THE ROLE OF SCIENTIFIC AND ENGINEERING SOCIETIES IN THE IMPROVEMENT OF SCIENTIFIC AND TECHNICAL INFORMATION

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1. Introduction

The daily work of a scientist or engineer involves the perception, processing and generation of scientific and technical information. It has been always so, but nowadays scientific research and the practical application of research results are assuming an unprecedented scope. Immense human, material and financial resources are being drawn into the realm of scientific and technological progress. There is growth in the network of research and design and development institutions, and in the numbers of research personnel. This process, which is intimately connected with the present phase of the scientific and technical revolution, is attended by a huge growth in the quantity of scientific and technical information. The reason is clear. Science is increasingly becoming a direct productive force. It is assuming leadership in the "science - technology - production" system. Capital investment in science proves four times as efficient as that in the expansion of production (1). It is not surprising therefore that growth of expenditure on science is a characteristic feature of the world today. Thus, the state investment in science in the USSR has increased more than 10 times over in the last 20 years. The number of research workers in this country has grown nearly eight times over in the same

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period, and amounts to over one million now, or nearly one-quarter of the world's scientists (2). Scientific institutions are growing as fast. In 1940 there were 2359 of them (including academic institutions) in this country, in 1960 there were 4196, and in 1972 as many as 5367. The numerical growth of research institutions was 786 - 1728 - 2697, respectively.

But the extensive pattern of scientific progress gives rise even now to factors which cause conflicting feelings. The conflict stems, on the one hand, from the tempestuous growth of human knowledge, and on the other hand, from the fact that people are not prepared to fully assimilate and utilise this knowledge just because of its enormous quantity and diversity. An expressive definition of this conflict is found in such frequently heard phrases as "information explosion" and "information hunger". The rapid growth of the amount of information has led to the researcher being unable to keep abreast of all the major developments in his field.

The actual losses for this reason borne by mankind, in spending enormous sums on duplicating research and development and on information retrieval, are great indeed. By American estimates, they make up 10 per cent of all the respective national allocations. Scientists spend 30 to 80 per cent of their working time on unjustified duplication (3), 72 to 76 per cent of applications for an invention duplicate those already known in the world practice. Moreover, the proportion of continuations grows every year. Thus, in 1946, 40 per cent of applications for the development and improvement of coal combines that were filed in the USSR proved to be continuations and in 1961, 85 per cent (4). Attempts of scientists and engineers to avoid duplication in research and development are paid for by increased spending on more detailed reviewing of scientific and technical information. Time losses incurred in information retrieval also add up to an impressive figure - more than 30 per cent of the scientist's working time, and this quantity tends to increase. On the other hand, by the estimate of a Czech scientist, L.Ořig, a complete utilisation of scientific and technical information would cut research costs by 60 per cent (5).

Indeed, losses are high even now and in the future they may assume a dangerous proportion. Thus, it has been estimated (4) that the volume of unutilised potentially useful information grows as the square of the number of scientists, which is doubled every 10 to 15 years.

In this light it becomes clear that new patterns should be sought in the management of science that would foster its intensive rather than extensive development. Specifically, solution for the problems of scientific and technical information arising from its quantitative growth, the problems of information crisis should be sought in the elaboration of essentially, conceptually new approaches. It would seem advisable to single out two such approaches which are being implemented in this country.

One is concerned with the establishment of large-scale organisational mechanisms that could serve as bases for building knowledge processing systems. It envisages specialised information systems (centres) or formations which will be more powerful than today's ones. One specific application of the philosophy behind this approach is the Unified Scientific and Technical Information System (USTIS) which is being developed in this country. What has been developed so far is the State Scientific and Technical Information System comprising 11 all-Union centres, more than 80 sectoral ones, 15 republican institutes and more than 70 inter-sectoral centres which are based on nearly 10000 information departments and units in industry and in offices. This is a powerful apparatus which is being continuously improved.

Another and no less important approach consists in finding and applying to information problems those vast resources of the society which cannot be fully realized within the framework of formal state-run mechanisms.

The daily contacts between scientists, lectures and talks, seminars and symposia, schools and conferences, personal initiative in the matters of creative evaluation of research findings, their criticism and promotion - mechanisms of this kind have evolved in society in a natural way, in response to the demands of life. However, these processes are being carried out on such an extensive scale even today that their contribution to total effort of the processing and utilisation of human knowledge is becoming ever more substantial. In this country, the organisational medium which gives rise to, directs and improves, the different kinds of scientific ~~and~~ information interchange is furnished by the Scientific and Engineering Societies (SES).

2. The evolution, nature and scope of the USSR's SES system

The Scientific and Engineering Societies in the USSR are voluntary mass organisations of engineers, technicians, researchers, agricultural specialists, and innovator workers. Their history is inseparably linked with the evolution and development of science and industry in this country.

The first large public scientific and engineering organisation in Russia was the Russian Engineering Society, which was established in St.Petersburg in 1899 on the initiative of progressive scientists and engineers. By the end of the 19th century Russia had about a dozen scientific and engineering associations grouped by subject field. From their very inception the societies provided a forum for discussing major developments in the science and technology of their day. Thus, in March 1869 a meeting of the Russian Physico-Chemical Society heard the eminent Russian chemist D.I.Mendeleev deliver a report on his periodic system of the chemical elements; on the 7th of March, 1895, A.S.Popov demonstrated the world's first radio apparatus at a meeting of the Physics Division of the same Society. Among those who spoke at the conferences of the Societies were such outstanding figures of Russian science as metallurgist D.Ch.Chernov, shipbuilder A.I.Krylov, physicist A.F.Ioffe, and others.

During the very first years of Soviet power the Societies received the nationwide recognition and complete support of the Communist Party and Soviet Government. A Decree of the Council of People's Commissars, signed by Lenin in August

1921, envisaged measures to be taken to raise the level of scientific and engineering knowledge in the country, set up scientific and engineering societies and bring engineers and technicians nearer to the working class in their practical activities. By enlisting the mass of the people to participate in the SES activities, essentially new conditions for their functioning were brought about. The need arose for coordination and management of SES activities. In 1954, the SES were re-organized according to the sectors of the national economy, and the All-Union Central Council of Trade Unions was charged with their management.

The membership of the SES system today embraces more than 7 million persons. Tens of thousands of enterprises and institutions are its corporate members. The All-Union Council of Scientific and Engineering Societies joins together 23 sectoral SES, which lean in their activities on 2,040 republic, territory, and regional SES boards and 40 homes of technology. Scientific and engineering societies publish, on their own or jointly with ministries and departments, 73 scientific and technical journals. These include such popular and scientific-technical journals as Radio Engineering, Electricity, Instrument Making, Machine Building, Mining Journal and others. Besides, the All-Union Council of SES publishes the journal Technology and Science. The structure of the SES system is given in Fig. 1.

By way of illustration we shall describe the A.S.Popov Scientific and Engineering Society for Radio Engineering, Electronics and Radio Communication which is among the largest scientific and engineering societies of the Soviet Union. Its origin dates back to the Russian Society of Radio Engineers. The Society has 354,000 personal members and comprises 42 sections, 4 commissions, 136 republic, territory and regional boards, 202 People's Universities of Scientific and Technological Progress and Economic Knowledge. Active amoung the Society's members are leading Soviet scientists: Academicians A.I.Berg and B.A.Kotelnikov, Corresponding Member of the USSR Academy of Sciences V.I.Siforov, the Society's President, and others. The two journals published by the Society, Radio Engineering and Electric Communication, enjoy great popularity.

The Society holds biannual competitions for the best papers in radio engineering, electronics, and communication. The winners are awarded the A.S.Popov Golden Medal, which was instituted by the USSR Academy of Sciences. The Society maintains close ties with scientific and engineering societies abroad, exchanges delegations and work experience. It makes a massive contribution to the entire SES system in the USSR.

The scope of promotionary and rationalisation activites of the SES System is great indeed. During the five-year period of 1968-1973, the Societies conducted 750,000 training courses, seminars, advanced practice schools, which were attended by a total of 16 million persons. Some 3 million lectures and reports were delivered which were heard by 84 million persons. The practical application of the proposals made by the primary SES units resulted in a saving of 5,500 million roubles.

The above figures point to the substantial contribution of the SES towards the popularisation and utilisation of scientific and technical knowledge in the national economy. We should like, however, to dwell on those fundamental aspects of the SES activities which determine its role in the perfection of scientific and technical information and cannot be described by figures alone.

3. SES role in perfecting scientific and technical information

3.1. SES and scientific and technological progress

The principal aim of improving information work is to accelerate scientific and technological progress and to raise the efficiency of production. Therefore, speaking of the role of the SES in this context it is necessary to outline the special features of scientific and technological progress as they naturally affect SES activities.

An important characteristic of scientific and technological progress is the rate or renovation and extension of production nomenclature, or, as an economist would say, renovation of components of the commodities and services vector. Renovation of products nomenclature results from the application of scientific discoveries and inventions. The transformation of scientific results into new products is, in Marx's felicitous expression, the process of objectivation of knowledge. Thus, the rate of objectivation of knowledge is the main characteristic of scientific and technological progress.

The steady acceleration of the pace of scientific and technical progress can be illustrated by the reduced time lag between the appearance of a well substantiated idea of a possible new development and the implementation of this development in the production and consumption spheres of the economy. To illustrate, the principle of photographic image, which was discovered in 1725, took 100 years to be implemented in practice; commercial electric motors appeared 60 years after a theory was developed for their operation; the radar was constructed 15 years after the effect of radio wave reflection was discovered; the nuclear reactor took 10 years to be built; transistors appeared in the market 5 years after the semiconductor theory was developed.

The objectivation of knowledge consists of several stages: basic research; applied research; technological proposals; development projects; preparation for production; output of new products.

Scientific and technological progress continuously gives rise to new types of technical systems and devices. The type of a technical system (e.g., cars and trucks, diesel locomotives, aircraft etc.) is a rather stable and durable category. Once emerged, a technical system type will go on developing in the form of progressively better models which will replace each other within the given type. This circumstance suggests the notion of the life cycle of a model, from its origination to its death - being put out of service in the economy, or out of supply for sale to consumers. Fig. 2. shows a life cycle diagram which represents the process of implementation of an idea of a technical system until the commissioning of this system and later discontinuing its manufacture. The dynamics of life cycle planning is given in Fig. 3. The special role of basic research in scientific and technological progress should be emphasised. It is basic research which is the primary source of drastic renovation of components of the commodities and services vector. One can quote a number of new technological and industrial fields which owe their origins to basic research results: atomic engineering and industry, rocket and space technology, computer machinery, semiconductor technique and microelectronics, lasers, microbiological industry, new materials, man-made diamonds, and so on, and so forth. It is basic research that generates new and original technical concepts which are adopted when new technology and processes are developed. The role of basic research is thrown in sharp relief by the following mental experiment. Just suppose that 20 or 25 years ago all research on solid state physics were stopped. Then, clearly, in the 70's we should not have advanced beyond valve electronics and radio engineering. The special role of basic research is reflected in the higher growth rate of allocations for basic research among the total research and development spending throughout the world. Recognising the primal importance of basic research for scientific and technological progress, the 24th CPSU Congress directions defined the furthering of basic and applied research as one of the tasks of the national economy development during the 9th Five-year Plan period.

All this has a direct bearing on the major task of information support to research and development dynamics in which the SES have an active part to play. We are speaking of the dissemination of basic research results among the sectoral applied research institutions and design bureaux. This task is even more important than the information service to basic research proper, even though it generally lags behind the information service to applied research institutions and experimental design bureaux. Moreover, the dissemination of basic research results among sectoral institutes and design bureaux tends to improve the originality of their technical solutions. (At present original solutions account for only 5-10 per cent of the total). This kind of information support would require the use of classification which may proceed in its design (extension) from the scientific disciplines (like the UDC), or purposes, tasks, or problems. A discipline-oriented classification is examplified by a fragment of the science tree for "Mechanics" which is shown in Fig.4. This kind of a classification helps represent graphically the differentiation of science: the lower level shows themes that may in future become separate research fields.

Integration of science, on the other hand, can only be represented by a classification proceeding from purpose, task, or problem. In this case the initial purpose is decomposed into an hierarchy of special purposes and tasks in which the adjacent levels are linked by the "purpose - means" relation and the lowest level is reprsented by the totality of basic research projects.

A purpose-oriented classification shaped as a tree is not complete in that it does not recognise the simple fact that an applied research project presupposes a whole spectrum of basic research results, or the fact that the findings of one applied research project can be utilised in several development projects. Relations of this kind transform mission- or problem-oriented classificatory trees to hierarchical graphs by which relations between fundamental sciences can be represented as well, i.e. the necessary integration can be achieved.

An hierarchical graph is illustrated in Fig.5. The graph exemplifies the decomposition of a large initial purpose into an hierarchy of specific purposes and tasks, the purposes and tasks of any of the lower levels being the means for achieving the higher level purposes. Therefore, the adjacent levels of the hierarchical graph are linked by "purpose-means" matrices. If, for example, the level following the general goal is regarded as the set of economy tasks $P = \{p_1, p_2, \ldots, p_n\}$ in a field (sector) which, when fulfilled, lead to the achievement of the general goal, then the next level will be the level of the development projects which must be completed to fulfil the tasks P. The set of development projects in Fig. 5. is denoted by Q, $Q = \{q_1, q_2, \ldots q_m\}$. The effect produced by design work q_1 on the solution of the problem p_j can be estimated by a quantity which will be denoted by γ_{ij}. The matrix of coefficients $C = \| \gamma_{ij} \|$, $i=1, \ldots, m$, $j = 1, \ldots, n$ is a matrix of association between the purpose P and the means of achieving it, Q. In a similar fashion, the matrix $B = \| \beta_{ij} \|$ $i=1, \ldots, l$, $j=1, \ldots, m$ will define the association between the set Q and the applied research set R, $R = \{r_1, r_2, \ldots r_e\}$, which is the means for achieving the purposes Q. Since some applied research projects cannot be initiated until results have been obtained from basic research projects, the set of which is denoted by S, $S = \{s_1, s_2, \ldots s_k\}$, applied research forms purposes for basic research, and the association between these sets is given by the matrix $A = \|\alpha_{ij}\|$ $i = 1, \ldots k$, $j = 1, \ldots l$. The effect or contribution coefficients α_{ij}, β_{ij}, γ_{ij} can be found with sufficient reliability by expert judgments. Once this has been done and the national economic tasks have been ranked by order of importance, i.e. the vector $P = (p_1, p_2, \ldots p_n)$ has been defined, the vectors of importance coefficients of design work, applied and basic research are defined by the formulae

$$Q = C \cdot P,$$

$$R = B \cdot C \cdot P, \text{ and}$$

$$S = A \cdot B \cdot C \cdot P$$

Thus, we can trace in quantitative terms the importance of basic and applied problem solutions for national economic tasks which is essential for resource planning and allocation in the research and development field.

It should be emphasised that the same systems analysis philosophy underlies both the integration of sciences and the program-goal planning and management. An hierarchical graph is formed by means of systems analysis of the conditions for achieving some large-scale purpose. This is a complicated and laborious task for which a broad range of highly competent experts must be enlisted. Forms and procedures for selecting and functioning of research teams that would carry out this expert work systematically have not become established so far. This is not due to methodological problems alone. Organisational problems are also important. State-run organisations cannot rely in their activities on such informal, ad hoc groups as the expert panels, set up anew with each problem. The country's SES system seems to be the best environment for developing such flexible, problem-oriented groups.

Science has accumulated considerable experience in the practical application of systems methods to the analysis of complex interrelations in science. A case in point is the work on an information system for malignant tumours commissioned by the World Health Organisation. It has been a joint venture between the USSR Academy of Sciences Institute for Management Problems, the USSR Academy of Medical Sciences Institute of Experimental and Clinical Oncology, and the International Institute for Applied Systems Analysis in Wien, Austria (7). During this project experts have formulated a list of research themes which are being elaborated throughout the world on the problem area "Malignant Tumours". From this list a graph of relationships between research themes was built. This graph is shown schematically in Fig. 6. The effect of each theme on the others is represented by the link between the node i, (i = 1,2,..., 124) and the node N_i, where by N_i is meant the totality (list) of themes dependent on the theme i. Because of the complexity of the graph thus built it defies direct analysis. An attempt to simplify the graph by aggregating its nodes on the basis of the conventional classification "by science" leads to a graph having 13 nodes, since the above list of 124 themes can be represented at a higher level of the classificatory tree by 13 research problems:

1. Tumour cell biology and biochemistry,
2. Virus carcinogenesis,
3. Chemical carcinogenesis,

4. Radiation carcinogenesis,
5. Tumour immunology,
6. Tumour-body relationship,
7. Tumour morphology,
8. Malignant tumour diagnostics,
9. Experimental and clinical chemotherapy,
10. Surgical treatment,
11. Radiobiology and radiation therapy,
12. Epidemiology and malignant tumour statistics,
13. Cancer fighting.

By way of illustration, let us explicate the subject scope of Problem 7.

7.1. Tumour histogenesis, classification and nomenclature;

7.2. Structural-functional characteristic of pre-tumour and tumour processes;

7.3. Therapeutic tumour pathomorphosis;

7.4. Refinement of techniques and procedures for morphological investigation of tumours (histochemical, immunomorphological, electron-microscopic, etc.);

7.5. Organisational aspects of the morphological tumour research (establishing data banks, reference centres, etc.);

7.6. The problem of pre-cancer period (diagnostics, morphological, clinical, and organisational aspects).

A simplified graph is shown in Fig. 7. It is still quite complex for analysis.

The research team headed by Professor A.M.Petrovsky at the Institute for Management Problems, USSR Academy of Sciences, has developed computer algorithms to simplify the initial graph by recognizing the real information links between research themes. The aggreation of graph nodes achieved by these procedures differs significantly from the conventional one. The graph thus built is shown in Fig. 8. Each of the eleven nodes unites a number of themes (their number is given in parenthesis) of the initial list which are strongly linked among themselves but weakly connected with the other themes. This property of the theme list is represented in Fig. 8.by an arc which begins and ends at the corresponding node. Some lists have the property of weak internal link between the themes, but strong connection with themes in another list; for example, pairs 5-9 and 6-7. To illustrate, we shall describe the subject scope of List 1, while preserving the original numbering of the themes (the first figure stands for problem number, and the second, for theme number within the problem):

1.1. Structural-functional features of the tumour cell genome at the molecular and chromosomic levels.

1.2. Molecular-biological mechanisms of the post-transcriptional realization of genetic information in a tumour cell.

1.7. Genetic engineering rectification of the defects responsible for cell malignisation;

2.5. The mechanism of interaction between tumour viruses and the cell at the molecular level;

2.7. Interaction of viruses with other carcinogenic agents;

3.6. Mechanisms of interaction between chemical carcinogens and the cell at the molecular level;

4.3. The genetic and epigenomic mechanisms of radiation carcinogenesis;

7.2. The structural-functional characteristic of pre-tumour processes;

9.5. The molecular mechanisms of tumour cell injury during chemotherapy.

This methodology proves to be highly effective in identifying interconnections between research projects and in designing information systems, as it reveals the nature and extent of informational associations between research projects.

3.2. The logical information analysis of the knowledge level

It is a well known fact that scientific-information activities consist of:

- firstly, a variety of information services, which include the dissemination of the so-called secondary information, and

- secondly, the logical information analysis of the level of knowledge, or the extraction of data from original documents, their processing and assessment.

While the former aspect of the information work is most effectively realized within the State Information System, the second aspect, namely the classification and analysis of knowledge level, seems to emphysise the role of scientific and engineering societies.

We have spoken of the scope of the SES promotionary activities, so it remains to be mentioned now that as a matter of fact the entire lecturing work of the SES is associated with the transfer of scientific knowledge to the audience of engineers and technicians; this transfer involves a logical-information analysis of this knowledge.

The SES play a major role in developing the so-called recommendatory information for institutions and individuals responsible for administrative and scientific and technical management at all levels of economy. Recommendatory information includes summaries and forecasts, reflects development trends, indicates alternative solutions, and the predictable consequences of each alternative. Recommendatory information is compiled by most competent members of the SES - prominent scientists, highly skilled specialists, talented engineers, - who can critically and in full awareness of their reponsibility analyse the material that has been selected, without missing any details which may be very significant indeed. The importance of this line of SES work cannot be overestimated. It permeates all the areas of this country's economy. It is noteworthy that in drawing up long-term national economic development plans SES's suggestions are considered and taken into account by the government bodies.

In 1973, a special committee headed by Academician A.N.Nesmeyanov which was formed by the State Committee of the USSR Council of Ministers for Science and Technology having analysed the SES activities highly appraised the proposals worked out by the SES and came to the conclusion that the Societies should be requested to initiate a periodical to be titled "Survey of SES Scientific and Technological Proposals and Recommendations". At the same time the committee pointed to the need for close collaboration between the SES and the national planning authorities.

5.3. The role of the SES in developing a system for inter-sectoral exchange of scientific and technical information

Information analysis is a traditional line of activity with the SES. It is worth mentioning that the SES can and should encourage information synthesis. What we refer to is the development and utilisation of essentially new techniques of knowledge organisation and dissemination.

In the development of novel technologies, experimental work, process improvement, capital construction, and factory reorganisation, known and tested solutions in different combinations are used as well as new technical solutions. Such technical solutions and their combinations may be familiar to one field or department but quite unknown to the adjacent ones. So there still remains the problem of dissemination of information on technical solutions and of tailoring it to development plans, reconstruction, capital construction, and process improvement. This problem can be solved in a centralied way by developing suitably updatable data banks of original and technical solutions. It can be also solved in a decentralised way by enlisting the participation of the SES, and in this sense it is similar to the sectoral and inter-sectoral problems of advanced know-how sharing. It would be appropriate to mention here that in both cases this work cannot be completed without the participation of competent and skilled specialists who are the core of SES membership. The attention that information specialists pay to raising the effectiveness of inter-sectoral information exchange is accounted for by inter-sectoral information being a considerable portion in the general flow of data. According to rough estimates, the proportion of inter-sectoral information in the total amount processed by the national scientific and technical information system ranges between 75 and 80 per cent (8), and it tends to grow. Here is one more example. In 1972, the All-Union Institute for Inter-sectoral Information (VIMI) circulated a newsletter reporting on cutters which provided for a ten-fold increase in cutting speed (10). More than 60 enterprises took an interest in the innovation, but none of them under the authority of the department in whose framework the tools had been developed. One could cite numerous other examples of this kind.

Because of this high importance of inter-sectoral information exchange, a remified network of inter-sectoral territorial information units has been developed within the State Scientific and Technical Information System (10). The VIMI and the All-Union Scientific and Technical Information Centre (VNTITs) play a major part in this system. The data bases accumulated by these institutions can, in respect of both size and scope, provide a groundwork for an inter-sectoral data bank wich would be similar, say, to the VOSKHOD data bank (11) designed to maintain an active inter-sectoral exchange of planning and economic information. It should be noted in this connection that the effectiveness of such data banks depends not so much on their size as on the organisation and quality of the data accumulated in them. Therefore, the participation of the SES both in information supply and in development of the guidelines for this work is essential to the success of this kind of undertaking, because it is precisely within the SES that the most active and skilled scientific and engineering personnel can be found, capable of viewing their tasks from an all-national rather than departmental position. It would be in order to recall at this point that, recognising the importance of tasks in improving scientific and technical information now facing the SES, the Praesidium of of the All-Union Council of Scientific and Engineering Societies decided in June 1974 to establish the Council Committee for Scientific and Technical information and defined the development of inter-sectoral information exchange as one of its primary tasks.

3.4. The role of the SES in communication

The urge to communicate, to exchange views is inherent in man generally, and in the scientist particularly. In the first place this fact was central to the establishment of the SES and their further progress. While in administrative, state-run systems the inter-personnel contacts are usually predetermined and standardised, the SES system throughout its history has laid an emphasis on informal communications. Therefore, the role of the SES in the organisation of information contacts among scientific workers cannot be overestimated. The importance of conferences, symposia, people's universities, schools of advanced practices, scientific and technical journals, homes of scientific and technological popularisation, and simply lobby interviews is great indeed. Some sociological studies point with certainty to a primary importance of informal factors in information exchange.

We have already quoted some data describing the scope of the SES promotional activities. Homes of Scientific and Technical Popularisation and Homes of Technology play a major part in this work. Thus, the F.E.Dzerzhinsky Home of Scientific and Technical Popularisation in Moscow conducts extensive work on the organisation of seminars, lectures delivered at factories and offices, lectures on the topical problems of today (e.g. "Operating systems of present-day computers" etc.). The basic unit of the Home is the section. There are 20 of them. All sections are sector-oriented, except the one for applied problems of cybernetics. The sections conduct regularly consultations for inventors and innovators, exhibitions of Soviet and foreign equipment (FRG packing, French console equipment etc.). Each year more than 100,000 persons take part in the Home's activities.

A few words about the periodicals that the SES issues independently or jointly with sectoral agencies. There are 73 journals associated with the SES. Here are a few examples.

The Mining Journal. This is one of the oldest journals. It was founded in 1825 and today has a circulation of 17,000 copies. The journal devotes its space to problems of design methodology, new achievements, advanced practices.

The Electricity. The journal was founded in 1880. Its circulation is around 9,000-10,000 copies. The following organisations take part in its publication: the Central Board of the Scientific and Engineering Society for Power Engineering and Electric-power Industry, the USSR Academy of Sciences, the State Committee of the USSR Council of Ministers for Science and Technology. The journal gives its space to matters of the theory of electrical engineering, surveys of latest advances, discussions on topical problems in science and technology, historical essays, papers by leading Soviet and foreign scientists.

The Journal of the Mendeleev All-Union Chemical Society. The journal was founded in 1956. It publishes papers on the Society's work, problem papers, collected articles on a subject Thus, in January 1975, the journal published a paper on the organisation and activities of the American Chemical Society. Papers by foreign chemical scientists are translated.

Thus, past experience has been brought to bear on the specific forms in which the ideas of scientific contacts have been implemented within the Societies. The present-day level of technological development equips humanity with new and powerful communication media: cinema, radio, television. The computer will probably become the technical basis for the communication facilities of the future. Even now attempts are made to develop computer networks serving broad user communities which operate on a developed data base and represent a kind of intermediary between the scientists and the collective human knowledge. The implementation of this programme will raise by an order the effectiveness of scientific and other intellectual work, and will be a real means for overcoming the information crisis.

Let us now point to some problems which are being dealt with by the SES either directly or through the influence they have on personnel at the appropriate departments and institutions.

1. One such problem refers to the previous question of the information support to the development process dynamics. The notion of life cycle makes it possible to introduce the so-called total planning - from the inception or generation of the idea of an innovative technology until its series produc-

tion and marketing. This poses the problem of information support to the entire total development plan and of tailoring information to the individual steps of the plan. It is precisely in the interest of accelerated practical application of scientific results that science-production associations are being developed nowadays. It raises one more aspect of the information support to the research and development dynamic

2. One useful activity of SES members is participation in the drawing up of scientific-technological forecasts. The USSR Academy of Sciences has gained sufficient experiences in scientific and technological forecasting, both standardisation- and research-oriented. A brilliant illustration of standardisation-oriented forecasting is furnished by the man-machine system for computer technology forecasting which has been developed at the Institute of Cybernetics, Academy of Sciences of the Ukrainian SSR. The simpler methods which have been used by the USSR Academy of Sciences will normally include both aspects of forecasting, standardisation- and research-oriented, but forecasting will begin in all cases from the building of classificatory trees or graphs which have been mentioned before. In making a forecast, foreign future-oriented documents (planning documents laying down the technological policy of a nation, concern, company, economic sector) should be traced as well as the facts of the future announced in these documents. The somewhat less important but numerous patent information should be also taken into account (e.g. approximately 10,000 patents are issued every year on aircraft alone). Patents call for a very careful selection, as they may be "paper", "scarecrow", "obstructive", "nuisance", "provocative", "misleading" etc.

3. One of the major tasks for the forthcoming Five-year Plan period is the development of a national automated scientific and technical information system and, correspondingly, the development of the Unified Scientific and Technical Information system as part of the national economy management system. Here the key problems are the choice of the right direction and the clear functional differentiation between the Unified System and the other national economy management systems. Anyway, the technical re-equipment of the scientific and technical information service through large-scale computerisation is a necessary and inevitable development. However, the wide use of computer technology, if both aspects of information work are considered, faces us with great problems indeed. Automating the first aspect of information activities presents no problem, since the computer provides a good back-up for on-line document retrieval systems, generation of bibliographies, a variety of secondary information products, and retrieval of specific documents on demand. The situation is much more complicated as regards fact retrieval systems which are necessary for automating the second aspect of information work, where the facts pertaining to a problem must be extracted from documents and ordered. In this case the computer is required to handle semantic text analysis problems, which are largely beyond its capabilities as yet. This problem is being worked out within the framework of the line of research known as artificial intelligence. Speaking about outlooks, an information retrieval system of this kind is supposed to provid for man-computer dialogue in a language which would be close to the natural one. The computers are supposed to have randomly structured data bases, the file structures being developed by

deduction procedures. In this connection, the automation of the second aspect of information work should proceed primarily along the line of using information graphs and matrices, which have been discussed before. Data banks will in this case be list-structured since the classification itself will be in the shape of a list. All this will require, however, considerable preliminary work on the classification and structuring of scientific and economic tasks and problems.

In assessing the results of the SES activities towards improving information work and the topicality of the tasks being handled by the SES it can be stated with confidence that the USSR's SES system is an effective means for accelerating scientific and technological progress, for active application of scientific advances in this country's national economy.

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