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KNOWLEDGE IS POWER

by

Senator Hubert H. Humphrey

Address Before

International Conference on
Machine Searching and Translation

Cleveland, Ohio

September 9, 1959

Last month, in a rare news conference in the Kremlin, Soviet Premier Nikita Khrushchev said that the object of his scheduled history-making visit to the United States next week, and the return visit later of President Eisenhower would be to find "a common language, and a common understanding of questions to be resolved."

Without violent interpolation, I can say that the aim of this week's conference, "standards for a common language for machine searching and translation", is in the same ballpark as Khrushchev's stated aim.

Although the present conference ^{your copy} is scientific and not political, the language used to describe specific aims resembles that of politics and diplomacy, ~~as follows:~~

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1. to encourage an environment for working toward a common machine language or a series of compatible machine languages for processing scientific and technical

literature so that it may be searched, selected, correlated, and translated by automatic equipment.

out 2. to characterize equipment requirements for use with common language systems or with compatible machine languages.

3. to create an environment in which it will be possible to foster agreements for cooperative processing and exchange of encoded materials for machine searching of the world's scientific literature.

4. to work toward initiating cooperative collection and analysis of scientific and technical terminology for preparation of dictionaries and thesauri for code establishment for use in machine searching and machine translation,
5. to promote cooperative research programs and free exchange of research materials,
6. to review interrelationships between machine literature searching and machine translation and to consider how progress in one field may advance the other.

I am convinced, both from my own personal experience, and from examining history, that the key to finding a common language on the international scene, as in the political, scientific, or other scene, is the willingness to seek a way to achieve mutual understanding.

My interest in the problem of machine literature searching and translation is deep seated. ^{For a time} Perhaps it is not too well known that I have served my apprenticeship as a teacher ^{Student & then as a Teacher} professor ^{at} -- at the University of Minnesota ^{Macalester College} -- and in the pursuit of a scholarship in my field it became apparent to me that it was a major

as a student, a teacher & a Public official

problem to resurrect and to exploit the information of interest to me that lay buried in books and journals whose contents were relatively inaccessible to the research scholar.

Later, the problem of utilizing recorded information faced me when I became Mayor of the thriving ~~metropolis~~^{city} of Minneapolis. The importance of making decisions quickly became apparent to me when considering the drastic reduction in the time scale of information gathering for decision making and control during the past forty years. This change corresponds to increases in the rates with which competitive

activity, changes in public opinion, and aggressive action can deteriorate economic, political, and military situations. In forty years, the time scale for information gathering for control by management has shifted from weeks to days, for machine operators from hours or minutes to seconds, and for automatic controllers from minutes to split seconds.

I discovered another dimension to this problem when I moved to the U.S. Senate. From that vantage point, I observed that the rapidly expanding research facilities of government agencies, universities, and industrial concerns were pouring forth a cascade

of new knowledge so great that existing arrangements for collecting and organizing the records no longer would control the flood. The inability to lay hands quickly on essential information has been leading to enormous intellectual and social waste which no business, no industry, and no government activity could either escape or afford.

As soon as I had the opportunity to do something about this problem I became busy. As chairman of the ~~the~~ Subcommittee on Reorganization and International Relations of the Senate Committee on Government

Operations, I was able to have the committee staff study the library problem thoroughly, in connection with a bill that I introduced -- to create a Department of Science and Technology -- ^{its} ~~whose~~ function ~~it~~ would be, among others, to take appropriate action toward -- *now quote*

"the development and utilization of mechanical aids and new devices for collating, translating, abstracting, indexing, storage and retrieval of scientific and technological information under the control of the Federal Government, and to coordinate such data as may be available from other sources."

Another function of the proposed new department would be "to establish rules and regulations governing the distribution of scientific publications as may be necessary to assure maximum utilization..."

The subcommittee held extensive hearings on this subject. The first group to testify was Dr. J. H. Shera, the distinguished dean of Western Reserve University's School of Library Science, and *Dr* J. W. ^{Perry} ~~Perry~~ and ^{Dr} Allen Kent, Director and Associate Director,

respectively, of the University's Center for Documentation and Communication Research. They presented a comprehensive picture of the Russian activities in the field of collecting, analyzing, and dissemination of the world's scientific and technical literature. It was a revelation to me that this group had performed so much of the pioneering research work in the field of machine literature searching and in mobilizing ^{na}ational attention on the problem through three

national conferences which they organized, in 1956, 1957, again in 1958, and now the present conference.

After their testimony there followed a parade of witnesses from government, industry and universities. Many spoke of the extreme needs for more effective control of scientific and technical information in order to advance the efficiency with which research in our nation is conducted -- particularly with regard to avoiding loss of our nation's precious

research time in duplicating work already completed or under way. I was shocked by the testimony of one research director in particular who estimated that the efficiency of chemical research in the United States is only 5-15% -- with much of this low order of efficiency caused by incomplete control of the literature.

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I heard other witnesses at the hearings who proposed the creation of a national center -- financed with federal

funds -- to coordinate the processing, abstracting, searching, and translation of the world's scientific literature output.

Estimates of 30 to 300 million dollars were made as to the cost of such a center. Neither of these figures frightened me when I considered the estimated \$7 billion annual research bill of our country. If the experience of the chemical research director who testified is valid for other

industries, then the 15% efficiency would point to an annual waste of between ~~3~~ ^{3 to} five ~~and ten~~ billions of dollars. I could not be staggered by costs of \$300 million to ~~some~~ of that estimated waste. [^] Nor am I frightened by the spectre of federal aid in this important field. The annual government expenditures to support research in our nation is so great that it ^{could} ~~could~~ afford a centralized literature effort for its own purposes -- even if it were

necessary to establish such a center entirely for use in research programs supported by the Federal Government.

Other witnesses at the subcommittee hearings represented various of the abstracting and indexing services in this country. In general, they described the heroic attempts that they are making to keep abreast of the mounting ^{flow of scientific} literature. Most of the editors of these services felt that they could more adequately cope with the

Scientific

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literature situation if more funds would be made available to them. However, they apparently did not clearly envisage the need for mechanized systems for searching and correlating the literature. I had the distinct impression that these editors were convinced that their responsibility for solving the problem was limited to providing the conventional tools such as printed abstracts and indexes. Also, at least one editor of a major service in this country felt that the reports of Soviet advances in

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this field were somewhat overrated, and that they were not making as much progress as might be inferred from their writings.

When the witnesses from federal agencies testified, I detected that many of these persons were following the opinions of many of the editors of the abstracting and indexing services. There appeared to be a defensive attitude toward what they had done and an attempt to justify what they had not done.

I think that much of their attitude stemmed from the generally defensive attitude on the part of the executive branch of the Federal Government resulting from the electrifying discovery of the progress that the USSR had been making -- and brought to public attention by the announcement of the launching of the first Soviet sputnik.

It was a curious experience to see two types of witnesses before my committee talk right past each other.

There were the users of scientific information who were, in general, frantic in their desire for better information services -- both with regard to desire for better coordination and coverage, and with regard to the development of better tools for exploiting the world's scientific literature. One survey reported at the hearings showed that industrial companies were engaged in supplementing existing

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services for abstracting and indexing of published literature. They reported that approximately 40% were incurring annual expenses of more than \$5,000, and only 4% of more than \$50,000, with the others expending from \$10,000 to \$35,000 annually.

The same survey showed that the median 1956 expenditure for professional societies in processing the published literature in their field for the benefit of their members was exceeded

by almost 20% of the individual "user" companies that processed published literature for use by employees.

In the face of these costs, it was reported that 50% of the companies replying indicated that their internal *scientific* literature processing expenses could be reduced and the effectiveness of exploitation of the published literature enhanced by auxiliary services from various centralized sources.

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It was also found that the user companies averaged about 10 abstracting and indexing services to which they subscribed. In this survey, 312 different abstracting and indexing services were identified -- a commentary on the fragmentation of secondary information processing services that have sprung up in a frantic and uncoordinated effort to control the burgeoning literature.

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On the other hand, many of the abstracting services and federal agencies with responsibilities in this field were all for standing pat, or at least were proceeding with too much hesitancy.

A year after the first hearings had been held on the committee's proposed Science and Technology Act of 1958, the subcommittee held further hearings on proposals to create a Department of Science and Technology, and on ~~in~~ a

proposed commission,
composed of representatives
from the legislative and
executive branches of the
Government and members of
the scientific community,
to determine whether or
not a Department of Science
and Technology would be
desirable and, if so, what
components of the Federal
Government should be
included therein.

The subcommittee also
took this opportunity to
review the progress that
had been made in the field

of documentation and machine retrieval within the year following its previous hearings. A

considerable amount of testimony was heard outlining the progress that had been made within that period. The tenor of the reports to the committee indicated that the actions taken in this field during the preceding year might be compared to similar progress, or lack thereof, over the previous five years.

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As a direct result of the hearings, I cite the following areas where some positive action has resulted.

First, there was a stepped up program of translation of Russian scientific publications, both within and outside of the Federal Government. There was also a greater effort made to pool translations so that there would be less duplication in having various groups work on identical translations.

Second, there was a stepped-up program of research and development in machine translation and machine searching, with the National Science Foundation acting to coordinate work in this field. In accordance with one of the objectives of the committee's bill, the proposed Science and Technology Act of 1958, one of the responsibilities placed on the Foundation resulted from the enactment of Public Law 85-864, which provided in part:

"Sec. 901. The National Science Foundation shall establish a Science Information Service. The Foundation, through such

Service, shall (1) provide, or arrange for the provision of, indexing, abstracting, translating, and other services leading to a more effective dissemination of scientific information, and (2) undertake programs to develop new or improved methods, including mechanized systems, for making scientific information available."

In accordance with this provision of the National Defense Education Act of 1958, the National Science Foundation has entered into a contract and made a preliminary grant to the National Bureau of Standards

for the operation of the program, to be undertaken by the Science Information Service, for the evaluation and development of existing programs in these fields.

During the past few years a number of other interesting developments have taken place, which have resulted in the improvement of the availability of scientific and technical information in the United States.

↳ The Western Reserve University Center of Documentation Research and Communication has been cooperating with the American Society for Metals and the

General Electric Company in developing a system of coding abstracts that can be stored and searched mechanically, and have developed a machine for this searching purpose. This is an excellent example of cooperative enterprise by university, professional society, and industry which could lead to a usable mechanical search system of textual and graphic scientific and technical material. There are approximately 58 similar and promising ventures under way throughout the country, in which Federal agencies are participating in many instances. (e.g., ~~Air Research~~

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~~and Development Command, Air Force Office of Scientific Research, Office of Naval Research, National Science Foundation).~~

A third area of constructive action has resulted in the stimulation of non-Federal groups, who have advanced a number of serious proposals to create a program for the centralized, mechanized exploitation of the world's scientific and technical literature. One of these that has been brought to my attention is the program of Western Reserve University, one of the organizers of this international conference. The pioneering Documentation Research Center of the University

is working toward the creation of a "model center for the mechanized exploitation of the scientific and technical literature." As a matter of fact, this plan is now before the National Science Foundation for consideration. Many of my colleagues in the Senate and the House of Representatives have ~~evinced~~ ^{shown} a keen interest in this proposed program, and my committee has endeavored to see that its full potential is evaluated and utilized as a part of the Federal support program. I shall be looking with

interest at the outcome of this project.

Mechanical systems and devices are part of the broad pattern of scientific information services, and this pattern is in turn a part of the processes of science. In order to properly mechanize processes or to design systems, we must be able to specify in great detail just how it is to be done. Much of this research must draw on the combined skills of trained information specialists and librarians, linguists, logicians, mathematicians, statisticians, computer

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engineers, operations, ^{research} analysts, philosophers, psychologists, behavioral scientists, and specialists in the different scientific disciplines.

Involved in these cooperative ventures are ^{many} educational institutions (such as the University of Pennsylvania, Harvard Computation Laboratory, University of California, Massachusetts Institute of Technology, Stanford University, Cambridge Language Research Unit (England), Georgetown University, Columbia University, etc.) and large business concerns (such as the International Business Machines Corporation, Radio Corporatbn

of America, General Electric Company, Eastman Kodak Company, Documentation, Inc., etc.).

While great progress has been made in these joint ventures, and while it can be safely stated that mechanical translation is possible, still I must caution that we have not yet reached the stage where we have either the system or machine to accomplish it rapidly or economically; much more research and development work remains to be done before we reach that point.

Scientific societies, long the backbone of strong scientific

effort in the United States, are passing through a period of self-appraisal and are actively seeking improvement of their publications and their publishing techniques. For example, the American Society for Metals supports an experimental mechanized literature searching project at Western Reserve University; the American Chemical Society has a program of research within its Chemical Abstracts services; the American Institute of Physics has commenced a similar study of the entire physics communication

problem; the biologists are reviewing their entire information mechanism, and among the steps they have taken to improve their communications is the formation of a Conference of Biological Editors and the planning of a central business and information office in the American Institute of Biological Sciences to coordinate and ensure data compilation activities of a specialized type; the American Physical Society has established an "express" journal, titled Physical Review Letters, as an experiment in rapid dissemination of short notes on current research in physics.

Another very important development in connection with the documentation program is the establishment of an Office of Documentation within the National Academy of Sciences.

The objective of this new office is to advise and assist not only activities within ~~the~~ National Research Council to insure proper direction, but it is also proposed that it will work out a system of maximum participation of leading United States scientists and engineers in the programs approved for support, in order to insure the highest possible contribution

these leaders in the field of science can make toward the development of an adequate documentation center. The third objective of the Office of Documentation is to create an advisory board of scientists, whose abilities would be directed toward serving the National Science Foundation and non-Governmental groups working in the documentation field, and to assist the National Science Foundation in determining the areas where Federal funds or grants could be best allocated toward achieving the maximum goals

in the development of an overall scientific information and documentation program and center.

A fourth result of the hearings of ^{our senate} ~~the~~ subcommittee ~~of the Senate~~ Committee on Government operations has been the attempt to assess first-hand the scope of the Soviet effort in this field.

A great deal has been said about the efficiency and comprehensiveness of the Russian system of publishing scientific material in abstracts and making it available to Soviet scientists. They have developed an extensive organization, and are expending a

great deal of energy in abstracting and indexing scientific material from all parts of the world. In addition, they are exploring vigorously the possibilities of mechanical storage and search in mechanical translation. We must not discount their effort, but there are some areas where there is doubt as to the superiority of Russian progress. For instance, it can be pointed out that Chemical Abstracts, produced by the American Chemical Society, is universally acknowledged to be the greatest abstracting and indexing service in the world relating to the field of chemistry.

To illustrate the foregoing comparison, this year the American Chemical Society will produce over 130,000 abstracts of articles of interest to chemists; the Russians will produce less than 90,000. Further, Chemical Abstracts' coverage is better, and its entries are issued more rapidly than those of its Russian counterpart. The Russians have better coverage in other fields, such as biology; however, Biological Abstracts has increased its coverage by $33\frac{1}{3}$ per cent during this year, and for the coming year it expects to very nearly equal the

number of entries produced by the Russians; the currency of Biological Abstracts entries matches that of the Russian service.

It should be noted that indexes to the abstracting services of the Russians are available only for occasional years, a factor greatly handicapping search of their abstract literature. Obviously, it would be very difficult to search through hundreds of thousands of abstracts without the benefit of good indexes such as are provided by the indexing and abstracting

services of the United States. As one example of the never-ending search in this country for better "finding tools" for more effective use of abstract publications, Chemical Abstracts is studying the feasibility of new types of indexes to supplement those already extant. Another is the formation of the National Federation of Abstracting and Indexing Services to effect better cooperation and to develop studies seeking better tools for the benefit of the scientists of this country.

In connection with these problems, the co-sponsor of this conference, the Rand Development

Corporation, headed by James Rand, took a hand in financing a long visit by Western Reserve University's Allen Kent, to assess the U.S.S.R. accomplishments in this field. When he returned from this trip last year, he reported to my committee and advised us that the Soviet effort was indeed of significant magnitude, and that in many areas of abstracting, and in research the machine searching and translation, the Soviet attack on the problem was of a most significant nature. He reported that about 500,000 scientific papers culled from the

world's published literature were being abstracted under the direction of their Institute of Scientific Information -- a branch of the Soviet Academy of Science. The abstractors -- as in the United States -- were specialists in their fields and were contributing part of their time to this work. Furthermore, the Russians have organized an "Express Information Service" which took the cream of the published literature and long summaries of these were printed in Russian each week in 36 fields. In addition, work was going forward in the

construction of an information machine.

As a result of this trip, and following contacts with the work in other countries, the present International Conference was conceived and organized. James Rand financed another trip for Kent to the U.S.S.R. to arrange for Soviet participation at the meeting. Also, Rand Development Corporation provided travel grants for a number of participants from overseas.

I should also like to extend my commendations to Mr. Rand for his testimony earlier this year

before the Senate Committee on Foreign Relations, when he made some very important observations which were of inestimable value to members of that committee. In addition to submitting comparative figures relative to Soviet progress as compared to advancements in the United States in the science information field, he was also able to submit many additional facts relating to the problems of inter-exchange of information between the two countries, which he has done much to overcome in connection with his work.

I believe all of us can agree that Mr. Rand has performed an

important service to our nation in his attempts to arrange for the cooperative activity evidenced by this meeting. All of the participants are rendering an important service to world progress and peaceful cooperation by spending a week here in Cleveland to work out solutions to a very vexing problem.

You may have wondered when I would get to the theme of this talk -- "Knowledge is Power." Every business or government manager knows the extent to which his ability to make worthwhile decisions and to exercise control is influenced by the amount of

knowledge pertinent to a given problem that he may have available to him. The power of the individual to do good and useful work is influenced by his information resources. A company's power to do business in a competitive economy is directly related to the knowledge of significant market -- the "know-how" - and other factors that it has available to it. In the same way, the power of a country to maintain its competitive position economically, scientifically, militarily, is strongly influenced by the convenient availability of important information at the time when it can best be used.

The effective exploitation of intellectual resources is perhaps the most urgent problem of our times, for upon it depends the solution to many problems, including that of survival itself.

The truth of the epigram that "Knowledge is Power" is more apparent today than ever before, yet a disturbing paradox confronts those most vitally concerned with the production and use of knowledge. Until quite recently, it was axiomatic that a research project in any field should begin with a review of the literature in order to provide the basis for research

planning and to avoid wasted effort in duplicating previous work. Previously recorded knowledge was the most important single tool of the investigator. However, today, with the inability to lay hands quickly on essential information, therein lies the paradox. Because of the chaotic state of our documentation services, our stockpile of knowledge has become an embarrassment of riches and we find ourselves ignorant in the midst of a plethora of knowledge.

A solution to the problem of documentary chaos will be found only when it is recognized that this is a problem in "intellectual

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engineering," and that such engineering must be based upon a body of fundamental knowledge out of which sound principles of operation may be derived. Traditionally, the collection and organization of the records of knowledge has been the task of the social institution known collectively as the "library," and the library profession has developed, partly from philosophical principles and partly from pragmatic experience, a body of general principles and established methods.

Today, as I look over the program of the world's leading

specialists coping with the problems of documentary chaos, I find only two librarians - the remainder are, by training, chemists, mathematicians, engineers, linguists, philosophers, logicians, physicists, lawyers, physicians, statisticians, lexicographers, and computer designers. I am pleased to see that the team of specialists attacking this problem has grown.

In seeking a solution, the problems of maintaining a common language, both intellectually as well as technically, is of extreme importance. The international attention and participation of

this conference is most gratifying. I will leave Cleveland with a feeling of gratification that the problem of our documentation chaos is in good hands.

Returning again to the concept of knowledge as power, let us examine what we really mean by the word "power."

I believe that careful analysis reveals that knowledge gives man three types of power:

First, the power to comprehend. This is the realm of pure science and relates to the power of man to understand the Universe and man's place in it. It includes, as well, the comprehension of

natural law and the ability of man to understand his environment.

Next, we have the power to build. This is the realm of technology, and relates to man's power to build himself a better physical world. This includes better homes, better means of transportation and better instruments, generally, with which to enrich his life and add to his physical comforts and well-being.

Finally, we have the very vital power to harmonize. This is the realm of personal and group relationships, and relates to man as a social being and man in his

relation to other men both at home and abroad.

Now I think it is evident that the problems to which this Conference is addressing itself relate to all three of these powers. And I believe it is also evident that mastery over man's recorded knowledge is essential to his ability to comprehend his environment, to build for himself a better physical world, and to create a world that is free from tension and in which he can live in peace and harmony with his fellows.

It is primarily with reference to this third power that I have

addressed my remarks this evening.

Strife and conflict, both among individuals and among nations, are born of ignorance. Our ability to reconcile our differences, to resolve conflicts and to create an atmosphere of mutual sympathy and understanding is related directly to our understanding of each other and of each other's problems, ambitions and points of view. I believe it is well established that people who understand one another are not likely to make war against each other. It has long been established that most of the great power conflicts occur in the political arena and

arise out of misunderstandings, lack of knowledge of motives, objectives and backgrounds.

On the other hand, we have had much success in establishing mutual relations and understanding among nations in the intellectual arena. Notable among man's achievements toward international understanding is the field of science, which has long been regarded as international, and I believe that history demonstrates that scientists have, in their professional contacts, done much to destroy international barriers. Therefore, the realm of science is clearly an admirable bridge

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over which we can pass from a world of tension to a world of peace.

The recent work in the field of international health of the Sub-committee on Reorganization and International Organizations has also demonstrated this truth in that field, to a degree comparable to the accomplishments in the field of science, which have resulted in an acceleration of the work being performed by various public and private international organizations in both fields.

Unfortunately, however, increasing specialization in science

tends to create barriers across this bridge and to obliterate the bands of communication that scientists have long maintained with each other. To improve the flow of scientific knowledge, both within our own country and between our own country and the other powers of the world, I have urged the establishment of a Department of Science and Technology which would serve the cause of international science as I hope our Department of State serves the cause of international peace.

I believe we will all agree that international understanding

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and agreement are fundamental to the free sharing of knowledge. Conversely, the free sharing of knowledge is also fundamental to international understanding and agreement. However, such understanding and agreement cannot be achieved without a common basis of communication. To achieve such agreement we must teach ourselves to work together, to plan and to develop solid working relationships in which all of us must share responsibility and contribute to the whole, even if it means that we must surrender

something of immediate
benefit to ourselves for the
good of the group.

This Conference is a very
important forward step in the
achievement of vital inter-
national understanding as it
relates to the freedom of
man to pursue knowledge and
to share that knowledge with
other men. It is particularly
appropriate that these
meetings are being held in
Cleveland with Western Reserve
University as one of its sponsors,
for it is here that the United

States is making one of its more significant contributions to the communication and dissemination of man's recorded knowledge.

In conclusion, I believe we can all agree that knowledge is power - but it actually reaches its greatest heights and achieves its highest use when it is shared with others for the benefit of all.

Tonight we dedicate ourselves, not to man's enslavement of other men, or to a nation's conquest of other nations, but to the mastery of knowledge itself.

This Conference is the prologue to man's ultimate conquest of knowledge. This is a heavy burden and a lofty goal, but it is vital to our survival, and I am confident of success.

"KNOWLEDGE IS POWER"

By Senator Hubert H. Humphrey

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Last month, in a rare news conference in the Kremlin, Soviet Premier Nikita Khrushchev said that the object of his scheduled history-making visit to the United States next week, and the return visit later of President Eisenhower would be to find a "common language, and a common understanding of questions to be resolved,"

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apprenticeship as a professor -- at the University of Minnesota -- and in the pursuit of a scholarship in my field it became apparent to me that it was a major problem to resurrect and to exploit the information of interest to me that lay buried in books and journals whose contents were relatively inaccessible to the research scholar.

Later, the problem of utilizing recorded information faced me when I became Mayor of the thriving metropolis of Minneapolis. The importance of making decisions quickly became apparent to me when considering the drastic reduction in the time scale of information gathering for decision making and control during the past forty years. This change corresponds to increases in the rates with which competitive activity, changes in public opinion, and aggressive action can deteriorate economic, political, and military situations. In forty years, the time scale for information gathering for control by management has shifted from weeks to days, for machine operators from hours to minutes to seconds, and for automatic controllers from minutes to split seconds.

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As soon as I had the opportunity to do something about this problem I became **busy**. As chairman of the Subcommittee on Reorganization and International Relations of the Senate Committee on Government Operations, I was able to have the Committee staff study the library problem thoroughly, in connection with a bill that I introduced -- to create a Department of Science and Technology -- whose functions would be, among others, to take appropriate action toward --

"the development and utilization of mechanical aids and new devices for collating, translating, abstracting, indexing, storage and retrieval of scientific and technological information under the control of the Federal Government, and to coordinate such data as may be available from other sources."

Another function of the proposed new department would be --

"to establish rules and regulations governing the distribution of scientific publications as may be necessary to assure maximum utilization"

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pioneering research work in the field of machine literature searching and in mobilizing national attention on the problem through three national conferences which they organized, in 1956, 1957, again in 1958, and now the present conference.

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Other witnesses before my committee hearings represented various of the abstracting and indexing services in this country. In general, they described the heroic attempts that they are making to keep abreast of the mounting literature. Most of the editors of these services felt that they could more adequately cope with the literature situation if more funds would be made available to them. However, they apparently did not clearly envisage the need for mechanized systems for searching and correlating the literature. I had the distinct impression that these editors were convinced that their responsibility for solving the problem was limited to providing the conventional tools such as printed abstracts and indexes. Also, at least one editor of a major service in this country felt that the reports of Soviet advances in this field were somewhat overrated, and that they were not making as much progress as might be inferred from their writings.

When the witnesses from federal agencies testified, I detected that many of these persons were following the opinions of many of the editors of the abstracting and indexing services. There appeared to be a defensive attitude toward what they had done and an attempt to justify what they had not done.

I think that much of their attitude stemmed from the generally defensive attitude on the part of the executive branch of the Federal Government resulting from the electrifying discovery of the progress that the U.S.S.R. had been making -- and brought to public attention by the announcement of the launching of the first Soviet sputnik.

It was a curious experience to see two types of witnesses before my committee talk right past each other.

There were the users of scientific information who were, in general, frantic in their desire for better information services -- both with regard to desire for better coordination and coverage, and with regard to the development of better tools for exploiting the world's scientific literature. One survey reported at the hearings showed that industrial companies were engaged in supplementing existing services for abstracting and indexing of published literature. They reported that approximately 40% were incurring annual expenses of more than \$5,000, and only 4% of more than \$50,000, with the others expending from \$10,000 to \$35,000 annually.

The same survey showed that the median 1956 expenditure for professional societies in processing the published literature in their field for the benefit of their members was exceeded by almost 20% of the individual "user" companies that processed published literature for use by employees.

In the face of these costs, it was reported that 50% of the companies replying indicated that their internal literature processing expenses could be

reduced and the effectiveness of exploitation of the published literature enhanced by auxiliary services from various centralized sources.

It was also found that the user companies averaged about 10 abstracting and indexing services to which they subscribed. In this survey, 312 different abstracting and indexing services were identified -- a commentary on the fragmentation of secondary information processing services that have sprung up in a frantic and uncoordinated effort to control the burgeoning literature.

On the other hand, many of the abstracting services and federal agencies with responsibilities in this field were all for standing pat, or at least were proceeding with too much hesitancy.

A year after the first hearings had been held on the committee's proposed Science and Technology Act of 1958, the subcommittee held further hearings on proposals to create a Department of Science and Technology, and on a proposed commission composed of representatives from the legislative and executive branches of the Government and of members of the scientific community to determine whether or not a Department of Science and Technology would be desirable and, if so, what components of the Federal Government should be included therein.

The subcommittee also took this opportunity to review the progress that had been made in the field of documentation and machine retrieval within the year following its previous hearings. A considerable amount of testimony was heard outlining the progress that had been made within that period.

The tenor of the reports to the committee indicated that the actions taken in this field during the preceding year might be compared to similar progress, or lack thereof, over the previous five years.

As a direct result of the hearings, I cite the following areas where some positive action has resulted.

First, there was a stepped-up program of translation of Russian scientific publications, both within and outside of the Federal Government. There was also a greater effort made to pool translations so that there would be less duplication in having various groups work on identical translations.

Second, there was a stepped-up program of research and development in machine translation and machine searching, with the National Science Foundation acting to coordinate work in this field. In accordance with one of the objectives of the committee's bill, the proposed Science and Technology Act of 1958, one of the responsibilities placed on the Foundation resulted from the enactment of Public Law 85-864, which provided in part:

"Sec. 901. The National Science Foundation shall establish a Science Information Service. The Foundation, through such Service, shall (1) provide, or arrange for the provision of, indexing, abstracting, translating, and other services leading to a more effective dissemination of scientific information, and (2) undertake programs to develop new or improved methods, including mechanized systems, for making scientific information available."

In accordance with this provision of the National Defense Education Act of 1958, the National Science Foundation has entered into a contract and made a preliminary grant to the National Bureau of Standards for the operation of the program to be undertaken by the Science Information Service for the evaluation and development of existing programs in these fields.

During the past few years a number of other interesting developments have taken place, which have resulted in the improvement of the availability of scientific and technical information in the United States. The Western Reserve University Center of Documentation Research and Communication has been cooperating with the American Society for Metals and the General Electric Company in developing a system of coding abstracts that can be stored and searched mechanically, and have developed a machine for this searching purpose. This is an excellent example of cooperative enterprise by university, professional society, and industry which could lead to a usable mechanical search system of textual and graphic scientific and technical material. There are approximately 58 similar and promising ventures under way throughout the country, in which Federal agencies are participating in many instances (e.g., Air Research and Development Command, Air Force Office of Scientific Research, Office of Naval Research, National Science Foundation).

A third area of constructive action has resulted in the stimulation of non-Federal groups, who have advanced a number of serious proposals to create a program for the centralized, mechanized exploitation of the world's scientific and technical literature. One of these that has been brought to my

attention is the program of Western Reserve University, one of the organizers of this international conference. The pioneering Documentation Research Center of the University is working toward the creation of a "model center for the mechanized exploitation of the scientific and technical literature." As a matter of fact, this plan is now before the National Science Foundation for consideration. Many of my colleagues in the Senate and House of Representatives have evinced a keen interest in this proposed program, and my committee has endeavored to see that its full potential is evaluated and utilized as a part of the Federal support program. I shall be looking with interest at the outcome of this project.

Mechanical systems and devices are part of the broad pattern of scientific information services, and this pattern is in turn a part of the processes of science. In order to properly mechanize processes or to design systems, we must be able to specify in great detail just how it is to be done. Much of this research must draw on the combined skills of trained information specialists and librarians, linguists, logicians, mathematicians, statisticians, computer engineers, operations research analysts, philosophers, psychologists, behavioral scientists, and specialists in the different scientific disciplines.

Involved in these cooperative ventures are educational institutions (such as the University of Pennsylvania, Harvard Computation Laboratory, University of California, Massachusetts Institute of Technology, Stanford University, Cambridge Language Research Unit (England), Georgetown University, Columbia University, etc.) and large business concerns (such as

International Business Machines Corporation, Radio Corporation of America, General Electric Company, Eastman Kodak Company, Documentation, Inc., etc.) . While great progress has been made in these joint ventures, and while it can be safely stated that mechanical translation is possible, still I must caution that we have not yet reached the stage where we have either the system of machine to accomplish it rapidly or economically; much more research and development work remains to be done before we reach that point.

Scientific societies, long the backbone of strong scientific effort in the United States, are passing through a period of self-appraisal and are actively seeking improvement of their publications and their publishing techniques. For example, the American Society for Metals supports an experimental ~~mechanized~~ literature searching project at Western Reserve University; the American Chemical Society has a program of research within its Chemical Abstracts services; the American Institute of Physics has commenced a similar study of the entire physics communication problem; the biologists are reviewing their entire information mechanism, and among the steps they have taken to improve their communications is the formation of a Conference of Biological Editors and the planning of a central business and information office in the American Institute of Biological Sciences to coordinate and ensure data compilation activities of a specialized type; the American Physical Society has established an "express" journal, titled Physical Review Letters, as an experiment in rapid dissemination of short notes on current research in physics.

Another very important development in connection with the documentation program is the establishment of an Office of Documentation within the National Academy of Sciences. The objective of this new office is to advise and assist not only activities within the National Research Council to insure proper direction, but it is also proposed that it will work out a system of maximum participation of leading United States scientists and engineers in the program approved for support, in order to insure the highest possible contribution these leaders in the field of science can make toward the development of an adequate documentation center. The third objective of the Office of Documentation is to create an advisory board of scientists, whose abilities would be directed toward serving the National Science Foundation and non-Governmental groups working in the documentation field and to assist the National Science Foundation in determining the areas where Federal funds or grants could be best allocated toward achieving the maximum goals in the development of an overall scientific information and documentation program and center.

A fourth result of the hearings of the subcommittee of the Senate Committee on Government Operations has been the attempt to assess firsthand the scope of the Soviet effort in this field.

A great deal has been said about the efficiency and comprehensiveness of the Russian system of publishing scientific material in abstracts and making it available to Soviet scientists. They have developed an extensive organization, and are expending a great deal of energy in abstracting and

indexing scientific material from all parts of the world. In addition, they are exploring vigorously the possibilities of mechanical storage and search in mechanical translation. We must not discount their effort, but there are some areas where there is doubt as to the superiority of Russian progress. For instance, it can be pointed out that Chemical Abstracts, produced by the American Chemical Society, is universally acknowledged to be the greatest abstracting and indexing service in the world relating to the field of chemistry.

To illustrate the foregoing comparison, this year the American Chemical Society will produce over 130,000 abstracts of articles of interest to chemists; the Russians will produce less than 90,000. Further, Chemical Abstracts' coverage is better, and its entries are issued more rapidly than those of its Russian counterpart. The Russians have better coverage in other fields, such as biology; however, Biological Abstracts has increased its coverage by 33-1/3 per cent during this year, and for the coming year it expects to very nearly equal the number of entries produced by the Russians; the currency of Biological Abstracts entries matches that of the Russian service.

It should be noted that indexes to the abstracting services of the Russians are available only for occasional years, a factor greatly handicapping search of their abstract literature. Obviously, it would be very difficult to search through hundreds of thousands of abstracts without the benefit of good indexes such as are provided by the indexing and abstracting services of the United States. As one example of the never-ending search in this country

for better "finding tools" for more effective use of abstract publications, Chemical Abstracts is studying the feasibility of new types of indexes to supplement those already extant. Another is the formation of the National Federation of Abstracting and Indexing Services to effect better cooperation and to develop studies seeking better tools for the benefit of the scientists of this country.

In connection with these problems, the co-sponsor of this conference, the Rand Development Corporation, headed by James Rand, took a hand in financing a long visit by Western Reserve University's Allen Kent, to assess the U.S.S.R. accomplishments in this field. When he returned from this trip last year, he reported to my committee and advised us that the Soviet effort was indeed of significant magnitude, and that in many areas of abstracting and in research the machine searching and translation, the Soviet attack on the problem was of a most significant nature. He reported that about 500,000 scientific papers culled from the world's published literature were being abstracted under the direction of their Institute of Scientific Information -- a branch of the Soviet Academy of Science. The abstractors -- as in the United States -- were specialists in their fields and were contributing part of their time to this work. Furthermore, the Russians have organized an "Express Information Service" which took the cream of the published literature and long summaries of these were printed in Russian each week in 36 fields. In addition, work was going forward in the construction of an information machine.

As a result of this trip, and following contacts with the work in other countries, the present International Conference was conceived and organized. James Rand financed another trip for Kent to the U.S.S.R. to arrange for Soviet participation at the meeting. Also, Rand Development Corporation provided travel grants for a number of participants from overseas.

I should also like to extend my commendations to Mr. Rand for his testimony earlier this year before the Senate Committee on Foreign Relations, when he made some very important observations which were of inestimable value to members of that committee. In addition to submitting comparative figures relative to Soviet progress as compared to advancements in the United States in the science information field, he was also able to submit many additional facts relating to the problems of inter-exchange of information between the two countries, which he has done much to overcome in connection with his work.

I believe all of us can agree that Mr. Rand has performed an important service to our nation in his attempts to arrange for the cooperative activity evidenced by this meeting. All of the participants are rendering an important service to world progress and peaceful cooperation by spending a week here in Cleveland to work out solutions to a very vexing problem.

You may have wondered when I would get to the theme of this talk -- "Knowledge is Power." Every business or government manager knows the extent to which his ability to make worthwhile decisions and to exercise control is influenced by the amount of knowledge pertinent to a given problem that

he may have available to him. The power of the individual to do good and useful work is influenced by his information resources. A company's power to do business in a competitive economy is directly related to the knowledge of significant market -- the "know-how" -- and other factors that it has available to it. In the same way, the power of a country to maintain its competitive position economically, scientifically, militarily, is strongly influenced by the convenient availability of important information at the time when it can best be used.

The effective exploitation of intellectual resources is perhaps the most urgent problem of our times, for upon it depends the solution to many other problems, including that of survival itself.

The truth of the epigram that "Knowledge is Power" is more apparent today than ever before, yet a disturbing paradox confronts those most vitally concerned with the production and use of knowledge. Until quite recently, it was axiomatic that a research project in any field should begin with a review of the literature in order to provide the basis for research planning and to avoid wasted effort in duplicating previous work. Previously recorded knowledge was the most important single tool of the investigator. However, today, with the inability to lay hands quickly on essential information, therein lies the paradox. Because of the chaotic state of our documentation services, our stockpile of knowledge has become an embarrassment of riches and we find ourselves ignorant in the midst of a plethora of knowledge.

A solution to the problem of documentary chaos will be found only when it is recognized that this is a problem in "intellectual engineering" and that such engineering must be based upon a body of fundamental knowledge out of which sound principles of operation may be derived. Traditionally, the collection and organization of the records of knowledge has been the task of the social institution known collectively as the "library," and the library profession has developed, partly from philosophical principles and partly from pragmatic experience, a body of general principles and established methods.

Today, as I look over the program of the world's leading specialists coping with the problems of documentary chaos, I find only two librarians -- the remainder are, by training, chemists, mathematicians, engineers, linguists, philosophers, logicians, physicists, lawyers, physicians, statisticians, lexicographers, and computer designers. I am pleased to see that the team of specialists attacking this problem has grown.

In seeking a solution, the problems of maintaining a common language, both intellectually as well as technically, is of extreme importance. The international attention and participation of this conference is most gratifying. I will leave Cleveland with a feeling of gratification that the problem of our documentation chaos is in good hands.

Returning again to the concept of knowledge as power, let us examine what we really mean by the word "power".

I believe that careful analysis reveals that knowledge gives man three types of power:

First, the power to comprehend. This is the realm of pure science and relates to the power of man to understand the Universe and man's place in it. It includes, as well, the comprehension of natural law and the ability of man to understand his environment.

Next, we have the power to build. This is the realm of technology, and relates to man's power to build himself a better physical world. This includes better homes, better means of transportation and better instruments, generally, with which to enrich his life and add to his physical comforts and well-being.

Finally, we have the very vital power to harmonize. This is the realm of personal and group relationships, and relates to man as a social being and man in his relation to other men both at home and abroad.

Now I think it is evident that the problems to which this Conference is addressing itself relate to all three of these powers. And I believe it is also evident that mastery over man's recorded knowledge is essential to his ability to comprehend his environment, to build for himself a better physical world, and to create a world that is free from tension and in which he can live in peace and harmony with his fellows.

It is primarily with reference to this third power that I have addressed my remarks this evening.

Strife and conflict, both among individuals and among nations, are born of ignorance. Our ability to reconcile our differences, to resolve conflicts and to create an atmosphere of mutual sympathy and understanding is related directly to our understanding of each other and of each other's problems, ambitions and points of view. I believe it is well established that people who understand one another are not likely to make war against each other. It has long been established that most of the great power conflicts occur in the political arena and arise out of misunderstandings, lack of knowledge of motives, objectives and backgrounds.

On the other hand, we have had much success in establishing mutual relations and understanding among nations in the intellectual arena. Notable among man's achievements toward international understanding is the field of science which has long been regarded as international, and I believe that history demonstrates that scientists here, in their professional contacts, done much to destroy international barriers. Therefore, the realm of science is clearly an admirable bridge over which we can pass from a world of tension to a world of peace.

The recent work in the field of international health of the Subcommittee on Reorganization and International Organizations has also demonstrated this truth in that field, to a degree comparable to the accomplishments in the field of science, which have resulted in an acceleration of the work being performed by various public and private international organizations in both fields.

Unfortunately, however, increasing specialization in science tends to create barriers across this bridge and to obliterate the bands of communication that scientists have long maintained with each other. To improve the flow of scientific knowledge, both within our own country and between our own country and the other powers of the world, I have urged the establishment of a Department of Science and Technology which would serve the cause of international science as I hope our Department of State serves the cause of international peace.

I believe we will all agree that international understanding and agreement are fundamental to the free sharing of knowledge. Conversely, the free sharing of knowledge is also fundamental to international understanding and agreement. However, such understanding and agreement cannot be achieved without a common basis of communication. To achieve such agreement we must teach ourselves to work together, to plan and to develop solid working relationships in which all of us must share responsibility and contribute to the whole, even if it means that we must surrender something of immediate benefit to ourselves for the good of the group.

This Conference is a very important forward step in the achievement of vital international understanding as it relates to the freedom of men to pursue knowledge and to share that knowledge with other men. It is particularly appropriate that these meetings are being held in Cleveland with Western Reserve University as one of its sponsors, for it is here that the United States is making one of its more significant contributions to the

communication and dissemination of man's recorded knowledge.

In conclusion, I believe we can all agree that knowledge is power-- but it actually reaches its greatest heights and achieves its highest use when it is shared with others for the benefit of all.

Tonight, we dedicate ourselves, not to man's enslavement of other men, or to a nation's conquest of other nations, but to the mastery of knowledge itself.

This Conference is the prologue to man's ultimate conquest of knowledge. This is a heavy burden and a lofty goal, but it is vital to our survival, and I am confident of success.



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