of Japanese Scientific and Technical Information in the United States". Hearings before the Subcommittee on Science, Research and Technology; House of Representatives, 98th Congress, 2nd Session: Washington, DC, 1984.
(3) Baker, D. B. *Chem. Eng. News* **1981**, *59* (22), 29.
(4) Dickman, J. T.; Platau, G. O. *J. Chem. Inf. Comput. Sci.* **1983**, *23*, 70.
(5) Pollick, P. J. *Sci. Technol. Libr.* **1981**, *2* (2), 3.

Productivity and Its Measurement at Chemical Abstracts Service†

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The unprecedented growth of scientific literature and the availability of computers have led Chemical Abstracts Service (CAS) to new modes of information processing and delivery based on the best utilization and interaction of intellectual effort and computer support. In order to survive economically and better serve the growing number of information users, CAS introduced far-reaching innovations, all directed toward increased productivity of professional analysis, clerical tasks, and machine support. Examples of such innovations are unified intellectual document analysis, online editing, more efficient keyboarding techniques, and machine edits such as spelling-error detection and author-name verification programs. A unique approach to the measurement of productivity in the "knowledge industry", based on the classification of staff into measurable and nonmeasurable categories, is detailed. Productivity, defined as the ratio of outputs to inputs, is measured at CAS by revenue per employee, sales per employee, value added per employee, and value added per salary dollar and equipment dollar. The goal of the organization remains that of producing publications and services on the basis of the triad of completeness, timeliness, and quality.

INTRODUCTION

In the decade from 1972 to 1982, U.S. productivity virtually stagnated, growing at a rate of less than 2%, while that of Japan more than doubled and that of France and Germany grew more than 50%. Indeed, as Benjamin Franklin said some two centuries ago, "success breeds complacency". Thus, we saw many American producers' markets stripped away by more aggressive, efficient foreign trade rivals. One industry analyst, having surveyed 120 personnel directors and corporate managers, reported that the average American employee squandered about one-third of the day by not working. The difference between hours paid and hours worked was aptly labeled as the "productivity gap" and "an insidious threat to the economy".[1]

Fortunately, as *Business Week* pointed out in early 1984,[2] there is a revival of productivity under way in the U.S. fueled by technological advances, a more experienced work force, and proactive rather than reactive management. In other words, the U.S. seems to have turned away from Mancur Olson's model of a stable, nonproductive society controlled by interest groups that are overwhelmingly oriented to struggling over the distribution of income and wealth rather than producing additional output.[3]

IMPROVING PRODUCTIVITY AT CAS

At Chemical Abstracts Service (CAS), the unprecedented growth of scientific information mandated significant productivity improvements, if we were to survive economically. The result has been optimum utilization and interaction of intellectual effort and computer support.

Concerns about CAS's survival and economic viability are not new but have existed since the first issues of *Chemical Abstracts* (CA) were published in 1907.[4-6] An American Chemical Society (ACS) Punched Cards Committee, having as members James W. Perry then of MIT, Howard S. Nutting of Dow Chemical, and E. J. Crane of CAS, was first formed in 1946 for purposes of studying the application of keypunching techniques at CAS.[7] That research effort culminated in the creation of a separate Research and Development department at CAS in 1955 to take full advantage of technological advances in electronics and communication. To increase productivity and reduce costs has always been the goal of CAS management.

Eleven years ago, at the Fall 1973 ACS National Meeting in Chicago, CAS presented a symposium on "*Chemical Abstracts* in Transition", where Dale B. Baker, CAS Director, discussed in considerable detail modern methods of producing CAS publications and services and their effects on economics and pricing.[8] That CAS is a "production-line operation" was clearly recognized by Patrick P. McCurdy, then the editor of *Chemical & Engineering News*, who in a 1973 editorial observed that such an operation involved schedules, deadlines, controls, discipline, and nitty-gritty to get the finished product out on time at the required quality.[9]

Today, this observation is reflected more formally by the stated CAS mission:

> "to be the acknowledged leader providing a family of diversified information services and systems related to worldwide activities in chemistry and chemical engineering to meet the needs of the international scientific and technical community and the general public."

NEW TECHNOLOGY AND NEW METHODOLOGY

The early 1960s saw improvements in the preparation of the volume and collective indexes. Index entries were typed onto specially designed cards and these were filmed one line at a time with a special camera to produce a strip of film corresponding to a column of the index, thus eliminating the hot typesetting. In the late 1960s, the first computer-generated

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