associations, societies and other institutions throughout the U. S. and Canada. It has been a most gratifying experience for me to have been met with a spirit of cooperation and friendliness everywhere.

I may add that SCANDOC is still an experiment. By the summer of 1963, the experiences so far will be summarized and it should be possible to make an evaluation and more clearly define SCANDOC's future activities.

One of the most important aspects of SCANDOC is its centralized nature. Through SCANDOC and SCAR and the national bridgeheads for SCANDOC, we have established an inter-Scandinavian network of communication by which all activities in the field of technical documentation and information can be coordinated. The national research councils and academies, by being actively engaged in the information problem, and by their participation in SCAR and SCANDOC have it in their power to direct and coordinate future activities in this fast moving and difficult field. We think this is important and makes it possible for the right people to take the right steps at the right time.

Finally, I would point out that these aspects of Scandinavian cooperation I have talked about, once again demonstrate the impact that science has on society in general, its power to change the social structure of nations, their way of thinking. We have, in fact, especially after the last war, plunged into what may be called the political stage of the scientific revolution. More strongly than ever before has the international nature of science become evident and has become a major force influencing the decisions made on all levels of national government. Let us hope that this forceful push toward internationalization imposed upon us by science may become as exponential in its rate of growth as science itself. Let us hope that peaceful co-existence not merely be co-existence but becomes peaceful international cooperation in all fields of human endeavor. Perhaps this impact of science upon politics may be the most important single factor preserving world peace.

Science Officers and International Communication*

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The subject of my talk is the Scientific Attache program of the Department of State. This program was established 1951, when scientific attaches were placed in several of our embassies abroad. Although this initial venture was drastically curtailed two years later, it established the pattern for a new beginning in 1959. Today we have science officers in nine of our embassies (London, Paris, Bonn, Stockholm, Rome, New Delhi, Tokyo, Rio de Janeiro and Buenos Aires). Additional positions recently have been authorized in Switzerland and Israel, and it is planned that several further posts will be staffed within the next year. The incumbents of these positions are drawn from the scientific community, on leaves of absence from academic, industrial or governmental positions. They have been eminent working scientists, almost always with previous experience in their countries of assignment, and this coupling of professional recognition with personal knowledge provides a ready-made entry to the foreign scientific community.

Since the quality of our program depends ultimately on the caliber of the men involved, I might briefly note two of the officers whose background is in chemistry. Dr. Ludwig F. Audrieth, in Bonn, is the well-known inorganic chemist from Illinois. He is author of over 150 research papers, founder of "*Inorganic Syntheses*," and a former Priestly Lecturer. He speaks fluent German, and has studied and worked in Germany. Dr. Edgar L. Piret, in Paris, came to us as Professor of Chemical Engineering from Minnesota. He studied and taught in France, and has been especially active in the field of engineering education. He holds several professional awards from both French and American societies.

The responsibilities of the science officers may be broadly grouped into three areas, *advising*, *reporting* and *representation*. In the first category they serve the ambassador and other officers of the embassy in supplying guidance and counsel on the implications which certain foreign policy moves may have on the advance of science and technology, both in this country and abroad, and they provide professional evaluation of the effects of scientific and technological advances on our relations with the host country.

It is in the next two areas that their activities are most directly applicable to the subject of this Symposium. The reporting function is, unfortunately, often misunderstood. According to popular conception, the job of the scientific attache is to ferret out detailed information on scientific research in other countries, preferably prior to normal publication, and to report them to Washington so that they may be available to interested scientists and technologists in the United States.

The volume of the exchange of scientific information between major countries would in itself bar such a function. Moreover, such a fact-gathering role would constitute duplication by the State Department of an activity in which numerous other private and governmental agencies already are engaged. Finally, periodic visits to the requisite number of active research centers to achieve the necessary coverage would be simply a physical impossibility for our small corps. Rather, the reporting activity consists of evaluating the influence which various developments involving science abroad may have on U. S.

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policy. One example would be the development in a foreign country of a synthetic material which might be substituted for a product which the U. S. has been importing or exporting. The ability of the science officer to recognize the potential of such a development at an early stage can provide the lead time required to make adjustments to meet the new situation.

The officer reports also on developments in fundamental research in fields intimately linked with positions which the U. S. government must take. For instance, progress is oceanograpaphy affects our position concerning the law of the sea; and research in radio-astronomy is directly connected with international telecommunications agreements. His readings of the attitudes of the foreign scientific community are also useful inputs to our consideration of cooperative programs in scientific hydrology, or of technical agreements on space research.

Other typical subjects which merit reporting by the attache include the creation or reorganization of governmental or private scientific bodies, appointments of individuals to important scientific posts, subsidization of scientific research, and similar matters useful to the U. S. in its future dealings with the country involved.

I have emphasized that the reporting function does not include routine reporting of substantive scientific information. However, it should be made clear that it is a legitimate and desirable function of the attaches to encourage and catalyze the international exchange of information. He achieves this in various ways. He is often the Embassy's representative to important scientific meetings in his country, and he maintains a close relationship with the local scientific community. He seeks to facilitate government and private programs for the exchange of scientists, and his expert advice is available to local individuals and institutions desiring to make professional contacts in the United States.

This last brings me to the third main responsibility—that of representation. Just as other embassy officers "represent" the United States to the political, economic, or other segments of the local population, the science officer, through continuing contacts, comes to be regarded as his country's "ambassador" to the local scientists. One measure of the acceptance of this role is the great volume of requests for the attaches to appear at Universities or other forums to lecture on either technical or other subjects of a scientific nature.

I hope I have established by now two points. First, there is a respectable volume of material coming back to America through regular State Department channels which represents useful information not often found in technical journals or normal literature sources. Second, there is now a body of men overseas, of ever-increasing competence, who have unusual vantage points for studying and evaluating the state of science and for facilitating direct contact between substantive specialists of both countries. A pertinent question is—how have these developments been exploited?

With respect to formal reporting, the situation within the government is excellent. By an admirable system of topic analysis, each foreign service despatch is routinely reproduced and distributed to all federal agencies which have even a peripheral interest. Any error is on the side of over-dissemination. It is not unusual for such a report to be disseminated in well over 100 copies, and there is ample evidence that they are well received. This has been borne out for instance by calls from an AEC office in Pittsburgh for a follow-up on a specific item, or by commendations from the Bureau of Reclamation Laboratory in Boulder, Colorado.

We are deeply aware of the fact that we in government are servants of the people, and that the fruits of reporting by our science officers deserve to be made equally available to the entire U. S. scientific community. But problems of staff, budget, and mechanisms are always with us, and have prevented us from achieving a completely satisfactory position here. We have been forced to discourage the several requests that have been received from private companies and individuals for routine access to their despatches, and are unable even to provide titles and references by subject matter. The following steps have been taken, however; we have cooperated with the National Science Foundation, in its production of what might be called *Foreign Science News Notes*. These come from a variety of sources and have been made available to a number of journals, such as *Chemical and Engineering News*, *Science*, etc. The editors are free to use them as they wish, and this service, although quite recent, has been received with a good deal of enthusiasm. There is no attribution to the scientific attaches.

Again, we are working out a plan to publish key despatches which deserve much wider reading. One of the first, I, will be on the Organization of Scientific Activities in India, by Dr. Earnest Watson, the Science Officer at our New Delhi Embassy, and it will hopefully be only the first of a series dealing with science policy, organization and administration in several foreign countries. Incidentally, we have no real way of estimating the demand for these, and would appreciate any comments from readers.

The *German Science Bulletin*, now being published by the Science Office of our embassy in Bonn, contains notes of research interest, and personnel and organizational changes, and normally at least one feature article treating in depth a given area of scientific investigation in Germany. It is a monthly publication, and is available upon request to the Science Officer, American Embassy, Bonn.

Finally, I should add that certain other agencies, notably the Department of Commerce and the Department of Health, Education and Welfare have procedures for releasing, to trade journals or in their own media, certain items of specific interest. From time to time we have been pleased to find our attaches' despatches quoted in, *e.g.*, the *Journal of the American Water Works Association*, and the *Chemical and Rubber Industry Report*. With respect to the efforts of the science officers to catalyze direct exchange of information between scientific communities in the U. S. and their countries of assignment, we are quite satisfied with the results to date.

They advise us that they are spending an ever-increasing amount of time promoting contact between individuals. One of our officers has made a special point of encouraging direct communication between trade association research organizations here and abroad. All work closely with their colleagues, the commercial attaches, so that American businessmen abroad can be put in touch with their direct counterparts. Considerable attention has

been given to assisting foreign scientists who are planning trips to America, so that visits to appropriate individuals and institutions may be included on their itineraries. Foreign requests for information on everything from where to study cardiology in the U. S. to possible sources of ultra-pure rare earth samples are handled as a matter of routine. The same assistance is willingly given, of course, to American scientists, all within the limits of available time.

In summation, probably the most effective means of communication is putting the right people in direct touch with each other. We believe that the Science Attaches of the State Department have an important role in this effort, and one which will increase in importance and effectiveness as their numbers grow and as understanding of their work becomes more widespread.

Development and Production of *Chemical Titles*, a Current Awareness Index Publication Prepared with the Aid of a Computer

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The introduction of *Chemical Titles* in 1961 marked the first publication produced almost entirely by computers and other data-processing equipment. The success of this innovation has generated many requests for more information about it. With this in mind, we hope to encourage other organizations to make use of this technique for dissemination of information by presenting here a history of *Chemical Titles*' development coupled with a description of its production.

Reasons for *Chemical Titles*.—With the great expansion of research activities in the chemical and allied disciplines after World War II came the now familiar but dramatic rise in the amount of published research information. It was not long before the traditional means of acquiring information, primary journals, reports, and abstract journals, grew so bulky that individuals were overwhelmed. Despite the desirability, both for intellectual and commercial reasons, of keeping up with current developments in one's field, one heard more and more that it was a hopeless task.

During the early 1950's many people began to look to the newly developing capabilities of computers as tools for organizing information. It was early suggested that indexes should be prepared by computers. While realizing the complexity of the process of indexing scientific reports, the newly formed Research Department at the Chemical Abstracts Service began to investigate the possibilities of using information-handling equipment to prepare an acceptable index to the newest research papers.

In the fall of 1958, we became convinced that the KWIC system of keyword indexing as designed by H. P. Luhn of IBM could be developed suitably as a scheme for indexing the titles of chemical communications by computers.[1]

Indexing by key words, with meaning clarified by context, was not new. Scholarly concordances have been known for centuries. The Central Intelligence Agency has prepared a permuted title word index using keypunch, reproducing punch, sorter, and tabulator since 1953.[2] However, Luhn's KWIC method offered easy and extremely rapid handling of large volumes of information, relatively simple preparation of the input to the computer, and output of a product which is readily reproduced by photographic offset methods and easy to use.

The Chemical Abstracts Service had long taken pride in its Subject Indexes, emphasizing standardized chemical nomenclature and indexing by concepts rather than words. At this point, however, the management recognized that to cope with the problems of timeliness, to the extent of producing an index to literature which has just appeared, required a departure from tradition. In the fall of 1959, the National Science Foundation's Office of Science Information granted $150,000 to the Chemical Abstracts Service to study for a year the feasibility and acceptability to chemists of keyword-in-context computer-produced indexes.

Early Stages of the Research Program.—The initial stage of the research program consisted of selection of a limited number of journals to be covered by the new service from among the over 9000 covered by *Chemical Abstracts*. It was decided initially to limit coverage to periodical publications which appear quarterly or more frequently. A number of staff members of the Chemical Abstracts Service cooperated in a survey of abstracts from presently published journals. They reached the conclusion that some 600–700 journals publish about 60 per cent. of the world's chemical research results. Several books dealing with the literature of chemistry were consulted in an effort to be certain that the major journals of each country and of each area of chemistry were included. The initial group selected, which was to be expanded later, consisted of 550 journals.

A second preliminary step consisted of selecting a group of words to be rejected as index entries. The machine program allows that a pre-selected set of words, the number of which depends on the memory capacity of the computer used, may be rejected as keywords because of