

Trends in Science Communication — Circumstances Enveloping Science Journals —

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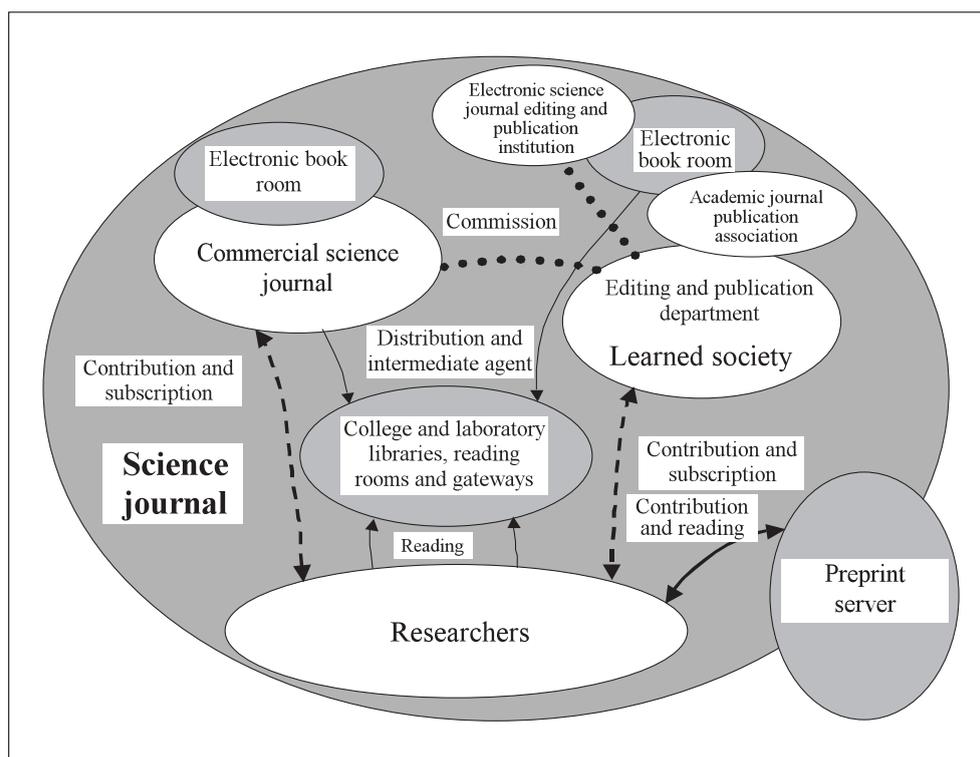
7.1 Introduction

Communication in scientific and technological studies (hereafter called "science communication") has a broad spectrum of interests including personal correspondences between researchers, presentations in study sessions and learned society meetings, paper presentations to science journals, proposal for research program, applications for research posts, and science communication as a means for linking science with society. Above all, publication of science journals, which is shouldered by researcher communities such as learned societies, is one of the most important means of

communication among researchers and plays an important role in developing researches. On the other hand, libraries, which continuously collect science journals and make them available for researchers, have guaranteed to some extent that researchers and students can read not only their own literatures but also those they do not subscribe to through interlibrary loan (ILL). In general, subscription fees of a science journal paid by institutional subscribers such as libraries and corporations are significantly greater than those paid by individual subscribers, and cover a considerable part of the journal's publication costs.

Science journals have functioned as important media for scientists since the 17th century.

Figure 1: Communication through science journals



As shown in Figure 1, papers contributed by researchers are edited by the editing and publication departments of learned societies and commercial science journals for placement in their journals. Printed and published journals are bought by individual readers and libraries via intermediate agents. Libraries sort and arrange them on bookracks to make them available for readers. Over the ages, this system has supported the continuing publication and subscription of science journals, laying the basis for communication among researchers. Review systems, which accomplish a peer review of papers in their editing stage by anonymous researchers in the same or similar field, are considered necessary for science journals to maintain the quality of papers placed in them through the filtering and enrichment of their information. In fact, a paper that has been subjected to a peer review and placed in a science journal is counted as one research merit for the author. In many science journals, their peer review system is supported by researchers volunteering their time.

Learned societies, publishing houses, libraries, intermediate agents, etc., which support the science journal systems, are confronted with and pressed to address problems that have

materialized due to the rapid increase in science and technology information such as more papers and the development of information technology.

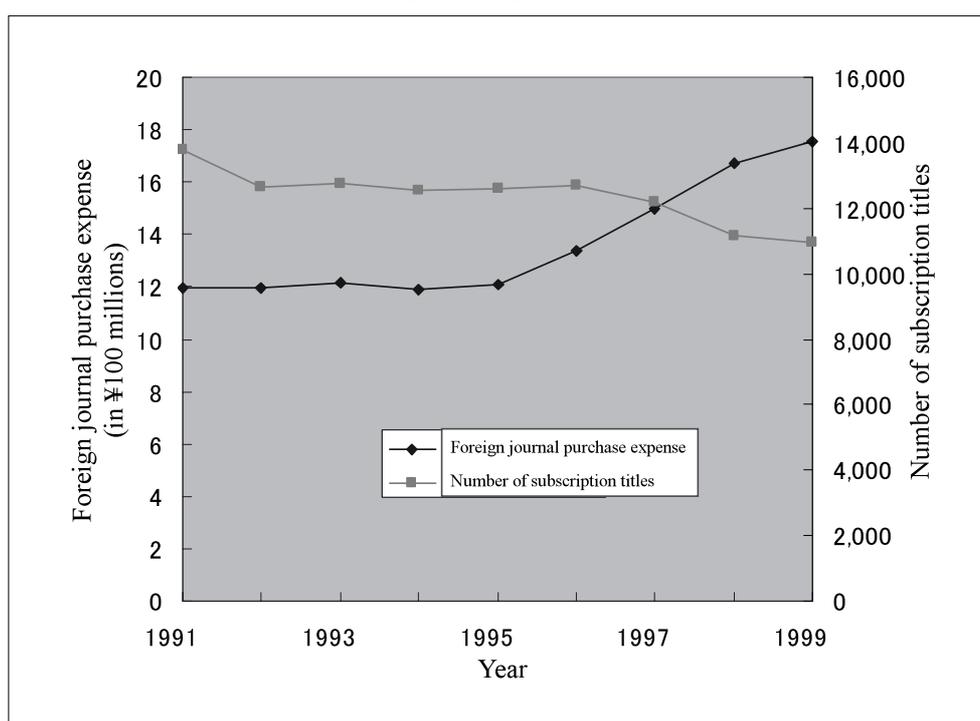
This paper first describes problems to be solved by science journals and the current state relating to them. We then introduce efforts on improving the science communication of related organizations including computerization. Finally, this paper proposes a commitment necessary for the evolution of science communication.

7.2 Science Journals and Their Circumstances

7.2.1 *Decrease in science journal subscriptions by libraries*

As pointed out by the Science Council of Japan, the number of subscriptions for periodical literatures by college libraries, etc., began to sharply decline from about 1990^{*1}. The report by the National Diet Library said that the number of subscriptions (of foreign journals) has continued to decline since 1990, and is about 40% of the peak value at present (1999)^{*2}. The cause is the rapid rise in the subscription prices of, among others, foreign journals, which is noteworthy when compared to the weak increase in journal purchase budgets of libraries. The rise in

Figure 2: Purchase by year by 40 colleges joining the Japan Pharmaceutical Library Association



subscription prices is also a serious problem in the U.S. The subscription prices are on a further upward trend recently since electronic and ordinary paper-version journals are sold in combination. As a concrete example showing this tendency, let us view the number of annual subscription titles and the amount of foreign journals purchased since 1991 by 40 colleges joining the Japan Pharmaceutical Library Association (Figure 2) [3]. Although the total literature purchase expense in 1999 is greater than that in 1991 by 47% (annual growth rate of 5.2%), the number of foreign journal titles purchased actually decreased by 23% during the nine years from 1991 to 1999 (annual decrease rate of 2.6%). Furthermore, the ratio of the foreign journal purchase expense to the total literature purchase expense climbed from 60% (1991) to 69% (1999). Such a decrease in the number of science journal titles purchased by libraries, which are major institutional subscribers, is a worrying development.

7.2.2 Computerization of science journals

The operational pattern of publication and its distribution has been dramatically changing due to the rapid development of information technology from the 1990s. Publishing firms are now able to deliver science journals directly to subscribers via the Internet. In particular, due to the increase of information such as science and technology papers and databases, it is expected that computerization of providing information and distribution (communication) will further accelerate. The merits of computerization are the possibility of obtaining recent papers immediately, obtaining papers without visiting libraries and having to find them, obtaining desired information from among enormous literatures through keyword searching, etc. An analysis said that a computerized paper is viewed more frequently and it has been pointed out that computerization can greatly contribute to improving science communication. It is also expected that libraries will suffer shortages of space for stocking their books in the future and therefore there is an active effort afoot to computerize paper literatures published in the past^{*4}. Many new attempts have begun to make the most of the merits of online

computerization. However, it is also revealing problems that cannot be thought of in paper document-based systems^{*5}.

7.2.3 Decrease in the number of members of domestic learned societies.

At present, there are many science and engineering learned societies whose members are diminishing. For example, the Japan Society of Applied Physics and the Chemical Society of Japan have undergone a 3.5% and 0.7% decrease in individual members every year, respectively. Reflecting the present economic trend, institutional members, such as corporations, of learned societies are decreasing at a much higher rate^{*6}. Moreover, information science and technology learned societies suffer not only a decrease in their members but also in the numbers of participants in national conventions and study sessions, and of research presentations in these meetings; thereby, as indicated in^{*7}, their working cost balance deteriorates and contributed papers are scrambled for among several learned society journals. The bursting of the bubble economy is considered as a remote cause of the operational problems of learned societies. Learned societies are undergoing consolidation in order to overcome such embarrassing situation as well as to seek a new ideal situation^{*7}.

7.2.4 Popularity of Japanese learned society journals

As an index to indicate how often Japanese science journals are read, the citation frequencies and impact factors of their papers published in 1999 can be found in ISI company's Journal Citation Reports 1999 Science Edition.

The most frequent citation in Japan is 2,928 times/year recorded by the Japan Society of Applied Physics' English journal, "JAPANESE JOURNAL OF APPLIED PHYSICS PART-1-REGULAR PAPERS SHORT NOTES & REV", and that in the world is 39,971 times/year recorded by the "JOURNAL OF BIOLOGICAL CHEMISTRY." Although the top ten journals in terms of citation frequency in Japan are all society journals, those in the world include four commercial journals.

Next, let us consider readers' attention to papers in terms of the level of their impact factors, which

show citation frequency per paper. From among the top ten journals in Japan, the journal winning the highest impact factor of 2.26 is the Society of Plant Physiologists' English journal, "PLANT AND CELL PHYSIOLOGY." From among the top ten journals in the world, the journal winning the highest impact factor of 47.56 is the "ANNUAL REVIEW OF IMMUNOLOGY." Although the top ten journals in terms of impact factor in Japan are all society journals, those in the world include nine commercial journals.

The data above reluctantly reveal that Japan has no journals corresponding to world top journals with such high impact factors.

7.3 Discussions about Science Journals

The reason why the subscriptions of science journals by Japanese libraries have been reduced is because the budgets of institutional subscribers such as libraries have not been increased despite of the rise in subscription prices. On the other hand, it seems that libraries joining the Association of Research Libraries (ARL) in the United States have taken action to prevent the number of subscriptions from dropping as much as possible. According to figures released by ARL, science

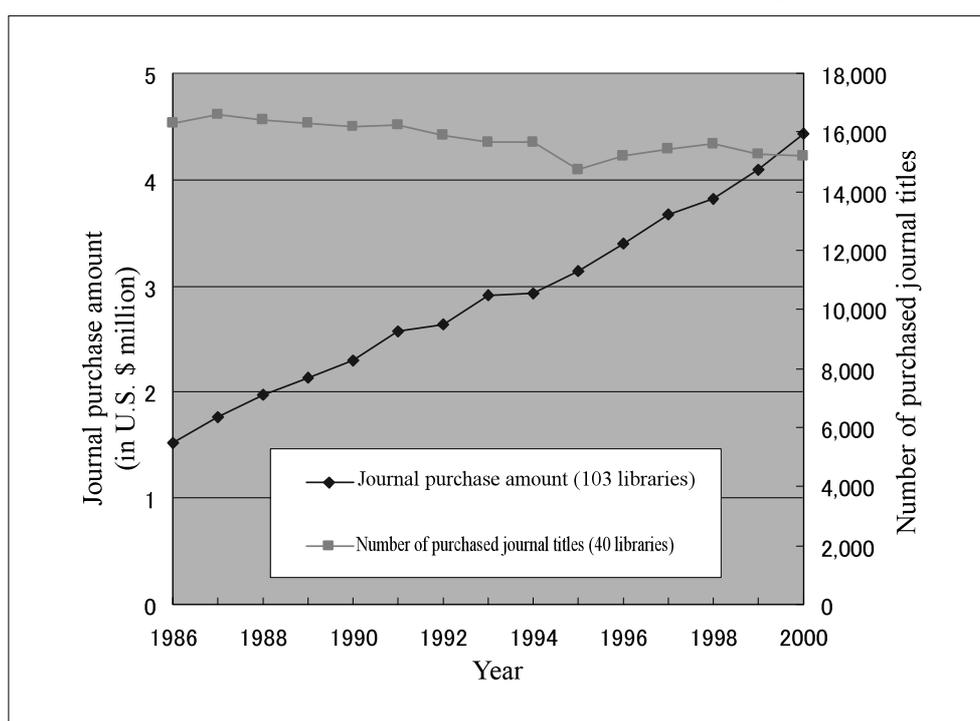
journal subscription cost increased 2.9 times from 1986 to 2000 (annual growth rate of 8.0%) limited the decrease in the number of titles purchased during this period to 7% (annual rate of 0.47%) (Figure 3). Incidentally, whereas the average annual price increase ratio of independent books purchased during the same period was 3.7%, that of journals was 8.8%, as high as 2.4 times of the former, showing the steep rise in journal subscription cost^{*8}. In addition, the ratio of the journal purchase cost to the total book purchase cost rose from 58% to 73% during the same period.

It is thought that the steep rise in science journal prices can be attributed to:

- (1) Increase in the cost of editing and publication due to the increase in research results (such as papers) contributed from research institutes;
- (2) Market over-concentration established through merger and acquisition in the publishing industry world; and,
- (3) Computerization cost, which is increasing recently.

Let us examine concrete data supporting cause (1). According to American figures, the number of

Figure 3: Total amount of documents purchased by libraries joining the U.S. ARL.



science journals increased by 62% in the period from 1975 to 1995, during which science and technology researchers doubled and the number of pages of papers per researcher increased by 70%*⁹. In Japan, during the period from 1981 to 1999, researchers doubled and the number of papers increased by 2.6%. Such perpetual increases in the numbers of researchers and their papers is also true in Europe*¹⁰.

Cause (2) has been pointed out by the Association of Research Libraries (ARL)*¹¹ and a Japanese library organization*¹². At present, science journal problems including rises in their prices are discussed by concerned parties including Euro-American libraries, publishing houses, learned societies, journal editors, information science researchers, etc., on the Internet*⁵. The following questions other than the problem of price rises are also being discussed and the directions of these discussions should be watched carefully by those who address science journal problems in future years: "How far does intellectual property rights (especially on computerized property) of a copyright holder (such as a publishing firm) extend?," "To whom should a copyright of a paper, based on the results of research conducted under the subsidization of taxpayers and/or companies, be given?" and "Who should bear the cost of editing and computerization and how much of that cost?"

Also in Japan, many learned societies publish their journals in English, so as to widely distribute their members' research results to the world. However, if the number of their issues continues to decrease as in the present, it is thought that the publication of learned society journals will put pressure on the operations of the societies in the near future*¹³. Concerns are rising that journals on a less secure footing and with small subscriptions are experiencing decreases in their subscriptions with their increasing prices, which causes their subscription prices to rise furthermore, which in turn causes their subscriptions to decrease furthermore and such a vicious circle finally creates a situation where they can not survive. On this account, many Japanese learned societies hesitate about positively adopting computerization of their journals and information technology into their operations, while they suffer

decreases in subscriptions of their journals.

7.4 Efforts of Related Organizations

This paper first introduces, as examples of the efforts on the publishing side, the efforts of the American Institute of Physics (AIP), which is well known with the advanced mode of attack and the computerization efforts of the Japanese Government which has recently established Institute of Pure and Applied Physics (IPAP) We next introduce the efforts of libraries, which are major subscribers (and intermediate agents), and a preprint server that has recently attracted a great deal of attention.

7.4.1 American Institute of Physics (AIP)

AIP is a nonprofit corporation established in 1931, which has the principal purpose of publishing and distributing learned society journals for physical and engineering learning societies. The member learned societies total 10, including the American Physic Society (APS) (these societies' members number 125,000). In addition, AIP cooperates with 22 related learned societies in their operations.

Let us explain how AIP computerizes its operation processes, while tracing the processes in which researchers present their papers for publication and wide subscription. In April 2000, AIP released a tool kit, which operates under Word 2000, to used by researchers to describe their papers. The widespread use of such a kit has increased electronic paper submissions. Computerized submissions in 2000 reached 50% of all papers submitted to AIP. Some journals see a ratio of 90%. Now, 48% of drawings in papers are presented electronically. The advantages include that manual inputting of data is eliminated, errors and costs are reduced accordingly, and the time to publication is shortened. The speedup resulting from computerization causes some papers to be published earlier than their expected issues, thus acquiring great popularity. The average number of days from adoption to publication is 30 workdays, with the shortest time being 25 workdays. Once a final copy is sent to the printing house, the paper can be read online by the next day. This means that the paper can be viewed more than one week

earlier as compared to when the journal is arranged in related libraries.

If a library selects online subscription, the subscription is discounted. Whereas the discount rate was 15% in 1999, it escalated to 20% in 2000, and 25% in 2001. Overseas libraries can now save on postage and obtain papers earlier through online subscription.

Back issues are also being digitalized and provided online. A literature cited is given a digital object identifier (DOI), which is used as a link to it. All journals published in the name of AIP are given this DOI. It is felt that the introduction of the cross-reference system using DOI will be made widely available. In 2000, more than 30 publications were added to the online journal publishing service. At present, more than 100 publications of 16 learned societies are incorporated into this online journal publishing service, in which more than 210,000 papers have been accumulated and utilized.

AIP does not assume that a library making an online contract with it will allow everyone to download its papers at no charge. If a contract library belongs to a research organization or college, it may allow its staff or students to download at no charge. However, if everyone can download via the library without charge, no one would buy the related journals and that library would have to pay the costs to generate such material (U.S. \$49 million in the case of AIP).

AIP does not allow a computerized paper to be placed on a homepage just as it is. Even the author of the paper is not allowed to do this. Since AIP returns the copyright of a paper to its author after having received it from him or her, he or she can use the computerized paper within the confines of fair use. However, he or she can only publish the paper on a homepage in a form other than the AIP computerized version. The reason is because an electronic paper published by AIP contains AIP's intellectual efforts in the form of editing.

7.4.2 Integration into European Physical Journal in Europe

Physical institutes in European countries have organized the European Physical Society since the European integration, which has begun to integrate traditional and authoritative journals in

these countries into the European Physical Journal. At present, it has five disciplines. The European Physical Society is acting with an eye toward integration with the Institute of Physics (IOP), aiming at the integration of their physical academic journals. Under circumstances where American science journals are being internationalized, attention must be directed toward the fact that a journal competing with them has been born in Europe*¹³.

7.4.3 Trend of Japanese physical academic journals

The number of recent science and technology papers is increasing considerably in Asia including Japan, in which, as with Europe and the United States, nonprofit organizations conducting academic publication operations have been established and efforts to realize online publication of science journals have started*¹³.

Taking a cue from the Physical Society of Japan and the Japan Society of Applied Physics, the government began the "Online Journal Editing and Publication System (NACSIS-OLJ) (under the control of the Ministry of Education —the present Ministry of Education, Culture, Sports, Science and Technology) and the "Japan Science and Technology Information Aggregator, Electronic (J-STAGE)" (under the control of the Science and Technology Agency —the present Ministry of Education, Culture, Sports, Science and Technology) under the 1998 budget (their functions are to be integrated within this year).

Subsequent to that, the Institute of Pure and Applied Physics (IPAP) was established mainly by physical learned societies. At present, IPAP has four member journals: Journal of Physical Society of Japan (JPSJ, published by the Physical Society of Japan with 19,000 members), Progress of Theoretical Physics (PTP, published mainly by the Fundamental Physics Research Institute of the University of Kyoto and the Physical Society of Japan), Japanese Journal of Applied Physics (JJAP, published by the Japan Society of Applied Physics with 23,000 members), and Optical Review (OR, published by the Optical Society of Japan, which is a sub-society of the Japan Society of Applied Physics with 2,000 members).

The publication costs in the year before the

inception of IPAP (1998) were ¥130 millions for JPSJ, ¥95 millions for PTP, ¥300 millions for JJAP, and ¥11 millions for OR. Although at present the publication balance breaks even in each journal, it is expected that their balance will become worse due to the perpetual decrease in members, representing their subscriptions, and the gradual increase in their publication costs^{*13}. A breakdown of their main income comprises of subscriptions, government subsidies, offprint fees (contribution fees), and individual membership fees.

At present, overseas contributions to JJAP are about 30%, with many of them from Asia. An English proofreading service is also offered. A total Web system specialized for JJAP and integrating contributions, review reading, editions, and accounting was completed in July of this year, eliminating the exchange of paper copies. However, a general-purpose online editing system has not yet been completed, since the editing method varies among joining learned society journals. IPAP recently published a virtual journal, "Novel Superconducting Materials," which selects papers on superconducting materials from several electronic journals and automatically links them to each journal with the cooperation from AIP and APS in the U.S.

The electronic journal of JJAP is released (free access) one month after the publication of its paper version. The reason the online journal is released a while after the publication of its paper version, in contrast to AIP, is because there are concerns no one will buy the paper version if the online journal is released earlier since the journal's main subscribers are paper version subscribers such as libraries. JPSJ similarly allows its electronic journal to be accessed free after its paper version is published, and makes back issues up to 1992 available. At present, the costs of publishing and computerizing in the both journals are almost covered by subscriptions paid by their institutional subscribers, but access to their electronic journals could be charged if the publication costs increase in the future. Computerization of past papers is proceeding with subsidies including the science research fund.

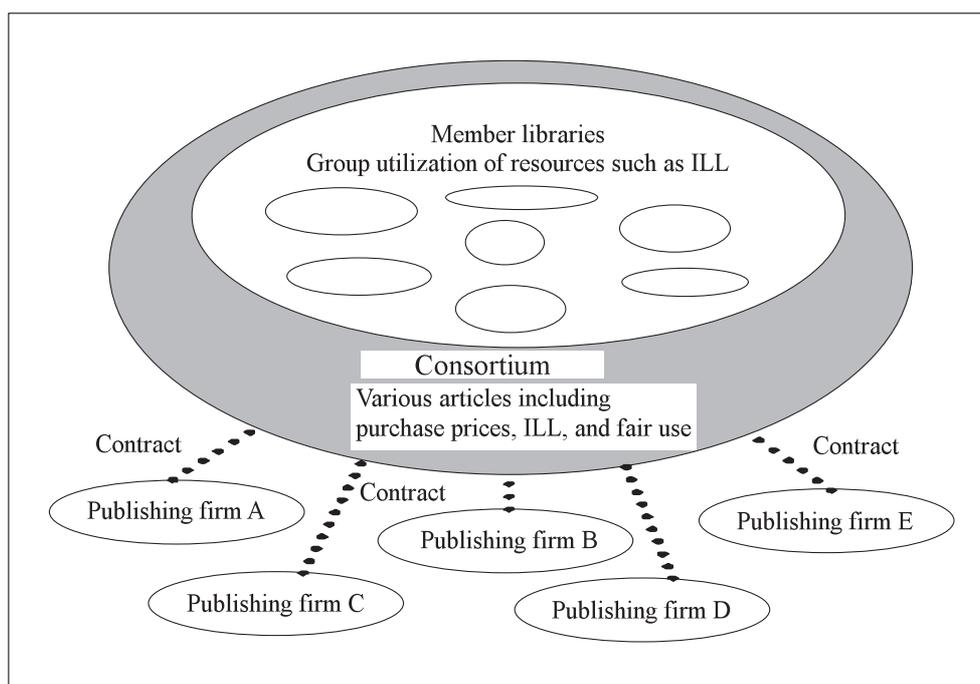
7.4.4 Efforts of libraries and intermediate agents

Since the 1990s, during which the number of purchased titles showed a remarkable decrease, in Japan as well, a high sense of crisis has been held by many thinking organizations including libraries, which subscribe and stock journals.

Recently, there is a move afoot by a library organization to ask the Japan Fair Trade Commission to investigate the pricing by a major overseas publication, which publishes many science journals^{*14}. Before this time, group buying through a consortium (a group jointly collecting and utilizing academic source materials) did not take much root in Japan for various reasons. However, it is expected that efforts through a consortium will become mandatory in the future for libraries, in order to continue to provide electronic information resources such as electronic journals under the current state in which it is difficult for them to find additional funds^{*15}. A library consortium is organized by many libraries in order to buy and jointly utilize electronic information through purchase and utilization contracts with publishing firms and database providers (Figure 4). It can be said that it serves cost-cutting goals, but poses challenges such as how to operate it, how to allocate its operation cost, etc.

Many libraries in Europe and the United States strive to continue buying journals by organizing consortia for group buying. There are about 1,000 library consortia in the world, which wrestle with group buying of journal books, electronic contents, etc., and co-ownership and joint use of resources among libraries such as ILL. It has become a general rule in Europe and the United States that a library joins several consortia^{*16}. However, since reductions in purchase costs borne by libraries through group buying, etc., in the form of a consortium are not substantial at the present time, it can be said that it is difficult to control the decrease in the number of journal titles purchased through efforts only on the library side.

Under the present circumstances where major publishing firms, which publish journals, and their users begin to exchange information directly over

Figure 4: Example of Consortium Operation Form

the Internet, intermediate agents are forced to greatly change their missions. However it can be said that they have the possibility of shouldering important functions in order that the merits of computerization are evolved in accordance with respective and various requests from different users in the future; It is thought that they will have knowledge on editing and publication of science journals, and perform construction of editing and publishing server systems customized for every learned society. In addition, it appears that they will find much business in the future in areas other than learned societies, such as libraries, research institutes, and universities. Their new fields may include database construction, data migration, management of intellectual property such as copyrights, construction of pay-per-use systems, which charge in accordance with the amount of papers downloaded, etc.*¹⁶.

7.4.5 Preprint server

In general, research papers are handled in the sequence of contribution, review (peer review), acceptance, printing and publication, and rarely released before their acceptance. Recently, however, many papers are released on the Internet before they are reviewed and accepted to be published, and researchers who want to pioneer in their research fields actively post their papers to computers connected to the Internet, which

provide paper registration and release service and are called preprint servers. Furthermore, after the publication, they can leave their papers on the servers to make them available for everyone.

A representative preprint server is XXX in Los Alamos (<http://xxx.lanl.gov/>). The XXX server receives 3,000 papers every month and is accessed one million times every week. When compared to the fact that the U.S. Physical Review Letter (one of the prestigious physics journals), to which papers are contributed from around the world, receives 2,855 papers in a year (1999), it becomes clear just how many papers are posted to XXX. Assuming that a preprint paper is actually read one time among 10 connections and is read for six months after its contribution, a single paper would be read about 10 times every day. At present, the National Science Foundation (NSF) provides subsidies of U.S. \$300,000 a year to XXX for its operations*⁵.

The success of the XXX server shows that if a system is intended only to receive and release computerized academic papers, it can be built cheaply, moreover the chance of the papers being read are extremely high, and the evolution of such a system has the possibility of significantly changing the ideal situation of science journals*¹⁷. However, since a preprint server does not necessarily guarantee permanent access and filtering of information is incomplete, it can be

said that it is complementary to the function of a science journal. It is pointed out that, in the field of life science, there are examples in which papers without sufficient results are early posted to preprint servers in order to gain an advantageous foothold in obtaining intellectual rights related to their researches.

7.5 Problems Arising with Computerization

7.5.1 Copyright and fair use of computerized papers

The problems are not limited to the steep rise in purchase prices. Publishing firms and publishing departments of learned societies require authors of papers to transfer their copyrights to them when they contribute their papers, in order to secure smooth publishing and distribution of their journals and management of the copyrights. Although it is thought that there are many complicated and outstanding or unknown problems about the copyright and fair use of computerized information, there is an opinion to the effect that it should be avoided to impose a significant restriction on the use of computerized science and technology information, especially when it is used for researches and education^{*5}.

7.5.2 Editing and computerizing costs

Simply raising the subscription fee to cover the costs of editing and computerization puts a load on subscriber libraries here and abroad, and therefore has a possibility of causing them to cancel their subscription. Under circumstances where papers are computerized and read via the Internet, since the frequency of downloading papers can be exactly measured by publishing firms, systems that charge users based on this count are being used. However, an appropriate system for charging is now being searched for and the challenge of solving the problems of costs for publishing and operating science journals including their computerization and of setting their subscription fee have not yet been cracked.

7.5.3 Electronic book room

In order that an electronic book room is maintained and accessible for a long time to come,

economic and technical problems to be solved for it are being discussed among experts. As for the form of an electronic book room, a conclusion on which is advantageous between the center concentration type, which collects books in a certain center, and the distribution book room type, which functionally connects book rooms distributed all over the world, has not yet been reached and experts are still discussing about this problem. Although each of these has its merits and demerits, there are many experts in Europe and the United States who say that the distribution book room type is realistic and safe from loss of data due to an accident, reflecting the recent rapid development of distribution computing technology.

In addition, there are problems to be solved, such as who and how to save electronic media and how to update them.

7.6 Conclusion — Science Communication in the Information Age —

Communication through science journals are supported by many organizations including scientist communities, learned societies, publishing houses, intermediate agents, and libraries, etc. However, under the circumstances where science journals are forced to change significantly, the related organizations must cooperate to build a new system. For this purpose, we make the following propositions:

(1) Computerizing science journals

Following the global tide of computerizing science journals, it is thought that computerization of Japanese journals must be pushed forward in order to improve their information transmission power. According to a recent analysis of papers on computer science published in the last several decades, computerized papers that can be accessible online tend to have a much better chance of being read and cited^{*5}. At present, publication of attractive journals for both the authors and readers are desired in Japan, justifying the promotion of advance efforts by making the most of the potential of computerization.

(2) Making necessary science information easily accessible as much as possible

In order that science journals widely propagate research results and to make the necessary information (papers) easily accessible as much as possible by lowering barriers, it is necessary to solve the problems pointed out above (7.5) and to have the related organizations cooperate toward this end. Especially, in Japan, science journals need to be reformed, taking intents of subscribers and contributors in the world into account.

Although preprint servers are becoming indispensable for researchers especially in fields in which researches are rapidly evolving, it is necessary to promote them while understanding that they are complementary to the function of science journals. It is thought that public research institutes' and the government's positive involvement in the operations of preprint servers are appropriate efforts to promote science and technology researches. For example, it may be possible that a laboratory, which furthers nanotechnology researches, hosts a nanotechnology preprint server ahead of the world to accelerate science communication, thereby contributing to the development of nanotechnology researches around the world. However, its operation requires an excellent "moderator."

(3) Maintaining objective, fair, and speedy peer review

Filtering contents of papers (science and technological information) through editing and peer review is considered to be effective for quality control. It is thought that an objective, fair, and speedy peer review not only improves the reliability of the journal itself but also eventually leads to enhancement of the authority of science communities such as learned societies engaging in the publication of journals.

Let us introduce an example related to this. Recently, a major medical journal announced that they will not place papers that are suspected of being interfered with by companies^{*18}. The reason is because researches funded by companies, which make huge investments in the development of new drugs increase in number and companies

deeply involve in these researches and contents of their papers published in many cases, which generates concerns that only information that is advantageous for these companies is released. Since researchers generally conduct researches under various pressure and interference as described above, although it is important to ask authors of research papers to maintain their morals, an objective and fair review will be required more than ever^{*19}.

(4) Continuously providing science information

On the other hand, it is thought that the role of libraries and research institutes, which build electronic book rooms and databases, and intermediate agents, which supports these organizations, will become increasingly important to establish smooth and economical communication^{*20}. Maintaining an adequate number of science journal titles purchased by libraries, etc., is important in order to support and develop book rooms, which guarantee that present and past documents as well as electronic information can be read. Under circumstances where information on science and technology is increasing, maintaining and strengthening the functions of libraries, which have the mission of "providing collected documents and maintained facilities for public use"^{*21}, is thought to be one of the important infrastructure construction programs in science and technology development and it is desirable to make an active investment in it to equip libraries with functions adaptable to future computerization.

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