

Review of the US/USSR Agreement on Cooperation in the Fields of Science and Technology

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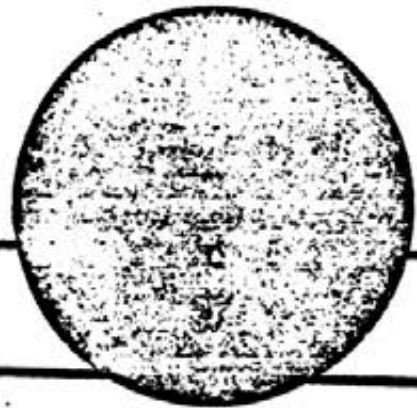
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Review of the US/USSR Agreement on Cooperation in the Fields of Science and Technology



Board on International Scientific Exchange

Commission on International Relations

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Board on International Scientific Exchange
Commission on International Relations
National Research Council

NATIONAL ACADEMY OF SCIENCES
May 1977

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the Committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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*This section will be provided by the Panel at a later date.

I

PREFACE AND INTRODUCTION

May 24, 1977 marks the expiration date of the five-year U.S./U.S.S.R. Agreement on Cooperation in the Fields of Science and Technology (S&T). This study is the response of the National Academy of Sciences (NAS) to a March 28, 1977 request by Dr. Frank Press, President Carter's Science Adviser and Director of the Office of Science and Technology Policy (OSTP), for assistance in evaluating the benefits from this Agreement and in establishing the form of the renewal. To be useful to him the report has to be submitted May 9; one week is the bare minimum for the Academy review procedure before delivery of the report. Thus, five weeks were available for determining the approach, choosing the study participants, obtaining information, and writing the report.

Government officials involved in the activities under the Agreement testified in November 1975 to the Subcommittee on Domestic and International Scientific Planning and Analysis of the Committee on Science and Technology (U.S. House of Representatives)--Thornton Committee. At Appendix B is a copy of pages 1-4 of a document including the 9 Recommendations which resulted from the Hearings before this Subcommittee. The Recommendations are found in a Congressional Committee Print entitled Review of U.S.-U.S.S.R. Cooperative Agreements on Science and Technology (Special Oversight Report No. 6, November, 1976). A reading of the very useful report of the Hearings on which it was based suggested that little additional would be gained by similar inquiry by the present Panel. It was decided to go to the primary source of information on the program--by talking in an organized fashion with a large fraction of the 250 U.S. scientists and technical people who have participated in this program as visitors to the Soviet Union or as both visitors and hosts to Soviet participants.

In order to gain a candid view of the goals of the Agreement, we solicited remarks from two of the prime movers--Dr. Norman Neureiter and Mr. Herman Pollack. We include elsewhere in this report the views of Dr. Egon Loebner, Science Counselor at the U.S. Embassy in Moscow from 1974 to 1976, who had responsibility for this Agreement at that end.

A principal limitation of our approach is the total absence of any current data from the Soviet side as to their views of the benefits and disadvantages of the Agreement. But we could not realistically have obtained dependable data of this type in a year, much less two weeks. The Soviet view will underly their position in the negotiation and conduct of the second five-year Agreement, and it is their actions

which are important to the U.S., not the views which may be held (whether or not they could have been elicited) by Soviet participants.

A further limitation, which became more apparent as the report was written and reviewed, lies in the narrow scope of our charter and of our interpretation of it (in order to be able to respond within six weeks) which limited our evaluation to the S&T Agreement itself, with no substantive review of the companion U.S./U.S.S.R. bilaterals or of the "Article 4" agreements between U.S. firms and Soviet entities. The U.S. government provides little if any financial support for these Article 4 industrial agreements, and this is the primary reason we excluded them from our brief review; but most of the industrial interaction probably takes place in this way, and the U.S. government may have some legitimate interest in reviewing such activities either in totality or by sampling.

It would have been difficult, if not impossible, for the Board on International Scientific Exchange (BISE) of the National Research Council's (NRC) Commission on International Relations (CIR) to undertake the present quick-response study if BISE had not already been involved in a similar, ongoing, related study. For roughly the last two years, there has been another BISE Panel (chaired by Professor Carl Kaysen) with the task of conducting an evaluative assessment of the now eighteen-year old program of exchanges between the National Academy of Sciences and the Academy of Sciences of the U.S.S.R. The experience and expertise garnered by BISE and the Panel which is reviewing the interacademy program has been of crucial importance in enabling and assisting the conduct of this study of the S&T Agreement. The "discussion outline" devised to guide interacademy-exchange participants in providing data to the Kaysen Panel served as a foundation for the present Panel's technique of prepared telephone interviewing.

It is expected that the Kaysen Panel report will be transmitted to the National Science Foundation early in June of this year. We feel that the reports of these two Panels of BISE will usefully complement each other.

It is evident that this Panel worked willingly and intensely, that our Special Reviewers in the fields of the various Working Groups in general expended much effort to obtain the primary data, and that the NAS report review procedure was put to a severe test. We are also greatly indebted to the staff of the Commission on International Relations of the National Research Council, which carried much of the burden of this activity.

We are also indebted to the many individuals in the government and outside, who generously gave us their time and best efforts to help respond on this time scale.

RICHARD L. GARWIN
CHAIRMAN, BISE Review Panel
of the U.S./U.S.S.R. Agreement on
Cooperation in the Fields of
Science and Technology

II

EXECUTIVE SUMMARY

Important conclusions or recommendations are assembled here for the convenience of the reader. Introductory material necessary to an understanding of these conclusions and recommendations is found elsewhere in the report.

1. CONTINUATION OF THE AGREEMENT. In view of the positive benefits and real interaction evident in some of the projects under the Agreement, of the intangible and unevaluated (but widely felt) non-substantive benefits commented upon by the participants, of the benefits unevaluated by us from the ten other bilaterals in part inspired by this Agreement and from the direct contacts through Agreements made under Article 4, the Agreement should be renewed. Some modification in structure and procedure are recommended to improve the cost-effectiveness to the United States.

2. MANAGEMENT FOR THE AGREEMENT. The Director, Office of Science and Technology Policy, will presumably be designated by the President to implement the Agreement and to serve as Chairman of the U.S. side. In addition, on occasion, the U.S. side of the Joint Commission should serve as a formal negotiating team with its Soviet counterpart. The U.S. side of the Joint Commission should serve as a Board of Directors for the Agreement, its Chairman acting as chief executive officer, and an executive committee of one.

3. THE COURSE OF COOPERATIVE ACTIVITY. Effective cooperation without senescence can occur if projects follow the life cycle-- proposal, evaluation on one side, exploratory discussion with the other side and exchange of information, negotiation of a project, joint research and development, completion (with or without transfer to an Article 4 Agreement under the Joint Commission). Responsible evaluation is needed at each step in this cycle. Working scientists and engineers should be involved at all stages, both in the advance through the stages and in the evaluation which leads to the next one. Substantial attrition in the first or second stages is to be expected and desired.

4. THE TREATMENT OF FOREIGN TRAVEL EXPENSES IN THE CONDUCT OF R&D. In cases under the Agreement where foreign travel is required for the conduct of R&D, it should be provided for in the proposal, conducted without further necessity for prior authorization, and evaluated like any other expense upon renewal or termination of the contract or grant.

5. STRENGTHENING AND GENERALIZATION OF OPERATING STAFF. An operating staff must:

- support the U.S. side of the Joint Commission in its functions
- ensure effective information exchange among the projects under this Agreement, and with other U.S./U.S.S.R. Agreements,
- dispose of funds and personnel for preparation and support of U.S. delegations in the Soviet Union and of Soviet delegations to the United States--interpreters travel funds, and the like,
- handle publication and dissemination of information created under the Agreement, beyond that possible in normal channels.

Among possible homes for this staff are the National Science Foundation or the National Academy of Sciences.

6. NSF FUNDS FOR THIS AGREEMENT SHOULD APPEAR AS A LINE ITEM IN THE NSF BUDGET. Its levels should be determined annually with a zero-based approach. Participation by other government agencies, universities, and industry in activities under the S&T Agreement can and does take place in some cases as a means to advance agency or industry goals in a cost-effective manner. Such activities can be justified in the normal fashion and may be aggregated as is convenient. However, substantial NSF infrastructure costs such as preliminary exploration of projects, provision of interpreters and travel funds for Soviet scientists in the U.S., translation (and publication and dissemination of literature of interest to the project) tend to make R&D under the Agreement more costly than domestic research with comparable published results. Because benefits are obtained from this joint research in ways additional to normal publication, the identification of this activity within NSF as a line item will facilitate both decision making and the support of this program by intervention of Department of State, OSTP, Commerce, and other interested parties. Both technical (peer) review of the substance and a more global analysis of the other benefits should guide initiation of joint R&D under the S&T agreement.

7. FURTHER EVALUATION OF U.S./U.S.S.R. TECHNICAL COOPERATION. Both the charter of this Panel and its interpretation of that charter were narrow in order to allow response within the time required. This limited report should not be considered an assessment of the overall status of U.S./U.S.S.R. technical cooperation, much of which goes on under the ten other U.S./U.S.S.R. bilaterals (which stemmed at least in part from the S&T Agreement) or under agreements between U.S. industrial firms and Soviet counterparts. Although many of these latter are formally "Article 4" agreements under the S&T Agreement, some predate May 1972. Although Article 4 envisages "...the conclusion as appropriate, of implementing agreements for particular cooperative activities engaged in under this Agreement", Article 4 agreements may well have a life of their own. At least one large U.S. firm seems quite satisfied with the substantial magnitude and nature of joint R&D pursued under its agreements with the U.S.S.R.

III

SUMMARY OF RESULTS

A. CONCLUSIONS COMMON TO REVIEW OF ACTIVITIES OF ALL WORKING GROUPS

These observations are drawn from the individual reviews (Section VIIB), or were emphasized in discussion among Panel members.

Soviet red tape. Almost all participants emphasized the helpfulness and warmth of the individual Soviet scientific or technical person at the working level, but contrasted this with what appears to be layers of stifling bureaucracy which enforce a rigidity in the interaction which very much diminishes its value to the U.S. and to the U.S.S.R. Lack of notification of the time, date, or place of arrival of Soviet visitors (and of their identity and background), inflexibility in travel arrangements for U.S. participants in the U.S.S.R., difficulties in obtaining supplies in the U.S.S.R. commonly available in the U.S. are all cited as serious problems.

Long delays in correspondence. Several subpanels cited 6-month delays in correspondence, after the communication was known to have been received in official circles in the U.S.S.R. Some indicated the unsatisfactory nature of any written correspondence, as if Soviet participants could communicate effectively with the U.S. side only by face-to-face encounters.

Primary value is access to existing work in the Soviet Union, rather than in joint work so far (except Electrometallurgy and Metrology where there is some cooperative work). Our subpanels indicated that this demonstrated benefit be sought specifically, with recognition that such exploratory contacts may not develop into joint work, and that these benefits be enhanced by a greater availability of translation and dissemination of such material. It should be recognized that much of this material is unpublishable by the U.S. side in normal scientific or technical journals, since it is not original research of the U.S. participants. One of our electrometallurgy reviewers observed, "None of the scientists knew of any formal communications which had been made to their colleagues other than the article in IRON AGE."

Little sharing of information within Working Groups and no sharing between Working Groups. Our subpanels recounted the participants' plaint that they were not aware of the experience of others in the Agreement activities, that they were neither briefed nor debriefed (so they knew that no benefit was obtained from the information or insights which they acquired.)

When a delegation travels to the U.S.S.R., it should be well-prepared. Some delegations have made little progress by not being aware of what had occurred before. The Soviets may feel confused as to the relationship between one Working Group and the previous one visiting that institute, and the U.S. visitors may be unable to enlighten them because of poor communication among the Working Groups or within a Working Group. There should be a good awareness on the part of the U.S. visitors to the Soviet Union, if not of the Russian language then of the setting of Soviet science and technology; this should be the responsibility of an expanded staff for the U.S. side of the Joint Commission. Our scientists and technical people visiting the Soviet Union or participating in the cooperative endeavors should not have unrealistic expectations of what can be accomplished, in view of the constraints on Soviet scientists. The sending of better informed American participants was deemed essential by those interviewed.

More working discussions. U.S. participants want more discussions with their working counterparts, fewer global introductions by heads of laboratories, less sight-seeing and large social dinners, and the like.

Real cultural and political benefits. Participants generally volunteered, independently of their assessment of the merits of the Agreement on the grounds of scientific or technological benefits to the U.S., that there was "real cultural and political benefit." They did not define these terms.

Lack of U.S. support such as translation. Typical was this comment of the Electrometallurgy review:

"The lack of administrative procedures for importing and exporting material, hosting conferences in the U.S., acquiring translation and transcription services, and providing social reciprocity have been major impediments in obtaining, interpreting, and broadly disseminating U.S.S.R. technical information in the U.S. The ease with which Soviets have been able to provide these services has given them a decided advantage in acquiring U.S. information at a very favorable cost/benefit ratio."

B. CAPSULE COMMENTS ON ACTIVITIES UNDER THE INDIVIDUAL WORKING GROUPS

Applications of computers to management. After 4 years of courtship, a reasonable working relationship has emerged. Benefits to the U.S. lie in a better guide to the Soviet literature in this and allied fields, in access to some unpublished work, but primarily in a better understanding of Soviet views and procedures in planning and management. A current expenditure level of \$1 million per year will probably have to be increased to accommodate a rising level of publication and of substantive joint work.

Chemical catalysis. About one third of those interviewed said that the contacts with the U.S.S.R. under this program had had some useful effect on their own science--not a lot, but some. The others said there was hardly any or none. Unless some of the best scientists from the Organoelement Institute in Moscow are permitted to visit the

U.S. under this program, and U.S. scientists are permitted to visit the laboratory at Chernogolovka, the project in homogeneous catalysis should be terminated.

Electrometallurgy. The Working Group in Electrometallurgy has taken on the structure of the E.O. Paton Institute (Kiev), the Soviet institutional participant. Familiarity with differences in approach and perceptions in solving technical problems in the U.S.S.R. has stimulated a considerable amount of rethinking of technical approaches in the U.S. The projects on electron beam deposition and solid-state joining have been highly successful, the former having involved the only two-way scientist exchange under the Working Group and both having involved exchanges of materials. Future negotiations should be directed toward providing the U.S. side with greater opportunity to propose the Soviet collaborators and research centers where joint research will be conducted, diversifying the work among more Soviet institutions than the single Institute involved to date.

Forestry. In this small program (about \$25,000 annually for travel, and \$100,000 for salaries), a first tentative step has been taken through a series of exploratory discussions. The Forest Service funded the exchange under its regular research budget, some scientists spending most of their travel budget to participate in the exchange so that their work at home suffered. The program should be modified to ensure broad participation in forestry, from universities, forest industry and the U.S. Forest Service. While funding and broader participation are clearly different issues, they cannot be separated.

Metrology. This Working Group is operated by the National Bureau of Standards (NBS) in the U.S. and the State Committee for Standards (Gosstandart) in the U.S.S.R. Out-of-pocket financial expenditures on the U.S. side of about \$20,000 annually (mostly for travel) have produced some conventional intercomparison of standards. The Soviets have provided very good data for incorporation in data evaluations and subsequent publication in tables and handbooks, e.g., thermodynamic data on ethylene. Lack of communication between Gosstandart and the other Soviet institutions where advanced standards research and development are done limits the effectiveness of S&T Agreement exchanges by impeding or failing to facilitate contacts between the appropriate people on both sides.

Microbiology. Not much actual Soviet-American exchange was created by the Microbiology Group, and the amount of exchange work was practically zero. The Working Group on Microbiology is funded by the NSF at \$1.8 million annually. The funds went for research grants to individual U.S. scientists, for work on topics that were seen in some sense as related to the U.S./U.S.S.R. S&T exchange. These grants did not involve Soviet coworkers; they did not support Soviet post-doctoral studies here; and they were not explicitly joint studies. The NSF contract mechanism is more appropriate for the support of work under this Working Group than is the grant mechanism that has been used. Funding for the program should be directed toward joint projects or the reciprocal visits of scientists. The program should be broadened on the Soviet side to include Soviet academicians and scientists who work for the Soviet Academy of Sciences.

Physics. No exchange or substantive interaction has taken place thus far in this Working Group. However, a joint research group on

condensed matter physics is planned for the Aspen Center for Physics for 8 weeks this summer, with individual participants jointly agreed upon (by name) by the U.S. and Soviet organizers 6 months in advance of the meeting. A 3-week joint research seminar on cosmic x-ray sources is scheduled for the U.S.S.R. in August, 1977. Although physics exchanges have long occurred under the interacademy exchange program outside the SET agreement, it has not previously been possible to obtain a firm commitment from the U.S.S.R. side as to the individuals who would participate.

Science policy. Since September 1974, about \$750,000 has been expended by the U.S. side on 4 subgroups. Those of Planning and Management of Scientific R&D, and Stimulating Development of Fundamental Research appear to have made useful progress, while "Financing R&D" and "Training and Utilization of Scientific and Engineering-technical Personnel" do not. It was almost unanimously agreed by those interviewed that the impact of the exchanges on our knowledge of the art and practice of science policy and its problems was modest. For the most part, it was not felt that the case studies, data or written material provided by the Soviets expanded the totality of U.S. factual knowledge of the Soviet Union. Yet most (and particularly those most versed in Soviet affairs) felt that their understanding of the Soviet Union had been enhanced by the discussions and meetings, and that they had new insights into the philosophy, institutional structures, and practices of the Soviet government in the areas of science and technology. Above all, the participants felt that a beginning had been made at building a relationship between both the people and the organizations involved on both sides.

Water resources. The U.S. cost of this program is not known, but may approximate \$100,000 per year. U.S. agencies involved were required to support the program from internal funds, typically diverted from their own programs of higher priority; universities were asked to absorb the costs of their personnel; industry was pressured to contribute funds and materials. The three areas of "Water Resources Planning, Use, and Management," "Cold-Weather Construction Techniques," and "Methods of Automation and Remote Control in Water Resources Systems" have produced little of value. The use of plastics in water resources construction is a field of continuing mutual interest which is recommended for continuation.

C. DISCUSSION AND RECOMMENDATIONS

Activities under the U.S.-U.S.S.R. Agreement on Cooperation in the Fields of Science and Technology have served a useful purpose. It should be borne in mind that the existence of this Agreement has led to other specialized Agreements, so that the benefits listed here are incomplete without consideration of the benefits of these other Agreements, which were beyond our scope to evaluate. Of the "forms of cooperation in Science and Technology" foreseen in Article 3:

- a. Exchange of scientists and specialists;
- b. Exchange of scientific and technical information and documentation;
- c. Joint development and implementation of programs and projects in the basic and applied sciences;

- d. Joint research, development and testing, and exchange of research results and experience between scientific research institutions and organizations;
- e. Organization of joint courses, conferences, and symposia;
- f. Providing help, as appropriate, on both sides in establishing contacts and arrangements between United States firms and Soviet enterprises where a mutual interest develops;
- g. Other forms of scientific and technical cooperation as may be mutually agreed.

all have been tried in one project or other under the Agreement, except possibly "c."

Activities of the individual Working Groups, under the direction of U.S. and Soviet co-chairmen, have made uneven progress within Working Groups and between Working Groups. In some, the major benefit of activities under the Agreement has been to form an acquaintance and a working relationship which could be the basis for future progress. In some, one can point to concrete achievements. Project-by-project survey assessments are found in Section VII.

In general, participants in the program point to significant political and cultural benefits, in addition to the relatively few citations of benefits to U.S. science and technology. Recognizing that expenditures on science and technology even in U.S. domestic organizations cannot produce in every case a return on the investment, the magnitude of results expected in such domestic work still serve as an implicit standard for those accustomed to peer review. Strictly scientific and technical benefits under this Agreement do not come up to that standard, especially when total program costs (estimated at \$13.2 million for the 5-year period) are used in the comparison rather than the specific expenditures which are usually quoted as program costs. For this reason, and on the basis of experience of the individual Working Groups, we recommend changes in organization and administration on the U.S. side to provide a better return on investment for those projects for which we recommend continuation, and for new projects to be undertaken.

In general, where it has occurred, long term residence of U.S. scientific and technical personnel in Soviet laboratories has been less productive than a similar stay in an advanced U.S. laboratory. Special chemicals and instruments, readily available from the very active scientific supply industry in the United States, are much more difficult to acquire in the Soviet Union. In many cases, benefits to the U.S. side thus far have arisen from a better understanding of the status of the Soviet programs in the fields of the individual Working Groups rather than in joint progress under the Agreement. In subfields of SST in which the Soviet Union is making significant progress, continuing interaction between the U.S. and Soviet scientists and engineers can be very cost effective from the U.S. point of view, in that it both provides stimulation and helps avoid unnecessary duplication of effort.

Thus, not only do U.S. scientists and engineers have the opportunity of acquiring at first hand new ideas and new perspectives from their Soviet colleagues, they also become more familiar with the relevant Soviet scientific literature and are alerted to particular Soviet scientists and engineers whose future publications likely merit

special attention. This has clearly been effective in the Electrometallurgy Working Group.

Some benefits from the Agreement come from the identification of individuals on the two sides who are particularly effective and helpful in making further contacts with the science and technology on that side. In this, there is a learning curve--initial meetings, expansion and intensification of contact, and the development of working relationships. Where real progress in substance does not follow, our judgment is that one should move on to introduce another project for which similar early benefits may be achieved. Our participants recommend and we endorse a procedure which provides continuing exploration and creation of new projects and termination of old ones, rather than the assumption of a 5-year term for each Working Group, coincident with the successive terms of the Agreement. The S&T Agreement, unlike the other 10 intergovernmental bilaterals, does not specify the detailed limits of fields of cooperation; it is therefore a natural agreement under which to explore new fields of cooperation and new subfields under the other agreements.

Science and technology by "Joint Agreement" of this type is not the usual mode of interaction of the U.S. community with foreign science and technology. That interaction is usually conducted in a "bottom up" mode at the initiative of individual scientists who believe that part of their research funds could usefully be spent on contact with foreign science or in collaboration with foreign scientists rather than entirely domestically. Alternatively, scientific societies arrange international symposia which provide in most cases multilateral rather than bilateral contact.

Access to technology normally occurs through a reading of the technical literature and by commercial arrangements between firms, such as licensing of patents and know-how, joint ventures, or shared ownership. The structure of the Soviet social system is not such that individual initiatives suffice, although there are elements, even outside the Agreement, of scientific interchange and "commercial" relationships. U.S. science is outstanding and U.S. commerce and industry highly productive in large part because of reliance on individual or corporate initiative rather than government direction; it would be a disaster for U.S. science and technology if foreign interactions in general were limited to such bilateral agreements, but if the usual mode of interaction does not work with the U.S.S.R. we should be sufficiently flexible to adopt another mode which may also serve as useful experience for contact with other nations with systems resembling more that of the U.S.S.R. than our own. Even with the Soviet Union, as relations develop, effectiveness will be increased by encouraging such interaction to take place under a direct Article 8 agreement or even outside the format of the Agreement, provided an equivalent degree of useful interaction can be obtained in this way.

As for format, we assume that the Director, Office of Science and Technology Policy will be U.S. Cochairman of the Joint Commission and will be assisted in this role by a senior professional staff person in that office. We recommend in general that the costs of the Agreement be budgeted as a line item in the NSF budget to cover Joint Commission Staff activities, as well as programs which are contracted for management to scientific societies or nongovernmental groups, or which are spread among many U.S. Government departments. Provision should

be made for the use of individual agency funds where U.S. involvement is largely limited to a single government agency, as is the case in the present Working Groups on Forestry and on Metrology.

An expanded Joint Commission Staff will allow:

-- Improved administrative interchange among groups participating in the different projects (e.g., information as to how best to cope with the Soviet scientific and travel bureaucracies).

-- A better and more uniform record of activities under the Agreement (e.g., composition and itinerary of various groups traveling to the Soviet Union under the Agreement, index to trip reports and documents written under the Agreement, and the like).

-- Provision of language skills, especially to small Working Groups under the Agreement.

-- Improved guidance on negotiating methods and a better coupling of the Working Groups among themselves and with the Joint Commission.

-- Publication of a newsletter to record activities under the Agreement, which will facilitate the sharing of experience among the various U.S. Working Groups and among the 11 U.S./U.S.S.R. bilateral agreements.

Funding mechanisms for goals transcending S&T. Our subpanels have all commented on the difficulty of funding infrastructure activities; they have noted that whatever the overall value of activities under the Agreement, they have not in general produced S&T results of value comparable with those expected from similar investments in domestic S&T; they have indicated in many cases relatively low ranking by peer review panels of such activities, perhaps for this reason. Yet the U.S. Government (and NSF in particular) has in the past been sufficiently flexible to provide grants in the hope of building facilities and competence for future results in S&T. Examples are the Materials Research Centers of ARPA, the Centers of Excellence grants of NSF, and the like. In these cases, it was explicitly noted that funds were being expended not for current research results but to bring into being a capability to compete for future support. In the present case of funding under the Agreement, if benefits are sought and expected in addition to those of S&T results comparable with domestic investments, the Departments of State and Commerce and the National Security Council should provide explicit support for the budget submission of the NSF or other agencies which provide funds for joint S&T Agreement programs which cannot be fully justified by their S&T results.

Alternatives to NSF funding. There is, of course, no necessity to limit consideration of funding mechanisms to the NSF Division of International Programs. In particular, advantages of NSF include the existence of respected peer review procedure, adequate management structures, economies of scale in the grant procedure, and the like. Disadvantages include the reality that to some extent these international programs compete directly within the NSF budget for expenditures on domestic science and technology,

even though to some extent the international programs have additional goals. The degree of competition could be reduced if such programs were placed in an Institute for International Science, which would have its own advantages and disadvantages. The degree of centralization of all international S&T cooperation programs should again be reviewed, the U.S. decision in the past having been to retain decentralization among U.S. government agencies and nongovernment programs.

IV

BACKGROUND

A. GENESIS AND ESTABLISHMENT OF THE S&T AGREEMENT

In order to provide an introduction, we include here a brief comment on the S&T Agreement by Dr. Egon Loebner, who spent two years in Moscow as the central figure in the U.S. activities under the Agreement. We have also had the benefit, during the course of this study, of the personal recollections of Herman Pollack and Norman Neureiter, two of the prime movers in the formulation and negotiation of the Agreement.

Brief Observation on the S&T Agreement

by Egon Loebner, 1974-1976 Counselor for Scientific and Technological Affairs, U.S. Embassy, Moscow, currently at Hewlett-Packard Corporation

The S&T Agreement of May 1972 in Moscow is included in five principles, which were the first documents signed during that Summit meeting, and explained by Secretary Kissinger on September 19, 1974 to the Senate Committee on Foreign Relations:

1. Necessity of avoiding confrontation.
2. The imperative of mutual restraint.
3. Rejection of attempts to exploit tensions to gain unilateral advantage.
4. The renunciation of claims of special influence in the world.
5. Willingness, on this new basis, to coexist peacefully, and build a firm, long-term relationship.

The sum total of two years of experience in Moscow leads me to the belief that the top Soviet leaders, charged with the responsibility to implement the eleven S&T bilateral agreements, exhibited sincere dedication in words and (most of the time) in deeds to carry out the intent of Principle five (in the first document) and the principles of A) equality; B) reciprocity; and C) mutual benefit within the limitations of time, place and organization given in each specific case. I hasten to add at this time that these limitations, dreadfully real, often fall short of expectations on both sides. Without detailed knowledge, comprehension and understanding of these limitations a meaningful assessment of the results of five years of cooperation is not possible. The four goals of the NAS proposal to OSTP are too narrow and distort, in subtle ways, the design of the S&T Agreement, as I understood it at the time that I began my activities for the State Department and the Embassy and as I still understand it.

I see the intent in design and the early selections of cooperative fields of endeavor not as an abstract or all-encompassing apolitical endeavor to advance science and technology per se, i.e., development of selected scientific and technological fields along lines which will meet with academic approval (standards of the time) but as a joint cooperative effort to achieve mutual benefits (including such as the seemingly trivial benefit of saving money by avoiding duplication of effort in agreed tasks and subtasks) for the populations of the two countries and, by implication, most of mankind.

For example, I see in the "top down" design of the cooperation project mix in eye on the practical and an attempt to avoid pockets where the orientation could become science for science's sake and technology to tool up for other technology and where the activity might remain barren and miss fruitful benefits altogether. I do not believe that this orientation necessarily signals a Soviet intention to gain a unilateral advantage. On the contrary, I have witnessed several cases where the Soviets failed to point out an unbalance in the favor of the U.S. in order not to rock the boat and in the hope of gaining "points" to compensate for "obvious" unbalance in their favor elsewhere in the same Agreement.

I do not believe that equality and balance and reciprocity is possible on a microscopic scale for each task, subtask, project and subproject. This ideal cannot be reached in reality. However, it is possible to set up a rigorous detailed accounting for all types and levels of concrete and less concrete benefits and pay-offs for each exchange. It also seems to me that these S/S exchanges are not a zero sum game, where resources are traded but a multiplicative cooperative effort where the result is more than the sum of the parts.

It should be realized that the first step is to locate and assess mutually profitable areas where there is approximate parity or complementarity. This step is exceedingly difficult and requires a multifactor awareness rarely available to either side. A lot of jockeying has been taking place on both sides in order not to reveal too much of a hand. I do not see anything wrong with that approach. It has to be remembered that the Soviets are in the game at a distinct disadvantage and should be naturally expected to compensate for it.

The U.S. government has been slow and unwilling at times to include (unclassified) information which is proprietary and belongs to the private sector, even in cases where there have been indications that the private sector might be interested in scientific and technological exchanges in what appear to be non-strategic areas. The Soviet perception is that the kaleidoscopically changing U.S. technobureaucracy is often less technically qualified and less expert than their private sector counterparts. NASA, ERDA, EPA, NSF, etc. are less operational and implementing than their Soviet counterparts. It is my view that the Soviet perception of the Federal bureaucracy is similar to the perception of U.S. firms of Soviet trading organizations and bureaucracies. They are a buffer and a layer isolating the organizations where the real action is perceived: the Soviet Ministries and the U.S. private sector.

B. BACKGROUND AND RATIONALE OF THE PRESENT STUDY

The U.S.-U.S.S.R. Agreement on Cooperation in Fields of Science and Technology is one of eleven bilateral intergovernmental agreements between the U.S. and the U.S.S.R. containing components of science and technology. Those eleven agreements between the two countries have been in existence since 1972 and are, in large part, a product of the onset of detente between the U.S. and the U.S.S.R. The Agreement on Cooperation in Fields of Science and Technology is generally regarded as the senior agreement of the eleven bilateral agreements.

Approach. The method chosen for this evaluation was to obtain primary data by a sampling of U.S. participants in the program--those who had traveled to the U.S.S.R. under the S&T Agreement or had hosted U.S.S.R. visitors; at a meeting of our Panel to pool the information obtained and to write brief sections for this report on the results of the individual reviews; to extract as "results" those observations common to the individual Working Group reviews or particularly significant in one or more of them; and from these "results" to form a judgment as to the value of the S&T Agreement thus far.

On the basis of this value judgment, the Study would propose modifications of the Agreement or of the conduct of the U.S. side under the renewed Agreement, and would express its views as to whether it was worthwhile to renew the Agreement in the recommended form. A Senior Review Panel of nine members was to be selected, one for each of the principal Working Groups under the Agreement. Each of the members was to be a well-known and respected professional in the field of the individual Working Group. In order to collect valid data, each Working Group area was provided two Special Reviewers, of the same stature as the Panel members. A "discussion outline" was sent to a selected set of those identified from State Department records as being participants in the individual Working Groups. In the smaller fields, all of the participants were contacted; in the larger ones, on the order of one out of three participants was selected. To focus the thoughts and to refresh the memories of the participants, a "discussion outline" was distributed to the selected participants, and the information was actually obtained from the participant by telephone interview conducted by the Special Reviewer or the senior Panel member. It was our expectation that participants in the activities of the Agreement would be willing to talk at length with our reviewers, and this expectation was more than fulfilled. Anonymity was offered to those interviewed.

C. HOW TO EVALUATE THE WORTH OF THE AGREEMENT?

Assuming that valid data have been collected and analyzed for the activities and results under the Agreement, how should the Panel estimate the value of such activities? As indicated in the NAS proposal, we understood that the S&T Agreement was designed to meet four basic goals:

1. the advancement of science and technology;
2. enhancement of the prestige of the U.S. and U.S.S.R., reduction of tensions between super powers, and encouragement of international understanding;
3. promotion of trade between the two nations; and

4. intergovernmental contact; access for U.S. Government officials to their counterparts in U.S.S.R. ministries and agencies, increase in the effectiveness of U.S. Embassy contacts, clarification of communication channels and reduction of redundant and wasteful effort.

The proposal went on to say "a Panel will be created to analyze science and technology objectives and will also sample the opinions of a selected group of experts regarding items 2-4 and the manner in which those goals have an impact on the overall program. The Panel will focus its efforts on the first of the four goals."

The NAS Panel has no special competence in evaluating progress toward goals 2-4; we can but report the collective views of our respondents. As for item 1, "the advancement of science and technology" (and we would include here as an advance in U.S. science and technology the awareness in the U.S. as a result of the activities under this Agreement of information available in the Soviet Union of which we were previously unaware in the U.S.), the Panel does have experience and competence in making an evaluation.

However, scientists, economists, administrators, and legislators have long puzzled over the appropriate manner in which to value advances in science and technology. This problem can be avoided in the present instance by comparing the scientific and technological results under this Agreement with those which might have been obtained by an equal investment in domestic science and technology in the same fields. It would be unrealistic (and bad economics) to imagine that these funds could have been invested domestically to produce in every case the very best science and technology; but it is reasonable to assume that they would have produced results comparable with those of the average funds invested in the field. Thus, a natural standard is an appropriate one for determining the value and impact of direct S&T results obtained under this Agreement.

In addition to progress toward the goals 1-4 indicated above, activities under the Agreement may have value in laying the foundation for achieving these goals. Accordingly, we have been interested in the degree to which investments thus far have paved the way for results later on.

Finally, since our evaluation is oriented toward determining whether a future S&T cooperation Agreement is worthwhile, not toward an evaluation of the past, we ask whether lesser expenditures could in the future produce comparable or improved results, by reducing or eliminating funding which does not contribute to the goals of the Agreement, by more efficient use of the funds which are to be expended in the program, and by increasing the availability of the results to the U.S. scientific, technological, and industrial community.

In summary, the NAS review has been limited to the single U.S./U.S.S.R. Agreement on Cooperation in Fields of Science and Technology and to an evaluation of the activities in only 9 Working Groups of that Agreement. Both the charter of this Panel and its interpretation of that charter were narrow in order to allow response within the time required. This limited report should not be considered an assessment of the overall status of U.S./U.S.S.R. technical cooperation, much of which goes on under the ten other

U.S./U.S.S.R. bilaterals (which in part, formally stemmed from this Agreement) or under agreements between U.S. industrial firms and Soviet counterparts. Although many of these latter are formally "Article 4" agreements under the S&T Agreement, some predate May 1972. Although Article 4 envisages "...the conclusion as appropriate, of implementing agreements for particular cooperative activities engaged in under this Agreement", Article 4 agreements may well have a life of their own. At least one large U.S. firm seems quite satisfied with the substantial magnitude and nature of joint R&D pursued under its agreements with the U.S.S.R. It seems that a wealth of industrial interaction is taking place under Article 4. Although the U.S. Government does not in general support such activities financially, it may have a policy interest which would be served by a review of such activities. It is not clear that such direct agreements are now dependent on the existence of the S&T Agreement. As a result of this review, we propose substantial changes in conduct of the Agreement, in order to improve effectiveness, provide a better basis for continuing evaluation and management, and suit the U.S. national style both of conduct of science and technology and of Government operations.

V

ORGANIZATIONAL ARRANGEMENTS AND ADMINISTRATIVE CONCERNS

A. PROBLEMS OF ASYMMETRY

Major differences in the ideology, structure, and management of the two societies are reflected in the organization and conduct of science and technology on the two sides.

Most striking is the fact that with the exception of some military and space technology, technology on the U.S. side is the province of private industry, which initiates, develops, and provides technology in its own interest, thereby according to the U.S. ideology and experience aiding the national interest. Even in the case of space and defense, where most of the overall large system technology is used and paid for by the government, much of the technological infrastructure is of the same type of private technology.

In contrast is the situation in the Soviet Union, where individuals cannot employ other individuals, so that all enterprises, especially technical or technological ones, are government operations. Thus by a government-to-government agreement, the Soviet Union can deliver knowledge, material, and people; the United States Government could do likewise only by a major reform of U.S. society in the Soviet mold. No such thing is likely to happen in the five year term of this Agreement. Thus U.S. technology is available to the Soviet Union via the U.S. Government only through persuasion--financial, moral, or the like.

In fact, the U.S. Government has great influence. U.S. participants in the activities under the Joint Agreement willingly devote their time and energies to what they have been persuaded (by the very request to participate) is judged by the U.S. Government as in the national interest. But this willingness extends only to those matters which are "in the public domain," and the degree of participation is limited by the conflict with a person's obligations to his regular employer, who derives more benefit from the individual's normal work than from his participation under this Agreement. Such participation will not long continue if the participant feels that his activities do not bring a net benefit to the U.S.

U.S. inventions can be patented in the Soviet Union, and the U.S. owner of the invention has an interest in encouraging the Soviet Union to use that invention in return for specified license fees. But U.S. firms have little interest in transferring technology to the Soviet Union which will enable the Soviet Union to compete with those same firms in the U.S. or foreign markets, or in the Soviet Union itself.

Thus, significant participation by U.S. industry will be on a basis of self-interest.

B. MICROOPTIMIZATION VERSUS MACROOPTIMIZATION

The U.S.S.R. would not have signed nor participated in the Agreement without the expectation of benefits. That the U.S. is a party to the Agreement is a clear indication of the acceptability to the U.S. of some benefits accruing to the U.S.S.R.

This is in accord with the desire for "mutual benefits."

Thus the United States participates in this Agreement on the basis of what it can gain from it, and the U.S.S.R. likewise. Limiting ourselves henceforth to the benefits from creation or exchange of S&T, and ignoring in this section the very real benefits of prestige, enhanced trade, and intergovernmental contact, the U.S. can gain from the acquisition of existing Soviet S&T results or from the joint creation of S&T results. Strict equality in this exchange might be demanded on the micro or on the macro scale. Microequality could be interpreted to mean that each participant--individual, firm, or U.S. government agency should benefit, and likewise each participant on the Soviet side.

A moment's reflection will show the impracticability of such a proposition. Even in the United States, a successful R&D organization receives money for its product, not barter. Thus, some mechanism must exist on the U.S.S.R. side and also on the U.S. side for striking the overall benefit to the nation on a macro-scale--at least between agencies, or between firms, or among individuals who are freely participating.

At the inception of the Agreement in 1972, substantial White House interest and influence on U.S. government agencies impelled participants and the commitment of funds. With the passage of time, the commitment of funds remains, but with less direct evidence of high-level Executive desire.

On the Soviet side, it is easy to imagine that the State Committee of the Council of Ministers of the U.S.S.R. on Science and Technology presents to the Council of Ministers its analyses of the overall benefit to the U.S.S.R. from the involvement of various Soviet agencies in the activities under the Agreement, and the Council of Ministers through its chain of command directs such agency participation. This is possibly incorrect and undoubtedly oversimplified. On the U.S. side, while one can imagine a similar analysis and direction, it fits less well the decentralized U.S. structure. But it fits not at all the participation of U.S. firms and very little the participation of those performers of science and technology in U.S. universities or institutes funded by government grants.

Before exploring solutions to this problem, one should consider the nature of the costs. In many cases, it is the direct cost of participation--travel expenses, translation services and the like. One should also reckon the opportunity cost--the benefits which would have flowed from the participation of the individuals in their normal

business of scientific research, development, or administration. Finally, there are the opportunity costs for industry, in some cases, associated with the transfer of technology which could otherwise have been licensed for a fee or which could be used by the U.S.S.R. to compete with that industry in the U.S.S.R. or in the world market.

One might imagine a U.S. government mechanism which does all these analyses and then applies the appropriate amount of persuasion (or money) to repay these costs. A much more natural arrangement would be for the U.S.S.R., which desires the benefits which result in a cost to certain U.S. participants, to pay these costs (presumably plus a normal profit). If the value system is different in the U.S.S.R. from in the U.S., it may be that the U.S. in order to obtain certain benefits has to deliver other participation which involves costs. On the U.S. side, it seems natural to suggest that there be a fund to support the participation of those who do not themselves benefit from the activities under the Agreement, the fund to be reimbursed by those who do benefit. In many cases, those who do benefit will be agencies which support U.S. S&T or its dissemination; if they can buy S&T results more cheaply by this mechanism, then they should do so. A strict reading of Article 1, involving "mutual benefit, equality and reciprocity," suggests that no overall transfer of funds from one nation to the other would be required. On the other hand, direct licensing should not be precluded.

The Soviet Union might in principle be able to provide to the U.S. valuable technology in Field A, in return for technology of more use to the Soviet Union in Field B, so that the Soviet Union would have a net gain from this involvement. The U.S. could also, in principle, show a net gain; it might well occur that technology of Field A would be more valuable to the United States as a whole than what it loses by providing technology of Field B to the Soviet Union, but the mechanism does not exist for the U.S. Government to pay the B industry and to charge the A industry. Significant technology transfer (and here we speak of non-sensitive technology) will thus take place only if the Soviet Union buys and sells technology to partners whose acquaintance has been made under this program or elsewhere. We regard this purchase of technology as good, not bad, providing the U.S. Government maintains adequate control, through the Commerce Department and other interested agencies, of the transfer of sensitive technology. And the problem we have sketched can as readily be solved by the mechanism of the market as by central direction.

Some basic and applied science is done in U.S. industry, but much of it is freely published and could be available under this Agreement if the industrial employers and the scientists were convinced that participation in the Agreement would be beneficial either to the U.S. Government or to the individual scientist or his employer.

Most of the science in the U.S. is funded by the Federal Government and is freely published. But even in this case, there is a strong asymmetry between U.S. and Soviet styles. The Soviet Academy of Sciences, for example, has a strong operating role, with many institutes directly subordinated to the Academy and managed by it. Much of U.S. science is funded by the government not to a university department or research institute as such but to the individual investigator. Thus while a visiting U.S. group or scientist under the Agreement may have access to a substantial part of a large institute

of the Soviet Academy (or of one of the ministries), U.S. science is much more fragmented and no comparable access exists for Soviet visitors.

U.S. scientists and technologists, other than Government employees, will participate in this program only so long as they independently believe that it is efficiently conducted, that they support its goals, and that such participation does not impede their competitive performance in science and technology, which is the basis for their support. On the Soviet side, there is an operational chain of command through which scientists and technologists can be directed to participate, no doubt with imperfect compliance.

Finally, the freer availability of instrumentation and supplies in the United States tends to make scientific research in the U.S. more productive for the visiting Soviet scientist than is the case for the U.S. scientist in the Soviet Union.

Thus, the Soviet side need not change its normal way of doing business to participate in this Agreement, whereas U.S. scientists and their sponsoring institutions must do very special things. Nevertheless, the participation of U.S. scientists and engineers in Soviet programs may well be a major perturbation for the Soviet system.

At Appendix C, together with the copy of the S&T Agreement, there are two charts containing diagrams of U.S. and Soviet agencies which have major responsibilities in science and technology.

C. GENERAL PROCEDURAL ASPECTS

A Stronger Managerial Role for the Joint Commission and Its Staff

Funds of the magnitude of those expended by the U.S. side 1972-1977 (it is estimated by the Panel that approximately \$13.2 million have been spent to date on the U.S. side for support of activities within the S&T Agreement and that about another \$0.3 million or more have been committed in support of further activity) will provide more benefits if there is a capable staff responsive to direction by the U.S. Co-chairman of the Joint Commission. In a mature mode of operation, within a given Working Group there will be some projects which are just starting, some in an exploratory stage, some in full operation, and some being phased out. Not every suggestion for cooperation need (nor should) be brought to completion. Additional Working Groups can be brought under the Agreement at various times within the 5-year duration. To facilitate this process and the interchange of procedural knowledge and techniques among groups, a staff together with some support capability are required.

We propose that the course of a normal cooperative enterprise be as follows:

PROPOSAL. Government agencies, scientific societies, industrial associations, and individual scientists and technologists should propose candidate topics for cooperation, with a brief explanation of

their value to the U.S. and the possible Soviet capabilities in that field.

After discussion in the U.S., some winnowing of these proposals could be accomplished, to the point where the remaining ones would merit a few man-days of real research as to the potential contribution by U.S. and Soviet participants. If the proposal clearly falls within one of the Working Groups which is making reasonable progress, the Working Group chairman should communicate with his counterpart to determine the degree of interest on the Soviet side. It should be clear at this point that there is no commitment by the two sides in this discussion. The principle of mutual benefit and the involvement of comparable people on the two sides in this preliminary discussion should limit the amount of effort required by either side. At this point, an informal census of possible interested organizations should be provided by each side in order to determine whether a preliminary, exploratory visit is in order.

Exploratory Visits by an Individual or By a Small Group would be the next step. If the preliminaries and results of the exploratory visits show that the criteria for initiation for joint research are satisfied, e.g.:

- the U.S. and the Soviet Union are both leaders in the field or can make complementary contributions,
- that excellent communication can be achieved between the U.S. and the Soviet sides,
- that the U.S. and the U.S.S.R. have comparable interests,

one should then organize joint research around the knowledge that has been gained from the exploratory visits and preliminaries. Such joint research should have goals and schedules communicated to both sides, to be used as a measurement of progress by the joint management and supporting structure.

Productive joint research will occur only when the participants know one another and have a clear understanding of the contributions each can make and is expected to make in the process.

Evaluation. These internal measures of progress are then available for periodic evaluations of the individual activities, which will occur in accord with the budget cycle.

Flexibility. These procedures are intended to ensure results for the efforts expended. Individual initiative should be encouraged, and there should be a category and budget for these "program initiation" preliminaries. Such early funds and support should be provided for substantially more programs than can be allowed to evolve into full scale joint research within overall budgets: this will ensure that enough such candidates are explored so that the best ones can be chosen.

A particular bilateral agreement on cooperation should not be regarded as having exclusive responsibility for that field. Thus, some particular aspects of cooperation in theoretical particle physics might as well be done under the SST Agreement as under the ERDA-

managed Joint Agreement, and programs might be explored under the S&T Agreement which should well be transferred, full-blown, to the Environmental Protection or Energy Agreements.

As regards a new Working Group or project, exploratory contact with the Soviet Union should not be initiated until the U.S. side has asked and answered (in a preliminary way) the question, "What are the mutual benefits if the contemplated work is eminently successful, and do they compensate the anticipated opportunity costs?"

Foreign Travel Problems

Scheduled travel to and in the U.S. by Soviet participants under several of the U.S.-U.S.S.R. bilateral agreements is often delayed or simply never undertaken for reasons at times summarized by Soviet officials as "a shortage of foreign exchange." This seems to be more of a problem with Soviet scientists supported by the Academy of Sciences of the U.S.S.R. and less for scientists supported by a Soviet State Committee or Soviet ministries. Even after specific arrangements have been agreed on, actual response to U.S. invitations is generally slow, often non-existent. But delays are not unknown on the U.S. side as well. They should be avoided by both sides. The Joint Commission format provides a means for resolving this problem. If each side (or at least the U.S.) takes seriously its schedule commitments on communications and travel and provides a firm schedule to which the other side agrees, calling to the attention of the Joint Commission serious or persistent failures to meet communications or travel commitments should bring a prompt reply from responsible officials on the other side.

There is a serious problem on the U.S. side which deserves attention: this is the singling out of foreign travel for special (and in many cases, prior) control. Travel ceilings were frequently mentioned by U.S. government participants as inhibiting exchange, since there is direct competition between travel to the Soviet Union and travel to implement domestic science or other international agreements. We believe that foreign travel is an essential contributor to scientific and technological progress; that grant or contract expenditures on foreign travel should be evaluated at renewal time for contribution to the goals of the project. Current administration of scientific foreign travel by ERDA, and to a lesser extent by other government agencies, is restrictive and creates unproductive administrative effort. The agencies and scientific productivity would be better served if foreign travel money were administered under the same rules which govern administration of other government funds by agencies and contributors. Excessive expenditures on foreign travel would be self-defeating in a properly administered grant or contract, in that they would make the individual non-competitive in performance or cost with others competing for the limited amount of scientific support available.

Requiring plans for foreign travel to identify by name the traveller, purpose of travel, etc. one or more years in advance is unrealistic; for instance, post-conference tours frequently give much more comprehensive access to facilities in other countries than formally-arranged visits. Actual administration by ERDA requires such plans in advance, but in turn the ERDA bureaucracy has been unable to

act on those plans until much too late for the laboratories and travellers to respond to invitations, prepare papers for conferences, etc.

It is undesirable to give priority to foreign travel funding for implementation of bilateral and other international agreements, as is currently the policy in ERDA. This blanket priority is defective for two reasons:

(1) It does not work well for its intended purpose since ERDA currently requires as much as two to three months to approve the issuance of an invitation to a Soviet citizen, even if it was already agreed to issue such an invitation as part of the bilateral agreement. Moreover, foreign travel approval by ERDA for an American to visit abroad is sometimes delayed as much as six months or more.

(2) Since the U.S. rarely executes formal agreements for scientific contact with the Western world, this arrangement directly discriminates against our closest scientific partners in favor of those from whom we may have less to learn.

D. ORGANIZATION

We concentrate on the U.S. side of the Joint Commission, in the expectation that the Soviet Union will achieve these required ends by similar or different means. We propose that the U.S. members of the Joint Commission serve as a board of directors for U.S. activities under the Joint Commission, as well as a high-level communication and negotiating team with their equivalent on the Soviet side. To exercise this responsibility, they need some degree of authority, which could be exercised through their executive agent, the U.S. Co-chairman of the Joint Commission. The U.S. Co-chairman could act most of the time as an executive committee of one, but there will be occasions when U.S. interests will require a frank Commission discussion of problems and remedies to an aspect of some Working Group performance under the Agreement. Thus, if one side does not fulfill its responsibilities under some project of the Agreement and no solution can be reached at the Working Group level, this jeopardizes the whole Agreement unless it can be remedied; as such, it should be escalated to the Joint Commission level for discussion at its next full meeting.

We propose that working scientists should be involved in making decisions. The success of the Agreement depends on the willing support of individual scientists; the strong support this Panel has received from our colleagues who have participated in the SST activities provides evidence of the readiness of the U.S. scientific and technical community to contribute effectively to decision-making.

The Commission Staff (or Secretariat) must perform a number of vital functions:

- briefing U.S. participants before they go to the Soviet Union so that they will be aware of Soviet customs and practices. Preliminary material to the individual traveler should also provide him with the names of Americans who have visited the same facilities and individuals in the Soviet Union, together with an

opportunity to read their trip reports and to call them by telephone.

-- similarly, this staff can help enormously to facilitate effective work of Soviet visitors and to reduce the effort required by their hosts and the possibility of an upset.

-- a newsletter should be published to record the activity under the Agreement, and to facilitate the sharing of experience among the various U.S. Working Groups.

-- this office should serve as a clearing house for information, a repository of trip reports which should be indexed (probably with the index available for search on a computer) together with housekeeping information on composition of a visiting group, itinerary, persons contacted on the business of the Agreement, and the like.

-- Such an office would provide more coherent contact with other U.S./Soviet bilateral agreements, a contact which has been largely absent during this first 5-year period.

The Committee for Scholarly Communication with the People's Republic of China of the National Research Council, the Social Science Research Council, and the American Council of Learned Societies provides one model for this office, although there is considerably more activity under the U.S.-Soviet Joint Agreement on S&T.

Crucial to the ability to make progress under the Agreement has been the communication system operated by the Department of State between Washington and the U.S. Embassy in Moscow, whereby communications originating in the U.S. for Soviet counterpart individuals or organizations are formatted by the Department of State in letter form for telegraphic transmission to Moscow. The Office of the Scientific Counselor in Moscow then simply uses a shear to prepare the body of the letter for copying on a local office copier, and delivers it in person or by Soviet mail (as appropriate) to the designated recipients. The Science Counselor can and does follow-up by telephone calls to insure that the return correspondence is received at the U.S. Embassy, Moscow, on time for transmission in similar fashion to the U.S. While some U.S./U.S.S.R. exchanges and cooperative activities make productive use of direct TELEX, the Department of State communication link is extremely useful for activities which have not yet progressed to that stage. The Panel would like to point out that the staff which serves as the Executive Secretariat for the U.S./U.S.S.R. S&T Agreement in the Department of State's Bureau of Oceans and International Environmental and Scientific Affairs (OES) should be credited for a good understanding of and precepts for identifying and conducting Working Group activities under the S&T Agreement.

Organizational Questions

The National Science Foundation is not an operating agency--it has no laboratories or research institutes staffed by personnel of the NSF. Yet the NSF supports and facilitates science, and chooses science and technology to receive support. If there are decisions to

be made about the balance among activities under the Agreement, about the worthwhileness of the Agreement as a whole, and the like, the overall effort should be made visible. Accordingly, we recommend that NSF support for this joint Agreement appear as a line item in the NSF budget.

In some projects under the SGT Agreement, our judgment is that the results thus far under the joint Agreement do not (in terms of their scientific and technological substance) merit the support given, in competition with the expenditure of equivalent funds on domestic research and development of average quality. None the less, we submit there are two additional reasons for continuing to support the Agreement--foreign policy benefits, and the investment in a process and a structure which can be more efficient in later years--with some modifications to increase the return on investment.

However, we do not suggest that it is desirable for all funds by any means to appear in the NSF budget. To a considerable extent, progress under the Agreement is achieved when NSF funds are no longer required--when some U.S. commercial firm may sign an "Article 4" Agreement with the Soviet government and continue exchange for its own benefit. There appears no reason why the U.S. Forest Service should not similarly sign an "Article 4" agreement and conduct its activities henceforth under the umbrella of the Joint Commission, but with a closer coupling with the Soviet counterparts. The aid of the Joint Commission office would be invaluable in the drafting and negotiation of this agreement, in order to ensure that expectations on both sides are reasonable--e.g., that the Forest Service be clear as to whether or not it has access through its counterpart organization to institutions under different organizational sponsorship. Assuming that such an Article 4 agreement is signed by the Forest Service, its expenditures on this program would of course be justified within its own budget. Quite late in the writing of this report, it became apparent that satisfactory joint R&D is being conducted under Article 4 agreements with at least some U.S. firms, giving support to the recommendation of this paragraph. Unfortunately, our methodology was not appropriate to reach these activities, which are not funded by the U.S. government. In fact, a considerable background of controversy exists as to the degree of reporting which should be required. Of course, where data or know-how are to be transferred to the Soviet Union, companies are required by the Export Administration Act to seek a license, and the text of Article 4 agreements are available to the U.S. Government, but beyond that there is only a modest degree of voluntary reporting. Not only would a different discussion outline but a different means of selection of interviewees would be necessary to evaluate Article 4 activities and some mechanism of access to industrial firms, perhaps with a promise not only of anonymity but also of non-divulgence of proprietary information.

Given that substantive direction and negotiating leadership come from the U.S. Cochairman of the Joint Commission who is also Director of the Office of Science and Technology Policy, he will need staff support of a fraction of the time of a senior professional staff person in his office. The State Department communication channel via the U.S. Embassy in Moscow works well and should be retained, and Department of State expertise and foreign policy guidance are invaluable.

It is the business of the National Science Foundation to select among investigators proposing work for support. NSF has a mechanism of peer review which works well. It is clear that NSF should be involved in the award of grants or contracts for the U.S. conduct of joint research or for the management of certain aspects of the exchanges. NSF does not have a long, successful tradition of actual exchange operation, although participants relying on NSF for staff support in some of the Working Groups give NSF high marks in this regard.

In building an appropriate organization, we are then left with the involvement of OSTP, DoS, NSF, and in some cases professional societies or other groups which may in fact be the executive secretariat of a particular Working Group.

We propose greater centralization of staff support in, for example, one of the following:

- National Science Foundation Division of International Programs,
- National Academy of Sciences/National Research Council/Commission on International Relations, on the model of the Committee for Scholarly Communications with the People's Republic of China (principal aspects of the manner in which this tripartite committee conducts its activities might serve as a useful model), or the Soviet Union/East European exchange program,
- Some non-profit organization in the Washington area--e.g., MITRE Corporation, or the like,
- A profit-making organization.

It would be inappropriate for this Panel to recommend a choice among these examples.

VI

SPECULATIVE ANALYSIS OF THE SOVIET
PERCEPTION OF THE S&T AGREEMENT

by Professor Loren Graham, Columbia University

In order to understand the evolution of Soviet-American cooperation under the S&T Agreement, including some difficulties which have arisen, it is necessary to attempt to understand the Soviet perception of the Agreement and how Soviet views have differed from American understanding of the same Agreement.

Any analysis of Soviet perception is, by its nature, somewhat speculative. Our sources are limited and often indirect. Nonetheless, the amount of information available to us concerning Soviet goals under the S&T Agreement is considerable. We have had the experience of negotiating the original Agreement in 1972 and, during the subsequent five years, of finding mutually agreeable areas for cooperation.

Each side has proposed projects, only some of which have been mutually acceptable. By going back through the records of the negotiations and by talking with the American scientists and officials who were present, it is possible to get a view of the profile of the "wish lists" of each side and to see the differences between these profiles. Second, prominent Soviet officials such as V. A. Kirillin, Chairman of the State Committee of Science and Technology (and a vice-premier of the Soviet Union), and D. Gvishiani, Deputy Chairman, have published articles in Soviet journals and newspapers in the last several years in which they gave their opinions on the need for an agreement and their responses to criticisms of it. Third, American scientists involved in the Working Groups and American businessmen who have made contacts with the Soviets under the commercial provisions of the Agreement have analyzed their experiences, and much of this information is available. And, last, American specialists on the Soviet economy and on Soviet science and technology have provided helpful background information.

The picture which will emerge at the end of this short analysis is one of considerable measure of misperception on both sides. There have been a few major disappointments, and such lowering of expectations. Yet it would be an error to overemphasize the differences in viewpoints. From 1972 to the present, both sides have attempted to avoid controversies and obstructions, and both sides continue to believe that a large area of mutual interest and benefit exists. The situation in mid-1977 can probably best be described as one of "sober realism" and continued hope for cooperation. But in order to understand this recent stage, it is necessary to trace the

evolution of the prior stages and the differences of viewpoint which have developed.

A. HISTORICAL BACKGROUND IN THE U.S.S.R.

In terms of the Soviet economy and of Soviet national interests, the immediate background to the 1972 Agreement was a growing realization among Soviet leaders that competition in the international arena was shifting from the more obvious areas of military strength and space exploits to economic vitality based on commercial and consumer technology. While the Soviet Union had been quite successful in building up basic heavy industry and in acquiring a formidable military force, it was faltering in the consumer sector and in the development of the means of controlling its increasingly complex economy. Furthermore, in those areas of advanced technology with broad applications across all sectors--such as the development of advanced computers and of a diverse and sophisticated chemical industry--the Soviet Union was in danger of falling further behind its major competitors. An additional major weakness in the Soviet economy seemed to be the difficulty with which innovations in fundamental research made their way into industrial application.

The exchanges in science and technology which the Soviet Union conducted before 1972 with the West, and particularly the United States, were not fulfilling Soviet needs. The exchange between the Academy of Sciences of the U.S.S.R. and the National Academy of Sciences of the USA, operating since 1958, concentrated primarily on fundamental science, not on technology or socio-economic goals. Trade in advanced technology between the United States and the Soviet Union was quite small, both because of export restrictions in the United States and also because of the lack of an atmosphere of mutual confidence in commercial relations.

In the late sixties and early seventies, the area of technology where the Soviet Union felt the greatest need for advancement was the computer industry. Not only were computers needed for a host of civilian and military applications but also for use in planning and controlling the Soviet economy. Every modification of the quantity of one commodity to be produced in that economy called for unending modifications in the quantities of others. The Soviet planning apparatus seemed to have an insatiable demand for bookkeepers and administrators. A Soviet leader in the field of cybernetics (a term attracting much attention in the Soviet Union), Academician V. M. Glushkov, wrote in the early sixties that if things continued as they were going it appeared that by 1980 the entire Soviet working population would be engaged in the planning and administrative process. In the late fifties, various decentralization reforms had been tried in order to find a more efficient way of running the economy; they either failed or turned out to be ideologically unacceptable. The most likely alternative solution seemed by the late sixties to be the introduction of computers, automation and labor-saving technologies throughout the various sectors of the Soviet economy. Computers and advanced technology assumed almost magical qualities in the writings of Soviet economists and administrators of the late sixties and early seventies.

B. THE IMPORTANCE OF DETENTE

While the need of the Soviet Union for western technology was clear, if one were to write a detailed history of the background of the S&T Agreement the most important antecedent would be the perception by both the United States and the Soviet Union of a need for reduced tension, a perception that culminated in the summit meeting between President Nixon and Premier Brezhnev in May 1972, and the promotion of detente between the two countries. Without that common goal, there would have been no opportunity for either the United States or the Soviet Union to pursue their somewhat differing secondary goals in the areas of science and technology. The overwhelming importance of the mutual desire to reduce tensions was to be evident in the subsequent detailed negotiations over the contents of the S&T Agreement. According to all reports from the people engaged in the negotiations, once the intent to have an agreement had been signalled on the highest level, the negotiations on the lower levels were not particularly difficult. Agreements were reached much more easily than the past history of Soviet-American relationships would have indicated.

C. DIFFERING PERCEPTIONS OF THE U.S.S.R. AND THE U.S. THAT EMERGED UNDER THE CONSENSUS OF MUTUAL INTEREST

In the United States the most important factor influencing the move toward a science and technology agreement with the Soviet Union was political. The United States desired greater world stability and an improvement of relations with the Soviet Union; it hoped to open Soviet society to more extensive interactions with the West, and it wished to have greater access to the Soviet economic and political leadership. All these desires overshadowed any thought of scientific or technical benefit. In sum, from the standpoint of the United States the mix of motivations behind the S&T Agreement was heavily weighted on the political side.

And yet there was also, on the United States side as well as on the Soviet, hope for technical and commercial benefits. As early as 1970 an ad hoc committee headed by James Fisk, president of Bell Telephone Laboratories, had concluded that there were opportunities for mutually beneficial contacts in science and technology between the United States and the Soviet Union. Some American business leaders were attracted by the commercial opportunities which the large Soviet economy seemed to offer.

At about the same time that the American government began to explore the possibility of more extensive contacts in science and technology with the Soviet Union, hints began to come from Soviet officials that new forms of cooperation in this area would be welcome. At a UNESCO meeting of the European Ministers of Science in Paris in 1970, an American science administrator was told by a Soviet official from the State Committee of Science and Technology of the U.S.S.R. that the time appeared to be ripe for discussions between the two countries about cooperative agreements in technical areas, and he further suggested that the appropriate body to deal with on the Soviet side was the State Committee.

No attempt will be made here to trace the ups and downs of the discussions and negotiations between 1970 and 1972 leading to the signing of the Agreement in the latter year. During this period it is probably true that more initiatives came from the Americans than from the Soviets, but both countries were interested in an agreement. That Agreement was reached and signed in May 1972 (reproduced here as Appendix A); it was very general in its terms and only later was it filled with actual substance.

In retrospect it is interesting that the first American drafts of the 1972 SST Agreement contained no references to the provisions that later were to be included in the famous Article 4. These provisions were inserted at Soviet insistence, and they provided for the establishment and development of direct contacts and cooperations between agencies, organizations and firms of both countries. The Soviets emphasized the significance of the word "firms," which they took to mean private American corporations; they later indicated on many occasions that they considered this part of the Agreement as establishing the legitimacy of commercial relations with American companies, i.e., the purchasing of technology.

The Soviet side considered this portion of the Agreement to represent a major shift in American policy. The Americans evidently did not believe that such a far-reaching shift had, indeed, occurred, and a number of subsequent difficulties in cooperation arose over the differing interpretations of Article 4.

When the American and Soviet delegations (headed by Edward David and V. Kirillin) met in Moscow in July 1972 to negotiate the specific areas of cooperation under the general terms of the SST Agreement, each side presented "preferred areas" to the other. The initial lists were as follows:

U.S.

1. Energy Research
2. Water Resources
3. Oceanography and Marine Sciences
4. Agricultural Research
5. Theoretical Physics

U.S.S.R.

1. Computers and Industrial Controls
2. Chemical Catalysis
3. Microbiology
4. Molecular Biology
5. Mechanization of labor-consuming industries (food, light industry)

Compromises on both sides were necessary in order to reach an agreed list of six areas. In the most general terms, the Americans

were more interested in fundamental research; the Soviets in technology. Three of the above areas listed by the Soviet Union were directly related to problem areas of the Soviet economy (computers, chemical catalysis, and mechanization of labor-consuming industries) and the Soviet delegates expressed their clear desire to get access to American technology in these areas. The Americans deflected the Soviet request for computer hardware to a suggested cooperative area on "Computer Usage in Management," and in that way avoided an exchange involving computer design and manufacture. The suggested area of "Mechanization of labor-consuming industries" was dropped entirely as a result of its broad and ill-defined character (in the U.S. view).

Two of the areas of fundamental science requested by the United States (Theoretical Physics and Oceanography) were dropped at Soviet request, but both later came back into the cooperative agreements between the two countries in subsequent negotiations. The Soviets proposed bringing all science and technology agreements under the Joint Commission (including the old exchanges dating back to 1958) but the Americans demurred, wishing to keep the exchanges working in parallel. The Soviets were not particularly eager to include the institutes of the Soviet Academy of Sciences (where most fundamental research is done) in the new exchanges, but did so at American request. All these changes were made in a spirit of accommodation, although the Soviet preference for technology and the American preference for basic knowledge remained clear.

The final list of six areas agreed upon in July 1972 was as follows:

1. Energy
2. Agriculture
3. Computer Usage in Management
4. Water Resources
5. Chemical Catalysis
6. Microbiological production

In later years, this list was modified. Energy and agriculture were moved out into separate agreements. Additional areas were added in electrometallurgy, forestry, metrology, physics, science policy, intellectual property, scientific and technical information, and standardization. The Soviets proposed an exchange in scientific instrumentation, to which the Americans did not agree. The Soviet hope that the Agreement would provide for actual technology transfer gradually diminished, and the emphasis was placed more and more on the exchange of information, not technology hardware, and on joint research.

D. SOVIET PERCEPTIONS OF THE AMERICAN POLITICAL AND ECONOMIC SCENE AND OF THE NATURE OF TECHNOLOGY TRANSFER

In the years since the signing of the 1972 Agreement, the differences between the Soviet and American perceptions of the agreement have become clear. The most significant of these differences can be categorized as: "The Soviet view of the American political and economic scene," and "The Soviet view of the nature of technology transfer."

The Soviet View of the American Political and Economic Scene

On July 8, 1972, at the time the details of the S&T Agreement were being hammered out, Dzhermen Gvishiani, the Deputy Chairman of the State Committee of Science and Technology, published an article in the Soviet newspaper Pravda in which he analyzed the background of the Agreement. The analysis was based on a model of conflicting forces in American governmental and business circles. Gvishiani pictured "far-sighted American businessmen" as being very eager to have trade contacts with the U.S.S.R. because they realized that such trade would be very profitable to them. Opposed to these businessmen, Gvishiani indicated, were conservative circles in the United States who tried to stop these contacts from being established and who were responsible for trade barriers through export controls. In Gvishiani's article, the important thing about the 1972 S&T Agreement was that it seemed to be a breakthrough for American technology to flow to the U.S.S.R.

Gvishiani wrote: "Commercial necessity and scientific and technological expediency have, in a concrete way, pushed representatives of American industry, science and technology toward the establishment of contacts with the Soviet Union, even though, as is well known, reactionary forces in the USA have obstructed this effort in every way."

In other words, Gvishiani pictured American businessmen as so eager to make a profit by selling ~~contacts~~ to the U.S.S.R. that all that was needed to start the flow of technology was to get the U.S. government to turn the levers which open the gates on export controls, and he saw the 1972 Agreement as the beginning of this opening.

Accompanying this model of the nature of trade was a more sophisticated portrayal of the need for a division of labor among nations in areas of science and technology articulated by V. A. Kirillin, the Chairman of the State Committee of Science and Technology, in articles, speeches and interviews after 1972. He emphasized that no country could cover all of science and technology and that there ought to be a division of labor. He remarked that the Soviet Union had decided not to try to go it alone, but wished to cover science and technology jointly with other nations. This decision was a marked change from earlier Soviet desires for economic and technical autarchy, and did indeed open up possibilities for genuine cooperation.

The Soviet View of Technology Transfer

Although the Soviet Union was, like the United States, interested in promoting its own interests under the S&T Agreement, it would not be fair to say that the Soviets proposed a one-way street. They attempted to create a two-way relationship, but the value of that relationship was greatly restricted by their characterization of technology as a "thing" (rather than a process) that can be transferred from one country to another without further intimate involvement on both economic and social levels. It was this effort by the Soviet Union to exchange science and technology in a mechanical "start-off" fashion without establishing true organic relationships that frequently made bilateral agreements between the two countries so

frustrating. The reasons for this Soviet attitude go to the roots of the differences between the two societies.

In a statement prepared for the Eighth "Dartmouth Conference" held in Tbilisi, Republic of Georgia, U.S.S.R., in 1974, Deputy Chairman Gvishiani referred to the beliefs of many Americans that economic agreements between the two countries should lead to better political understanding:

The only point I would object to is the one that states that agreements on joint production are a way to overcome differences, including the field of ideology. We have different socio-economic systems and different ideologies--this is an existing reality to be reckoned with. Ideological differences between us exist and will continue to exist and we should not count on eliminating them by way of developing industrial cooperation or by some other way.

We also believe to be unrealistic the formulation of the question of shared participation of American entrepreneurs in Soviet enterprises--this runs counter to our legislation and the very substance of the socialist socio-economic system.

When American businessmen remarked that it was difficult for them to develop markets in the Soviet Union unless they could have direct contacts with consumers of their technology and in that way analyze the needs of the Soviet economy in order to develop products and services which meet those needs, Gvishiani replied:

A few comments now in connection with the fact that the report of our colleagues mentions the question of "bureaucratic hurdles" and the desire of American businessmen for direct contacts with "real Soviet consumers of their technology."

As far as the so-called "bureaucratic hurdles" are concerned, they seem to exist, to some extent, on both sides. To a certain extent, it is probably inevitable at the current--in fact, initial--stage of the development of trade between our countries....As regards the expansion of contacts with "real consumers," we do not see any particular problem here. Very often, the initiators of new deals for purchase of equipment can be and, in fact, are those who are called "real consumers." It is precisely they who make offers on purchase of certain equipment and in many cases specify a concrete desirable supplier. Representatives of the consumers take part in negotiations, in the selection of supplies, and so on.

It may be pointed out that the American-Soviet Trade and Economic Board is composed, for example, of many directors of the biggest Soviet enterprises--direct consumers of American machines and equipment.

In other words, Gvishiani strongly favored trade between the two countries, but he portrayed it as the passing of technology between the "peaks" of the respective bureaucracies--between American companies and the heads of giant Soviet ministries and directors of

Soviet enterprises. His portrayal saw little or no reason for the American companies to get involved with the details of the use of that technology at the lower levels or with the development of markets in a creative way that might not accord with the initial suggestions made by the top Soviet administrators. The Americans should be happy if they receive payment for their machines.

Compare for a moment this concept of technology transfer and trade with that voiced by Herbert Fusfeld, Director of Research, Kennecott Copper Corporation:

Very few western companies are in business to sell "technology" as a product. Many will license their usable technology as a by-product. Most will not, and often cannot, separate their technology from their legitimate business interests. Thus, they do not look upon the problem as one of "technology transfer," but rather as establishing an overall business opportunity.

This is both a source of friction and of solution. Developing countries have expressed resentment at what they consider unfair tie-in of business conditions to technology transfer. They often fail to perceive that the "tie-in" is an effective mechanism for focusing and making usable the technology involved.

Fusfeld referred further to the

"occasional misconception that 'technology transfer' is something like a pass from a thrower to a receiver. In fact, it has more of the characteristics of an organ transplant, with all the attendant requirements of compatibility with the environment, plus the surgical (i.e., managerial) skills necessary to establish all the intimate working relationships between the transplant and the connecting parts of the system."

It is true that Dr. Fusfeld was speaking particularly here of the relationship between a developed country and a developing country, somewhat different from the relationship between two industrial powers like the United States and the Soviet Union. Nonetheless, American companies are accustomed to developing multi-level ties with firms and agencies in other nations, with buying as well as selling, with the development of markets and permanent business relationships involving services as well as products; American businessmen frequently found the bureaucratic stand-off relationship offered by the Soviet Union as foreign to their normal experience.

American businessmen were not eager to create competition in their own marketplaces by selling manufacturing processes to the Soviet Union; therefore, the simple transfer of manufacturing technology without guarantees of continuing profitable business relationships was often not attractive. The Americans were further troubled by the financing difficulties they encountered in doing business with the Soviet Union (shortage of foreign currency on the Soviet side; requests for credits).

The frustration described above is, of course, only part of the total picture. A few American companies, such as the Joy Manufacturing Company (coal mining equipment) have found much to gain in making agreements with the Soviet Union, and some of them are actively pursuing continuing relationships. And in the non-commercial and academic sides of the S&T Agreement there have been a number of bright spots, such as in some aspects of electrometallurgy. Those successes are reported elsewhere in this report. But the conflicting perceptions between the two countries of the meaning of cooperation in science and technology has led to considerable frustration.

E. THE SHIFT IN SOVIET AND AMERICAN EXPECTATIONS: POSSIBLE PROSPECTS FOR CHANGE IN THE COMING YEARS

Within the mutually desired context of a movement toward better political relations, the original Soviet goal under the S&T Agreement was acquisition of American technology. Gradually, Soviet administrators recognized that this goal was not obtainable. In both the commercial and the non-commercial contacts facilitated by the Agreement, actual technology transfer has been minimal. On the commercial side, about fifty American companies signed agreements of "intent" with the Soviet Union under the provisions of Article 4 of the Agreement. Many of these industrial agreements would not have involved the transfer of truly novel, high-level technology even if they had been fulfilled. However, corporate enthusiasm of these companies for trade opportunities with the Soviet Union has greatly diminished; now, very few agreements of intent are being negotiated, and the older commercial agreements are less active than predicted. In part this lowering of expectations is a result of the bureaucratic difficulties of dealing with the Soviet Union and in part it is a result of continuing restrictions on the export of technology, imposed by the U.S. government. Soviet participants must surely have recognized that it is profits, not activity, which interest U.S. firms, and that price is an important aspect of trade.

On the non-commercial side, the work in the 12 areas under the S&T Agreement has continued, but success, as reported elsewhere in this report (on 9 of the areas), has been far from universal. As a generalization, we can observe that activity here has moved more and more toward work at the "fundamental" end of the "fundamental-applied" research spectrum. On numerous occasions the Soviet delegates have called for the involvement of more industrial representatives in the Working Groups, and for the exchange of scientific instruments and computers, but the transition toward academic exchanges of information has been unmistakable.

Soviet attitudes toward cooperation with the United States in science and technology can probably be described as:

1. Acquisition of technology was never the only Soviet goal in negotiating the Agreement, although it was a significant one. More important on a general political level was the relaxation of tensions with the United States, a goal that derives from international security considerations. That Soviet goal still exists, and cooperation in science and technology, for all the problems it entails, is still one of the best ways of signalling the desire for good relations.

2. Soviet leaders such as V. A. Kirillin emphasized from the beginning that one of the reasons that they wished to have an S&T agreement was to foster a "division of labor" in science and technology. Certain technical problems can be best addressed in a joint fashion. This Soviet attitude still prevails, and it offers genuine possibilities for valuable scientific and technical cooperation in non-strategic areas.
3. Although the opportunities for trade under the S&T Agreement are less than expected, and mutually beneficial technology transfer is difficult to achieve, it is true that the Soviet Union has achieved some gains in these areas, particularly in non-strategic technologies. Soviet science administrators can be expected to continue to call for the involvement of more industrial researchers in the exchange.
4. The Soviet Union has learned much about the research-and-development establishment in the United States, and this information has been helpful in its efforts to invigorate its own research. Soviet science administrators believe that they have much to gain from studying methods of research management in the United States, and particularly the means of translating fundamental research into usable technology.

We are now in a period of realism under which both sides have retracted their more ambitious goals and concentrated more and more on secondary ones. Rather than seeing this as a discouraging prospect, there are good reasons for believing that with careful pruning of existing ineffective programs, a solid basis exists for genuine cooperation in selected areas of benefit to both sides. The Soviet Union's desire for a division of labor in science and technology provides not only a valuable opportunity in terms of its potential results in technical areas, but also a rather novel suggestion for true cooperation. Furthermore, the Soviet Union has opened up institutions and areas of its country under the Agreement that were previously closed to Americans. Beyond that, the Agreement has provided new access to influential Soviet leaders. So long as the financial and security costs are not high (and experience indicates that they need not be), continued cooperation with the Soviet Union under this Agreement seems possible and desirable. Indeed, the shift of Soviet goals discernable during the last five years--away from hopes for acquisition of technology and toward true cooperation in research--is encouraging.

VII

FINDINGS AND RECOMMENDATIONS

A. GENERAL

Individual project assessments and the responses on which they are based tend to be more concerned with administration and bureaucracy than with the substance of exchange (with which only a small number of the participants have had real experience).

The complaint with the most serious implications for the future, is the slowness of communication within the Soviet bureaucracy. In some cases, communications took six months to reach the institution involved. Inability or unwillingness of the Soviets to specify which scientists will be sent to meetings, and late arrival or non-arrival for participation in activities under the Agreement frustrate the expressed goals of the nations involved.

The U.S. side is not blameless in this regard, and comparable observations could come from the Soviet side of the Joint Commission. But scientists are not interchangeable, and joint research anticipated with one Soviet visiting participant cannot be conducted with another.

The participants whom we interviewed often commented critically about a particular deficiency in the activities under the Agreement, as conducted by the U.S. side. "Receiving side pays" is the goal--i.e., travel and subsistence costs of Soviet visitors in the U.S. to be paid by the U.S. host and travel costs for U.S. participants in the Soviet Union to be paid by the Soviets. Two problems are evident in achieving this goal:

- (1) In the case of a single participating agency on the U.S. side, it is hard for that agency to see benefits (justifiable in its normal administrative channels) from expenditures for Soviet visits to other agencies, firms, or academic institutions. Such visits thus tend not to happen and this significantly reduces the value to the Soviet Union of participation in the Agreement.
- (2) There are no funds for amenities for the Soviet participants in the U.S. It is one thing to ask or expect U.S. hosts at the working level to give their productive time and energy to this program, at very real opportunity cost. But the out-of-pocket expenses for hospitality, sight-seeing, and the like are a severe burden on any host. The absence of funds for entertainment usually limits such hospitality to visits to the homes of U.S. hosts and colleagues. The provision of interpreters or escorts is not funded. And the disparity

between treatment of U.S. participants in the Soviet Union is painful to the U.S. participants, who would in fact prefer on their visits to the Soviet Union, to have less sight-seeing, social dinners and the like, and more substantive discussion and exchange. But if Soviet hospitality were reduced to the U.S. style and level, the program would not work, as interpreters, technical guides and chauffeurs are necessary to U.S. groups visiting the Soviet Union.

We propose, therefore, that the staff support of the U.S. co-chairman of the Joint Commission have funds and budgetary control over support of Soviet participants in the U.S.

It should be noted that exchanges under IREX (International Research and Exchanges Board) and the Inter-Academy Exchange Program benefit from the existence of knowledgeable staffs and the availability of travel and support funds not linked to a single host.

It is important to realize that science exchange is not a zero-sum game. Thus, the goal of negotiations should be to obtain more information, not to give less.

The U.S. members of the Joint Commission and their staff must productively evaluate the effectiveness of the individual Working Group leaders as managers, negotiators and communicators. Mistakes will be made and some individuals should be replaced when their performance does not come up to expectations. The task of a Working Group leader is a difficult one, especially as involves interaction with the varied U.S. technological community, but timeliness in communication, effectiveness in negotiation, and adequate quality control of reports can serve as indicators of the performance of the individual.

A normal pattern of agency and industrial behavioral on the U.S. side by optimizing the return to each decision unit, has the effect of reducing overall benefits to the U.S. This is the natural desire of each unit to participate only if there is expected benefit to that unit, thereby excluding potentially highly beneficial interactions whereby the U.S. benefits by involvement of unit A (firm or agency) more than it loses by cooperation involving another firm or agency B. The National Science, Technology and Engineering Policy Act of 1976 which created the Office of Science and Technology Policy, and the integrative science establishment under the President's Science Advisor provides a mechanism of persuasion and decision which can be used in important cases to counter this problem. The initiative should come from that agency or firm which stands to gain substantially from a particular cooperative endeavor.

If A and B are both U.S. government agencies, transfer of funds within the government from Agency A to Agency B, or some justification in the budget support documents could be used. This can be done only in important and unusual cases because the use of this mechanism is so expensive in time of important people; imperfect optimization is the price paid for delegating decision and operating authority in the interests of reasonable response time and span of control. The Soviets have different sources of inefficiency.

If A and B are U.S. firms, one solution is the market--a fair and willing payment to the firm that provides something of value and a charge to the firm that gains. The mechanism can best be left to the commercial realm of licensing by the Soviet Union of the U.S. firms and by the U.S. firms of the Soviet Union. On the other hand, U.S. government agencies in the Executive Secretariat for any of the agreements should not exclude the industrial firms from cooperation in the agreement, as may be administratively convenient in the interest of maximizing influence and minimizing effort.

We have proposed a staff office to carry out a number of important support functions for U.S. participation in this Agreement. Clearly, small Working Group activities and also the exploration of new types of cooperation will be done by this office, with the involvement of selected outside scientists and technical individuals. But the substance of the larger areas of cooperation need not be managed from this office. A contract between the National Science Foundation and the American Chemical Society for catalysis is entirely in order; but ACS or similar Working Group secretariats should make use of the concentrated infrastructure and not duplicate it.

B. INDIVIDUAL PROJECT-BY-PROJECT SURVEY ASSESSMENTS BY PANELISTS AND SPECIAL REVIEWERS

Review of the Activity Under the Working Group on Applications of Computers to Management

**Victor A. Vyssotsky, Panel Member
John Donovan & Ivan Selin, Special Reviewers**

1. Summary and Conclusions

From 1972 through mid-1975, this Working Group was in a "courtship" stage; since the second half of 1975, the amount of real cooperation and interchange has been substantial. It was inevitable that start-up would be slow, both because of the difficulty of establishing good working relations with the Soviets in general, and because of specific Soviet and U.S. sensitivities about computer technology. The effective working relations which now exist are regarded by the U.S. participants as due in large measure to the patience and dedication of D.D. Aufenkamp, the U.S. Working Group Chairman. To build further on the base thus far established, continued full-time program management of this caliber on the U.S. side is essential. In our Panel's effort, 26 participant scientists on the U.S. side were interviewed.

The Working Group has been able to implement all the forms of cooperation listed in Article 3 of the agreement, except that joint research, development and testing have thus far been minimal. There is a possibility of mutually beneficial joint research, development

and testing over the next few years; for most of the topics of this Working Group, such joint research will likely occur through natural evolution. However, one topic pertains to theoretical foundations of software. If joint research in some areas of this topic is to be done, it will be necessary to have more discussion of computer technology than has taken place so far under the Agreement. Such discussion could occur without any "giveaway," on the basis of the very large amount of technical data on U.S. computer technology available to the Soviets through other avenues.

Although the Working Group has been successful in implementing cooperation as described in Article 3 of the agreement, the value of results to date is not great, in terms of the objective stated in Article 2. But much progress has been made in providing the base for future results. In accord with the title, "Applications of computers to Management," little of the value obtained by either party through this Working Group has been directly related to computer science and technology. Some useful information has been exchanged pertaining to economics, econometrics and management science, but the value of this exchange is probably not commensurate with the total U.S. commitment of effort to the Working Group. The Soviets have probably received more technical value in computer topics, in econometrics, and in management science than has the U.S., largely because the U.S. is more advanced in these areas. The most significant value to the U.S. gained by the Working Group so far lies in better U.S. understanding of the Soviet planning and management process, and of Soviet status and approaches in economics, management science and computer science. This understanding is particularly useful for those interested in Soviet economic planning, in the mechanisms of East-West trade, and in specific Soviet markets for U.S. products.

After many project meetings, joint research materialized in September 1976, with the extended visit of 4 American software specialists to the U.S.S.R. This is real progress in mode of operation, but it is too soon to evaluate the resulting benefits.

If the Agreement is renewed, the Working Group on Computer Applications in Management is worth continuing. To be effective, the program of the Working Group should evolve gradually from its present state, towards more intensive efforts in those particular subtopics where the best cooperation and results are being achieved. Any U.S. attempt to introduce a discontinuity would most likely set the Working Group back into the "courtship" stage again.

During the next few years, it will be desirable to place increased emphasis on publications, and on visits of longer duration for joint research. Publication activities are already well under way; the need for added emphasis on publications and longer duration visits will translate into added cost for this activity. Visits to the U.S.S.R. of several months or more have been difficult to arrange, because of unpredictability and bureaucratic problems on the Soviet side, coupled with difficulty in making appropriate U.S. participants available at a mutually suitable time and a shortage of U.S. participants interested in making long visits to the U.S.S.R. These difficulties can be surmounted by continued patient effort on the part of the U.S. administrators of the program, and it is important that this effort be made.

One minor modification of present procedure is in order. Prior to their first visit to the U.S.S.R. under the S&T cooperation program, U.S. participants should be required, rather than just invited, to attend discussions on what to expect and how to cope in the Soviet Union, and on what has been learned by others visiting on the same topic. It is wasteful of program resources and potentially disruptive to the program to permit U.S. participants to arrive in the U.S.S.R. less than fully prepared for the stressful and frustrating differences they will encounter.

NSF administration of the U.S. effort in this Working Group has been somewhat complicated by the fact that the normal mode of operation of NSF depends on unsolicited research proposals. Activity of the Working Group clearly cannot depend on unsolicited proposals from U.S. workers, and the U.S. Working Group Chairman has had to run what is in effect a directed program within an agency whose primary mode is quite different. This has not caused any serious problems, but it is important that NSF explicitly recognize that the nature of the activity requires a high degree of central direction and coordination.

2. Further Discussion and Details

Five topic areas are subsumed under the Working Group on Computer Applications to Management:

- Econometric modeling
- Computer analysis applied to the economics and management of large systems
- Application of computers to the management of large cities
- Theoretical foundations for software for applications in economics and management
- Computer-aided refinement of decision-making and education of high-level executives

During the course of the agreement, about 100 U.S. participants have visited the Soviet Union, many of them several times. About 50 Soviet participants have visited the U.S. There have been a number of joint conferences and symposia; a large number of papers have resulted from these. Thus, the Working Group has been an active one.

The topics covered by the Working Group were chosen to satisfy certain constraints and pressures. The Soviets were (and are) eager to have computer science and technology included under the Agreement. The U.S. viewed the Soviets as lagging far behind the U.S. in most technical aspects of computing, and saw little likelihood of mutual benefit accruing from any strictly technical joint endeavor in this field. As a result, topics were chosen which cover various things more or less closely related to computing, but which mostly do not lie within the main thrust of computer science and technology in either country.

The choice of topics, together with the inherent difficulty the Soviets have in working flexibly outside of their own established channels, ensured that it would take a long time for the cooperation to produce results of value. Indeed, it is rather surprising that so much has, in fact, been accomplished. Thus, it is not appropriate to measure results to date against what one would expect from joint endeavor between U.S. institutions, or between the U.S. and other developed countries of the West. Rather, one must view the primary achievement of the Working Group to date as being the establishment of good working relationships with a number of Soviet institutes, ministries, individual managers and technical contributors.

To assess this we must briefly consider the state of the art in the Soviet Union, and ask where mutually beneficial opportunities may lie.

In computer science and technology, the U.S.S.R. lags several years behind the U.S. in both hardware and software. For example, Soviet work on operating systems and on data management systems is rudimentary by U.S. standards. Some Soviet theoretical work is of high quality, and they have a significant number of capable individual technical contributors. However, their ability to move from theory to practice seems to be very weak. This limits the potential benefits in two ways. First, with a few specific exceptions, there is little we can learn from the Soviets about computer science and technology. Second, since the Soviets have not managed to translate into practice the wealth of American technical data already available to them through the open literature, their technology is unlikely to benefit greatly from any further technical data we might disclose, except certain specific data which are proprietary or classified, and which we would not make available in any event.

However, there are respects in which strictly technical cooperation on computing can be beneficial. For one thing, there seems to be substantial difficulty in each country in assimilating the literature from the other. We have trouble locating pertinent Soviet literature, even that which has been published. Under the Agreement we have received a large number of technical papers which would otherwise have been hard to locate and acquire. Soviet papers tend to omit the context from which the work arose, so that it can be quite difficult to discern why the work was done, and to what it might be applied. This difficulty can be considerably eased by personal communication between U.S. and Soviet workers. It seems that the Soviets have corresponding difficulties with our literature. There is no other obvious explanation for the fact that the Soviets seemingly do not make use of results published in the U.S. which we view as directly applicable to what they are engaged in doing. So they, too, can benefit from direct communication in this respect. And finally, there are certain topics, such as the computer architecture of small computers, and techniques for program optimization, where their theoretical work and ours are not greatly disparate. On such topics as this, both countries, and indeed the general field of computer science, can benefit from cooperative endeavor. Thus, in computer science and technology, there is limited but real prospect for mutual benefit. This is now being pursued in one of the topics of the Computer Applications to Management Working Group, and the endeavor should be continued.

With respect to economics and econometrics, Soviet work is extensive and intensive, but largely inapplicable to the U.S. situation. Embedded in their economic theory are various assumptions invalid in the U.S.; indeed, many U.S. experts believe some of their assumptions are invalid even in the Soviet Union. An added complication in cooperation on this topic is that Soviet papers presented at joint symposia have tended to be general and diffuse, but there is some indication that this problem is declining.

Cooperation in this area is yielding some benefits, and these might be categorized roughly as follows. First, there is the same value in clarifying the literature that accrues in computer science. Second, the Soviets seem to find it useful to them to have our people point out constraints and assumptions in their models which we believe to be invalid. Third, we learn much about their approach to planning and modeling by understanding their approach to economics and econometrics. Finally, some Soviet work that is inapplicable to macroeconomics in the U.S. may have value to use in work on the microeconomic internal structure of single firms or enterprises.

This last point comes across more clearly in connection with the Working Group topic on use of computers by city governments. In both the Soviet Union and the U.S., the city government is an identifiable enterprise which provides a broad range of goods and services. So it is not surprising that this topic has become an effective area of cooperation. A jointly developed book is being prepared for publication, and it seems that significant mutual value emerges from comparison of how U.S. and Soviet municipal governments approach problems of planning and delivering municipal services.

Soviet workers in the field of management science and management information systems seem to be oriented toward topics and papers which are broad, theoretical, and often rather detached from the practical details of the real world. Of course, one can find plenty of instances of this approach in the U.S. as well. But in Soviet academic work, there is a notable lack of papers oriented to the "how to" approach which characterizes much of the U.S. literature. This is a field in which, if we are to learn anything from Soviet methods and experience, it must be done through close cooperation and face-to-face discussion of the sort which is occurring under the Agreement. Even with personal contact, it has taken considerable time and effort to get useful communication going. In addition to all of the other factors which impeded technical cooperation on this topic, a Soviet academic propensity for the broad-brush approach in this field showed up in early joint conferences. But the Soviets have been gradually adjusting their approach as they come to understand the outlook and focus of their U.S. counterparts.

This last observation is an example of a phenomenon which has shown up throughout the activities of the Working Group on Computer Applications in Management. Individual Soviet participants have mostly been eager and willing to engage in close cooperation and open discussion. However, their weltanschauung is so different from ours that it takes much time and patience, and repeated efforts on our part, to get past what seem to us to be rather mystifying roadblocks. The Soviet participants and coordinators are very concerned to have the Soviet Union show up well in this cooperation, so they gradually modify their modes of operation when they perceive something as

reflecting adversely on Soviet competence. But it hasn't happened rapidly.

It is because the Soviets have undergone a process of adaptation which was apparently quite difficult for them that it is important not to introduce discontinuities in the program of the Working Group, if the Working Group is to continue at all. Any major discontinuities in direction or level of effort which the American side might introduce would undoubtedly disrupt the process of adjustment which the Soviet counterparts have been going through. It would be a severe setback for the program if the Soviets were to infer that U.S. interests in this Working Group are too unstable to warrant the accommodations the Soviets have been learning to make.

One would like to be able to formulate a clear assessment of the cost effectiveness of the work on Computer Applications to Management. The activities of this Working Group are currently consuming just under \$1,000,000 per year. One can reasonably foresee a rise to about \$1,500,000 per year, to accommodate a rising level of publication and of substantive joint work. Is it worth it? This is a difficult question to answer, because it's not obvious how one should answer the question: "Compared to what?"

If the Agreement were not desirable for other reasons, it would be extremely difficult to justify the cost of this work on grounds of economic return or of increase in scientific and technical knowledge. However, if one takes the Agreement as given, one must allow for the inherent difficulty and delay in dealing with the Soviets on matters of this sort. With allowance made for this, the results and trend of the Working Group are considerably better than what one would expect *a priori*. So we conclude that if the Agreement is to be continued at all, the work of the group on Computer Applications in Management should continue, with attention to improved efficiency and effectiveness in conduct of the activities, and should evolve gradually towards more joint research and joint publications.

Review of the Activity Under the Working Group on Chemical Catalysis

F.A. Cotton, Panel Member
J. Rabo and G.A. Somorjai, Special Reviewers

1. Procedure

(a) From the entire list provided to us by the Department of State were selected 13 persons who 1) had visited the U.S.S.R. under the Agreement and 2) could be contacted by mail and telephone for questioning. The list of those persons we actually interviewed is attached as Table I.

(b) In addition, it was decided to speak with a significant percentage of the U.S. chemists and engineers who have served as Project Coordinators or Principal Investigators, and with Dr. J.D.

Baldeschwieler who has been the U.S. Chairman of the entire Working Group in Chemical Catalysis. Table II lists those persons questioned.

(c) All information was obtained by telephone after the interviewee had had a few days to examine the discussion outline that had been mailed.

In Part 2 we shall give a summary of responses, including, where pertinent, an indication of the range of views expressed on the different points. These summaries are a synthesis of F. A. Cotton's own experience with about 1/3 of the persons interviewed plus the evaluations made by his expert reviewers, Drs. Rabo and Somorjai. In Part 3, we attempt to answer the three questions posed at the end of the memo entitled "Goals and Methods of the NAS Review."

Some additional preliminary information is worth stating to put the evaluation in perspective. The funding, as obtained by phone from NSF is as follows:

FISCAL YEAR	AMOUNT
1973	\$ 254,000
1974	896,000
1975	82,000
1976	391,200
1977	<u>395,000</u>
	\$2,018,200

The organization of the program into subareas has changed with time and now differs from that originally adopted, as given for example, in the November 18-20, 1975, hearings before the House Committee on Science and Technology, pages 219 and 220. According to information received verbally from J.D. Baldeschwieler the organization is now approximately as follows:

1. Homogeneous Catalysis (J. Halpern, Project Coordinator)
2. Heterogeneous Catalysis, Chemical Physics approach (W.K. Hall, Project Coordinator).
3. Heterogeneous Catalysis, classical physical-chemical and kinetics approach (V. Haensel, Project Coordinator).
4. Engineering (J.J. Carberry, Project Coordinator).

Finally, the consensus from all interviews was strongly that the overall administration of the program by J.D. Baldeschwieler has been responsive and efficient and that the American Chemical Society (ACS) office has done a very good job of handling travel arrangements as well as of getting and circulating reports from persons who have visited the U.S.S.R.

2. Responses of Those Interviewed

All but one interviewed had been in the Soviet Union, many for periods of months, most for one or more week-long visits. All gave the impression of having started out very sympathetic to the program. For most, not all, the program represents their sole meaningful direct contact with Soviet scientific institutions and personnel.

No one rated Soviet work "at the forefront" except perhaps on occasional, very limited, particular problems. Taking catalysis as a whole, the ratings were generally that they lag behind the U.S., Western Europe, and Japan by a significant amount. Their rate of growth was said to be slow or zero by nearly everyone.

About one third of those interviewed said that the contacts with the U.S.S.R. fostered by this program had had some useful effect on their own science - not a lot, but some. Others said there was hardly any or none. As far as technology and industry are concerned, no one seemed to think ours had benefitted noticeably from the Soviet contact.

In general, with perhaps only two exceptions, all thought that there was real cultural and political (in the larger sense) benefit from the program as a result of the personal contacts.

With only a few small, specific exceptions, no one thought U.S. progress in catalysis was dependent upon contact with or detailed knowledge of the Soviet work. A very typical comment was that it had been interesting to get a better idea of what they do and how they do it, but what that knowledge showed was that, with very few exceptions, they are far behind us. Consistently it was said that those of their facilities that we have seen are far inferior to ours. It is, of course, possible they have some better ones that Americans have never been permitted to see. The Chernogolovka laboratory of Shilov (see later) and a synchrotron x-ray source in Dubna are possible examples.

No concrete suggestions were made for good new areas of future collaboration, other than perhaps synchrotron x-ray study of supported catalysts, jointly by Dubna and SLAC.

No respondent felt that the Soviet repression of its citizens directly affected the program (see below for one possible exception) or his or her attitude towards participation. They dislike the repression but feel that participation in the program should be continued anyway.

As already said, few felt that the program was beneficial to the U.S. on purely scientific or technical grounds, and even those who did respond affirmatively on this referred to very limited topics rather than general benefits. Everyone who went for a working visit to a Soviet laboratory (3-6 months) said the same length of time spent in an advanced research laboratory in the U.S. or Western Europe would have been vastly more productive and, in the purely technical sense, educational.

With respect to the homogeneous catalysis program, everyone concerned emphasized two serious shortcomings due to Soviet intransigence. First, Dr. Vol'pin (of the Organcelement Institute in

Moscow), considered by many the best Soviet chemist in the homogeneous area, has never been allowed to leave the U.S.S.R., let alone come to the U.S., and except for a 3-month visit to Chicago by one person, neither has anyone else from his group. Second, Dr. Shilov, the other principal Soviet chemist in this area has two labs. One in Moscow appears of lesser importance while the other in Chernogolovka (near Moscow) is the source of very good work. However, no American has even been allowed to even see, let alone work in, the Chernogolovka laboratory. These two highly important restrictions have been the subject of repeated appeals and protests from the American side. If there is no change regarding these matters, those now participating in the homogeneous program do not think it is worthwhile for them to continue in that program.

The homogeneous area has not, despite sustained efforts by the U.S. project coordinator, J. Halpern, fared very well. The U.S. had several of its very best people as principal investigators at the start, but they have become thoroughly disillusioned and quit.

It was suggested by several that unless the Soviets are willing to accommodate on the two points mentioned above, the homogeneous chemical catalysis program should be terminated, or continued only in terms of sending representatives to conferences, but not as a joint research effort.

The engineering program seems to have worked better according to some--but not all--of those who worked in it.

In general, those who went for working visits found individual Soviet scientists friendly and helpful, to the extent they could be. It seems to be the bureaucratic levels above that cause the inhibitions, restrictions and downright blockages.

3. Conclusions

A. On what basis do the current projects merit continuation? Only a small fraction of the projects seem to merit continuation purely on the basis of their cost effectiveness as research. On the other hand, nearly all participants thought that cultural and political benefits flowed from the programs and that these alone might justify continuation even when S&T pay-off does not. However, a problem here is that, starting several years ago, applications by U.S. principal investigators for funding are being subjected to standard peer-review evaluation. It is hard to see how or why funding could be recommended for projects in which we send people to do research there, which are unlikely to result in excellent science. It is very clear that no excellent science, and only a small amount of even routine science has resulted from this type of cooperative research program during the past 5 years. On the other hand, there have been and could well be further examples of projects in which Soviet scientists come and work in our laboratories. But the program would then be quite unbalanced and fail to meet the criterion of being mutually beneficial.

B. Who gets what? The program has had only a slight (and certainly not cost-effective) impact on our S&T in the catalysis area. It would appear that the Soviets have derived quite a lot of benefit

by seeing how our superior facilities or organizations work, and by learning techniques.

C. Are there problems of program management? Soviet red tape is the problem. This manifests itself in unjustified restrictions, g.g., refusal to let Vol'pin travel, and denial of access to Shilov's main laboratory, as mentioned. There is little freedom and no flexibility in travel plans for Americans visiting the U.S.S.R. Finally, agencies and institutions in the U.S.S.R. over which the Soviet Academy has no control or influence are seldom available to the Americans, even when they are highly relevant to the work of the program.

TABLE I

PERSONS INTERVIEWED WHO MADE
WORKING VISITS TO THE U.S.S.R.

Dr. Kathleen C. Taylor
Physical Chemical Department
General Motors Research Labs
Warren, MI 48090

Dr. Roy H. Magnuson
Department of Chemistry
Boston University
685 Commonwealth Avenue
Boston, MA 02215

Dr. William C. Connor
Box 1021 R
Allied Chemical Corporation
Morristown, NJ 07970

Dr. Glenn Tom
Department of Chemistry
University of Chicago
Chicago, IL 60637

Dr. John L. Gland
Physical Chemistry Department
General Motors Research Labs
Warren, MI 48090

Dr. Duane D. Bruns
Department of Chemical Eng.
University of Tennessee
Knoxville, TN 37916

Dr. Michael P. MacLaury
General Electric Company
Corporate Research and
Development
Building K-1, Room 5A-10
Schenectady, NY 12301

Dr. Stanislaw B. Ziemecki
Dupont Experimental Station
Building 328
Wilmington, DE 19898

Dr. Thomas Weil
24 W. 241 Hemlock Lane
Naperville, IL 60540

Dr. Randall Partridge
University of Delaware
Department of Chemical Eng.
Newark DE 19711

TABLE II
U.S. PROJECT COORDINATORS AND
PRINCIPAL INVESTIGATORS INTERVIEWED

Dr. John D. Baldeschweiler
Division of Chemistry and
Chemical Engineering
California Institute of Technology
Pasadena, CA

Dr. Alexis T. Bell
Department of Chemical Engineering
University of California
Berkeley, CA

Dr. J.E. Bercau
Division of Chemistry and
Chemical Engineering
California Institute of Technology
Pasadena, CA

Dr. Michael J. Boudart
Department of Chemical Engineering
Stanford University
Stanford, CA

Dr. James J. Carberry
Department of Chemical Engineering
University of Notre Dame
Notre Dame, IN

Dr. Vladimir Haensel
Vice President
Science and Technology
Universal Oil Products
Des Plaines, IL

Dr. W. Keith Hall
Department of Chemistry
University of Wisconsin
Milwaukee, WI

Dr. Jack Halpern
Department of Chemistry
The University of Chicago
Chicago, IL

Dr. Leon Lapidus
Department of Chemical Eng.
Princeton University
Princeton, NJ

Dr. Eugene E. Peterson
Department of Chemical Eng.
University of California
Berkeley, CA

Dr. W. Henry Weinberg
Department of Chemical Eng.
California Institute of Technology
Pasadena, CA

Dr. Alvin H. Weiss
Department of Chemical Eng.
Worcester Polytechnic Institute
Worcester, MA

Review of the Activity Under the
Working Group on Electrometallurgy

Arden L. Bement, Panel Member
George Dieter & Joseph Klein, Special Reviewers

Introduction

In order to review and assess the accomplishments under the Working Group on Electrometallurgy four individuals, including the Project Leader, were designated from each project for telephone interview by an expert reviewer. At least one representative each from industry and a university were included among the four. From this grouping seventeen in all were interviewed. Professor George Dieter, Carnegie-Mellon Institute, surveyed the projects in electroslag remelting, plasma arc remelting, and electron beam vapor deposition. Dr. Joseph Klein, Cabot Corporation, surveyed the projects in solid state joining, welding and welding materials, and engineering properties (with emphasis on welding materials for low temperature applications). In addition, questionnaires were sent to ten experts in fields related to electrometallurgy, but who were not actively involved in the bilateral exchange. Bement interviewed two individuals selected from this group in addition to Dr. Nate Promisel, the Working Group Chairman. The sampling from the active participants in the bilateral exchange (active investigators, conference attendees, and delegates) represents approximately thirty percent of the total.

Of this 60% or so, [*Does not include many unidentified industrial participants] who actively participated in the Working Group in Electrometallurgy 28 visited the U.S.S.R. at least once, 5 visited twice, and 2 visited three times. Each U.S. project leader under the Working Group was included in the U.S. delegation to the first joint U.S.-U.S.S.R. Working Group meeting held in Moscow and Kiev during the week of October 29 through November 2, 1973. In addition to two Working Group meetings held in the Soviet Union individual project team meetings were held: the Plasma Arc Welding team met with their U.S.S.R. counterparts in September, 1974. Likewise, the Solid State Joining Team met in 1975, the Electron Beam Evaporation team met in September, 1976, and the Cryogenic Team met in October 1976. Two joint Working Group meetings have been held in the U.S. Additional project team meetings were held in the U.S. during visits of Soviet experts (Electroslag, Plasma Arc, Solid State Joining, Electron Beam Evaporation, and Cryogenics).

One joint U.S.-U.S.S.R. joint symposium on cryogenic materials and welding was held during October 10-14, 1976 at the Paton Institute, Kiev, Ukraine, U.S.S.R. The symposium was attended by seven members from the U.S. and by some 150 scientists and engineers from the Ukraine and Russia. Of the 34 papers presented, 12 were presented by the U.S. team. Although the symposium was reasonably well organized and conducted, the Russian papers were difficult to follow, and additional conversations with the authors were necessary to gain understanding. The U.S. papers represented research in progress in the field of cryogenic materials and welding, but work outside of the actual joint Working Group. The Soviets (especially Verkin)

registered disappointment in the U.S. participation. Among the complaints were the following: of the 20 Americans expected* [*These included a number of U.S. industry persons not directly involved in the cryogenics task force but separately invited by the Soviet side] only seven came; the symposium organizer and project leader from the U.S., A. Van Echo from ERDA, did not attend (because of foreign travel funding restrictions); and the group leader, R.P. Reed of NBS, was called home on the last day of the conference. In addition, four American scientists (outside of the task force) from NBS had been invited to be guest research workers at the Technical-Physical Institute for Low Temperature at Kharkov and none of the invitations were accepted. The Soviets agreed to publish the proceedings of the symposium in English and provide copies to the U.S. Working Group members free of charge.

A second general joint symposium is planned to be held in Kiev (E.O. Paton Institute) in October, 1977, to serve as a vehicle for presenting progress under the various projects within the joint Working Group Agreement, most of which are scheduled to be completed during May-June, 1977. In addition, Soviet investigators working under the project on engineering properties will present papers at a symposium on cryogenic materials to be held in Boulder, Colorado, in August, 1977.

Motivations

The primary motivations on the parts of both American and Soviet participants were to effect an exchange of technology, to become more familiar with centers of excellence and specialists involved in them, to increase interpersonal access by fostering better working relationships, and to achieve a more confident appraisal of the state of the art in the fields of electrometallurgy in both countries. In addition to these specific technological motives, there were some secondary motives.

Prior to the U.S.-U.S.S.R. Agreement on Scientific and Technical Cooperation there was interest within the E.O. Paton Institute in establishing cooperation with the U.S. in electrowelding and melting. Having perceived themselves as a center of excellence within the U.S.S.R. and at the cutting edge of technology throughout the world they expected through such an exchange to enhance their prestige within the Soviet science and technology community in order to serve their own political ends and to expand their reputations throughout the free world. Furthermore, since the E.O. Paton Institute is primarily engaged in melting technology (ingot preparation) but also engages in equipment design, development of welding methodology and standards, and the transfer of welding technology to Soviet industry, considerable advantages would accrue to them in not only observing U.S. approaches to equipment development and manufacture but also in establishing business relationships with U.S. industrial firms for licensing Soviet inventions in the field of electrometallurgy.

Consequently, from the onset of the working Agreement the projects adopted took on the organizational structure (branches) of the E.O. Paton Institute and the Soviet project leaders corresponded to Branch Chiefs within the Institute.* [*Two of the projects, however, (solid state joining and materials for cryogenic applications) were suggested

by the U.S. side and were to involve Soviet scientists from other institutes, i.e., the Baikov Institute, Moscow; the Institute for Problems in Strength, Kiev; and the Physical and Technology Institute for Low Temperature, Kharkov]. This had several ramifications in establishing meaningful joint activities under the Agreement:

1. The U.S.S.R. side had offered a highly vertically-integrated, technology-oriented institute as the basic source of Soviet participation. In contrast the participation from the U.S. side consisted of a horizontally-integrated group of university scientists and industrial engineers.
2. Many of the scientific and engineering interests of the U.S. participants were not matched by the scope of activity within the E.O. Paton Institute but were instead coupled with activities in other scientific-oriented institutes in the U.S.S.R.
3. At the initial meeting of the Joint Working Group the Soviets had well-constructed plans and knew what they wanted (heavy industrial involvement). Although the U.S. delegates had to initially probe and "counterpunch" there was constructive "give and take" and a mutual respect and understanding of each side's interests were reached.

There were several reasons for the selected U.S. participants (selected because they were leaders in the fields) agreeing to participate in the exchange: professional interest, interest in learning about Soviet activities and their key people in the field of electrometallurgy, responsiveness to a request from their government, etc. To some extent, however, the existence of the Agreement also presented an opportunity for some to receive NSF support for the kind of research not normally supported by the NSF. Among the industrial participants with existing or emerging business interests directed toward the U.S.S.R., participation would promote familiarity with Soviet technology and people and would probably give them an advantage over the competition in capitalizing on any technical innovations or surprises.* [*It should be noted, however, that information about and data derived from the total program were made readily available to any interested parties, and visits by Soviet experts were made to non-participating companies and research institutions.]

Many of the above differences in approach and motivations were overcome in the course of negotiation and the establishment of working relationships. However, the initial disadvantage (due to the Soviet position) felt by the U.S. side was turned into a psychological advantage during the course of the exchange. The ability of a collection of individuals with disparate interests and coming from a variety of U.S. institutions to organize themselves quickly around a common goal and to turn out significant research in a free, collaborative mode has had a telling impact among the Soviets. It is thought by some U.S. participants that their Soviet counterparts believe they are giving more than they are receiving in the sense that their better ideas may be more easily and quickly exploited in the U.S. than in the U.S.S.R. and that their apparent lead will be quickly lost.

Summary of Conclusions, Findings and Recommendations

A. Nature and magnitude of effort

Projects approved under this Working Group and project leaders are the following:

- Electroslag Remelting (ESR); M. Flemings, MIT
- Plasma Arc Remelting (PAR); R. Wasilewski, NSF
- Electron Beam Vapor Deposition; R. Bunshah, UCLA
- Welding and Welding Materials; W.F. Savage, RPI
- Engineering Properties (with emphasis on welding materials for low temperature applications); A. Van Echo, ERDA
- Solid State Joining; R.W. Heckel, Michigan Technological University

Much of the successful work accomplished to date has resulted from unfunded industrial participation, which has been promoted and coupled into the NSF-funded work through the personal interest and entrepreneurship of the Working Group members and the good will of the industrial participants. Nearly all of the 10-15 tons of testing materials sent to the U.S.S.R. have been donated by industry. The value of these contributed efforts could be equal to (or might exceed) the \$1.76M provided by the NSF through FY 1977. The NSF support by years has been \$810K in FY 1975 (two-year awards), \$550K in FY 1976, and \$800K (\$150 committed, \$120K in progress of being awarded) for FY 1977. The annual rates of NSF expenditures for the six projects are approximately \$50K for welding and welding materials (heavy industry contributions), \$250-300K in electroslag remelting, \$250K in plasma-arc melting, \$150K in electron beam deposition, and \$150K in solid state joining. Most of the work in cryogenic materials and weldments is being contributed by industrial and governmental laboratories.

Among the NSF-funded contractors under the exchange are the following:

UNIVERSITIES

- MIT--ESR and Plasma-Arc Melting
- RPI--Welding and Welding Materials
- University of Illinois--ESR
- Stanford University--Plasma-Arc Melting
- University of Michigan--Plasma-Arc Melting
- UCLA--Electron Beam Deposition
- Lehigh University--Solid State Joining and LNG Structural Materials

Case Western Reserve University--Solid State Joining

INDUSTRY AND NFP

Cabot Corporation--ESR

Battelle Columbus Laboratories--Plasma-Arc Melting

Manlabs--Electron Beam Deposition

Metcut--Electron Beam Deposition

Westinghouse Corporation--Solid State Joining

Among the contributed investigations are those being provided by the following:

ARMCO Steel--LNG Structural Materials

ALCOA--LNG Structural Materials

U.S. Steel--Welding and Welding Materials

International Nickel--LNG Structural Materials

NBS--LNG Structural Materials

Vacuum Engineering Company--Electron Beam Deposition

Chemetron--Welding and Welding Materials

Union Carbide--Welding and Welding Materials

Hobart Fraser--Welding and Welding Materials

The work being done under the above projects covers the spectrum from high-quality applied research to rather conventional product characterization and mechanical property evaluations. Some very good work is being done in ESR, PAR, and EB evaporation in fundamental process definition and modelling.

A concise description of the activities and accomplishments under the Working Group on Electrometallurgy is given in the Report to the Fifth Meeting* [*Currently scheduled to be held in July 1977] of the Joint U.S.-U.S.S.R. Commission and in the outlines of the Project on LNG Structural Materials (attached).

B. Contributions made to science and technology as a whole through the Agreement

Vehicles

1. Specific contributions made to U.S. science and technology.
- a. Detailed knowledge of the alloy chemistry, microstructure, and mechanical properties of Cr-Mn structural steels for cryogenic applications. Their counterparts do not exist in

the U.S. for economic reasons (i.e., because the U.S. has ready access to Ni for high-Ni steels).

- b. A significant rethinking of solid state joining technology in the U.S. based upon surprising diffusion bonding successes for dissimilar materials achieved by Kasikov at the Meat and Dairy Institute and in the several practical applications in which such bonds are being used.
 - c. Knowledge of significant developments in new types of welding equipment at the E.O. Paton Institute.
 - d. Detailed characterization and evaluation of a new, low-cost ferritic filler material which can have a significant economic impact on the welding of shipboard LNG tanks.
 - e. Evaluation of process technology and equipment design for plasma-arc remelting for which there is little or no commercial capability in the U.S.
 - f. Understanding of advanced U.S.S.R. refractory coating technology for tungsten-carbide and high speed tool steel cutting tools.
 - g. Evaluation of the benefits of high-nitrogen steels (which cannot be produced currently in the U.S.) made possible by plasma-arc melting technology. Also the understanding of how such steels can be thermally-mechanically treated to develop superior properties.
2. Specific contributions to U.S.S.R. science and technology.
 - a. Detailed evaluation of U.S. welding procedures and their effects on weldment quality.
 - b. Understanding of the application of acoustic emission in assuring the quality of weldments and diffusion bonds. This technology is not highly developed in the U.S.S.R.
 - c. The use of computer modelling methodology in process simulation, definition, sensitivity analysis and optimization.
 - d. Fundamental understanding of the thermo-chemistry of slag-metal interactions in ESR and gas-metal interactions in PAR.
 - e. Detailed characterizations of U.S. Ni-steels and aluminum alloys for cryogenic applications which are not yet employed significantly in the U.S.S.R.
 - f. Evaluation of U.S. electron beam coating equipment which is more sophisticated than U.S.S.R. counterparts (especially in power supply equipment).
 - g. Understanding of how highly-developed scientific approaches to the metallurgical and fracture mechanical evaluation of weldments in the U.S. can benefit welding technology.

- h. Confirmation through U.S. investigations of compositions, properties, and overall quality of high-N steel ingot produced by PAR. Also, understanding of how such ingots can be fabricated into useful mill forms.
- 3. Assessment of Soviet technology.
 - a. U.S.S.R. is at the world forefront in plasma arc melting and the application of ESR for shaped castings and hollow ingots.
 - b. Their work on EB coating of cutting tools is rated quite high both in understanding fundamental principles and in reducing these principles to practice.
 - c. The U.S.S.R. is lagging somewhat behind the U.S. from an overall point in the development of EB vapor deposition equipment.
 - d. The quality of cemented tungsten carbide tools in the U.S.S.R. is definitely inferior to those in the U.S.; however, a newly acquired plant from Sandvik (Sweden) will soon correct this deficiency.
 - e. On the aggregate, the Soviets are in a strong position relative to the U.S. in the development of materials and components for cryogenic (LNG) applications and are dedicated to strengthening their position due to heavy emphasis on energy-related technology. The evaluations of their materials being conducted under the exchange will clarify their comparative strength in this technology.
 - f. The U.S.S.R. has strong capabilities in solid state joining and is applying this technology outside of the aerospace industry where the principal applications exist in the U.S.
 - g. With respect to welding, the E.O. Paton Institute is quite advanced in equipment design and process development but is less so in non-destructive evaluation techniques, knowledge of metallurgical fundamentals, and quality control and assurance procedures.
- 4. Does the Agreement facilitate keeping abreast of Soviet S&T?
 - a. There is a positive consensus on this question. A few U.S. scientists had Soviet contacts before the Agreement. For these few the Agreement has probably been of marginal benefit.
 - b. The Soviets were generally accommodating in arranging visits to their institutes and key scientists, the selection of which were made through mutual discussions. Learning where the good work is being done, how much of it is significant, and who is worth knowing in the U.S.S.R., however, has been a process of education.
 - c. U.S. investigators who had either little interest or a low opinion of the Soviet S&T literature before the Agreement now

seek out articles by Soviet scientists for whom they have gained respect.

- d. Familiarity with differences in approaches and perceptions in solving technical problems in the U.S.S.R. has stimulated a considerable amount of rethinking of technical approaches in the U.S.
5. Degree to which Agreement fosters international S&T contact.

This is not considered to be a significant factor in electrometallurgy, since good awareness and technical interchange exist independently of the Agreement.

C. Grounds on which current projects in the Agreement do or do not merit continuation

By most criteria this program has been relatively active and successful, as indicated by the following:

- a. There have been visits to both U.S. and U.S.S.R. research and production facilities by the U.S.S.R. and U.S. Working Group members, respectively.
- b. Several joint Working Group and task group meetings have been held to plan joint programs and to exchange technical information.
- c. There are active research tasks underway in each project area. Over fifteen research tasks have been approved by the NSF covering each of the project areas.
- d. Nearly 15 tons of materials from each side have been exchanged in the following categories:
 - Plate and pipe weldments, welding rods, and welding fluxes under both the Welding and Welding Materials and Engineering Properties Projects (liquefied natural gas container materials).
 - A 400-kg plasma-arc reselted billet of a Fe-Cr-Mn-Ni (High-N) steel has been supplied by the U.S.S.R. for characterization in the U.S.
 - Both standard and coated (semi-commercial) cutting tools have been exchanged for cross evaluation.
- e. An exchange of scientists is currently underway involving a two-month visit by a Soviet scientist to UCLA and Stanford (1 month each) and a one-month visit by a U.S. scientist at the E.O. Paton Welding Institute in Kiev. The Soviets have urged additional exchanges, but suitable U.S. candidates have not been available.
- f. There has been a major conference sponsored by the joint group in Kiev in October 1976. A second major conference is scheduled for Kiev in October 1977. In addition, about five

Soviet participants under the Working Group will participate in an International Symposium in Cryogenic Materials to be held in Boulder, Colorado during August 1977.

The following general comments apply to this Working Group activity:

There is considerable interest by U.S. industry and government groups in U.S.S.R. technical capabilities and applications of ESR and PAR because of the long development lead time (since 1950's) and extensive scale-up of these technologies in the U.S.S.R. Current assessments place the Soviets ahead in applying these technologies on a production scale and the U.S. ahead in the fundamental understanding and modelling of the underlying mechanisms and process automation. These factors have had a direct bearing on the motivations of the two sides in setting program objectives. The U.S.S.R. members interested in ESR and PAR have attempted to push these objectives toward industrial "scale-up-type" programs involving heavy U.S. industrial participation; whereas, the U.S. side has pushed laboratory-scale modelling and fundamental studies involving principally university participation. The NSF sponsorship of U.S. programs has fostered the latter approach. The U.S.S.R. would now prefer to break away from these industry-oriented projects because of the high U.S. interest in proprietary U.S.S.R. technology, such as hollow-shape casting. These technologies are extensively used in the U.S.S.R. for military hardware (ESR for heavy armor steels and PAR for titanium).

The following recommendations are made for continuation of projects under the Working Group:

- a. The Working Group on Electrometallurgy should be renewed under the new Agreement; however, after an additional year of activity a "zero-base" analysis of each project based upon the data that are just now becoming available and new data generated during the interval should be made.
- b. The project in ESR has been disappointing and has caused frustration on the part of the U.S. team leader because of Soviet intransigence and their early insistence that the exchange have heavy industrial and, hence, low scientific content. At one time the Soviets requested that this project be dropped and then later changed their minds. Although the NSF is funding some research at MIT and Cabot Corporation none of this is effectively coupled with U.S.S.R. investigations. This is an area where the U.S. could benefit from an effective exchange not only because of recent technical advances but also the sheer magnitude of effort in this technology in the U.S.S.R. However, should it be continued the project leadership should come from industry and hard bargaining should be entered into to get a meaningful quid pro quo.
- c. The project in Plasma Arc Remelting has the prospects of good joint scientific and technical activity and should be renewed. Consideration should be given to expanding the project scope

to include nickel-base and titanium alloys in addition to ferrous alloys.

- d. The projects on electron beam deposition and solid state joining have been highly successful. The former has involved the only two-way scientist exchange under the Working Group and both have involved important exchanges of materials. There is good parity in the U.S. and U.S.S.R. achievements in these technologies, and synergistic benefits can be derived through continued joint cooperation. There are some limitations, however, in joint programs that can be defined under the Solid-State Joining Project because of technology export implications and the sensitivity surrounding some of the materials (composites) defined for evaluation.
- e. The project on welding and welding materials will shortly be completed. Most of the effort to date has been a calibration of mutual capabilities and characterization of welding materials and weldments. Unless a more substantive program of research can be identified with a reasonable mutual payoff there seems to be little justification for initiating a new program.
- f. The project on LNG structural materials will be completed in a month or two. New initiatives have been proposed for discussion at the fall symposium in Kiev and the concurrent meeting of the joint Working Group. There is a desire on the part of one member of the U.S. task force that the Soviet side be more open about their aluminum alloy technology, and this should be considered in deciding on renewal of this project.
- g. Future negotiations under the Agreement should provide the U.S. side with greater opportunity to propose the Soviet collaborators and research centers where joint research will be conducted. To an increasing degree, the work should be diversified among more Soviet institutions rather than tailored to the interests of a single U.S.S.R. institute as has been the case to date.

Problems of Program Management and Possible Approaches for Solution

It must be recognized by the U.S. government that successful negotiation and program implementation require a significant amount of continuing effort on the part of the investigators and especially the Working Group and task force chairmen for the exchange to be successful.

Problem: A significant amount of time since 1973 has been spent not only in negotiating acceptable projects with the U.S.S.R. participants in the Working Group but also in trying to anticipate both Department of State guidelines for industrial participation and Joint Commission reviews of the proposed projects. In addition, normal NSF proposal review, approval schedules, and standard contracting practices were counterproductive to early program start-up.* [*Actually, Soviet work started before U.S. work] The NSF is credited as being an objective

funding agency which has been relatively flexible in evaluating and approving projects promoted by the Working Group. Also, the NSF program manager has been given high marks for his technical competence, effectiveness in dealing with Soviet delegates, and cooperation. However, most participants feel that the NSF is not an appropriate agency to administer a technology-intensive agreement under their existing policies. Many of the active projects were eventually approved despite unfavorable peer and internal reviews. Although some would prefer program administration by a mission-oriented federal agency there are also concerns that this will narrowly structure the program along such an agency's mission objectives.

Proposed Solution: A continued Agreement should be administered by either a not-for-profit institute or a professional society under a grant from the NSF. Flexible policies should be established for proposal acceptance, industry-university coupling, and publication and dissemination of both U.S. and U.S.S.R. work accomplished under the Agreement. This would also provide a means for adequate administration, coordination, and liaison with all potential interest groups. The American Society for Metals, the American Institute of Mechanical Engineering and the American Welding Society are among possible management organizations for an Electrometallurgy Working Group in the future.

Problem: There was no unified source of guidance available to the U.S. team at the beginning of negotiations to use as a basis for planning research objectives or setting priorities. Such guidelines developed as the program unfolded. Such interactions along with uncertainties in funding support stood in stark contrast to the Soviet initiatives which were coordinated and backed up with adequate funding authority. This constrained the U.S. side (from a timing standpoint) in defining meaningful joint projects involving firm commitments. However, success under the exchange was achieved relatively quickly primarily due to Dr. Promisel, the Working Group Leader, who exercised consummate skill in dealing with all parties concerned, in defining the U.S. position, and in keeping all interested Government agencies informed.

As yet there are no clear guidelines from the Department of State in coupling industrial-university research activities under the program. Yet, these types of programs are most meaningful in achieving mutual technical benefits in the electrometallurgy field. Nevertheless, Department of State specialists were exceptionally helpful in the implementation of the Agreement.

The lack of administrative procedures for importing and exporting material, hosting conferences in the U.S., acquiring translation and transcription services, and providing social reciprocity have been major impediments in obtaining, interpreting, and broadly disseminating U.S.S.R. technical information in the U.S. The ease with which Soviets have been able to provide these services has given them a decided advantage in acquiring U.S. information at a very favorable benefit/cost ratio.

The inability of U.S. teams visiting the U.S.S.R. to take their own interpreters greatly restricted the amount of technical

interchange, since the discussion among U.S.S.R. scientists was totally lost to the U.S. participants.

Many complaints have been lodged about the amount of non-productive touring and socializing associated with visits to the U.S.S.R.

Solution: Many of the above problems can be readily solved by better planning, development of policy guides for U.S. team leaders, and better inter-team coordination and communication. A more realistic approach is needed not only in setting the level of funding required for achieving meaningful progress under the Agreement but in how the funding can be used. Since it will always be difficult to persuade U.S. scientists to work in the U.S.S.R. for an extended period of time and since symposia are too few and far between it is recommended that week- to month-long workshops be pursued to explore technical problems in depth and to jointly conduct short-term demonstrations and experiments.

D. Candidates for new projects under the S&T Agreement:

The following have been proposed:

- a. High-pressure metalworking.
- b. Metallic corrosion.
- c. Basic research in steelmaking.
- d. High temperature coating.
- e. Superplastic forming.

Of these only items a. and b. have undergone experimental evaluation to establish mutual interest, reciprocity, and willingness to cooperate. The other areas should go through a similar evaluation for a time adequate to at least answer the question: "What are the mutual benefits if the exchange is eminently successful?"

None of the above items fit logically under the established Working Group in Electrometallurgy. It is recommended that the scope of the present Agreement not be expanded to accommodate any of the above but rather that they stand on their own merit for separate justification. The reasons are simple: 1) there is no benefit to be derived in diluting a well-focused activity just to provide a broader umbrella, 2) each of the above projects has a logical set of subactivities which would be necessary to achieve a meaningful exchange, and 3) each of the above requires separate technical leadership from the top down in order to make the enterprise successful. However, considering the increasing importance of materials in global matters, such as trade, economic development, environmental protection, and security of availability, consideration should be given to establishing a new Agreement in Materials Science and Technology to encompass vital areas of mutually profitable scientific and technical exchange under the broader field.

As a final recommendation, Working Group leaders for existing or new Agreements should be selected from those who have broad Washington experience as well as extensive industrial and university contacts. The character, management ability, and persuasive capabilities of the Working Group leader are probably more important for success under

such an enterprise than the scientific strengths of the individual participants.

Review of the Activity Under the Working Group on Forestry

James Bethel, Panel Member

K. B. Dickerman & Gerard Schreuder, Special Reviewers

I. General Recommendations

1. That the Forestry scientific exchange be continued within the S&T Agreement. The program topics identified in forestry fit into neither agriculture nor environmental agreements. The forestry program involves both science and technology and is well accepted in the U.S.S.R. under the S&T Agreement.

2. The U.S. needs to develop a more effective means for exchanging information about program plans, agreements, trips and results of activities within the S&T Agreement and between the other major agreements (environment, agriculture, energy, etc.).

3. Translation and availability of scientific publications is a continuing problem in forestry and from what we have heard it occurs substantially in other subject areas. We believe it would be desirable for key individuals associated with the S&T agreement to take the leadership in overcoming this problem.

4. Before an existing area of exchange is closed out, it would be highly desirable to assure ourselves that there are no further gains to be made. Once an area activity is terminated it is unlikely to be taken up again. Before a new area is included in the program, there should be exploratory discussions with U.S.S.R. scientists as to the potential for mutual benefits.

5. Considerable U.S. activity will take place in Alaska in the coming years, while the U.S.S.R. is developing Siberia. Remote sensing materials from ERTS/LANDSAT projects are readily available to both U.S. and U.S.S.R. participants. This promises a fruitful area for study of methodology and evaluation.

6. Forest Productivity. It is of considerable interest to the U.S. what the U.S.S.R. forestry plans are for Siberia, specifically whether the Siberian forest products will largely be moved west (to the European markets) or east (to the Asiatic markets). In either case U.S. trade relations in the Pacific area could be impacted dramatically. An understanding of Siberian forest productivity coupled with a knowledge of the developing transportation infrastructure, the harvesting and forest industrial capacity in Siberia, could contribute greatly to an understanding of timber supply outlook questions in the U.S. as well as in the U.S.S.R.

7. The funding mechanism for the exchange program should be changed to ensure broad participation in forestry: universities, forest industry and the U.S. Forest Service. In addition to travel

monies, monies to buy some release time should be available. While funding and broader participation are clearly different issues, they cannot be separated.

8. In general, major science input and output is not likely to emerge until the program matures. In forestry, at least, a first tentative step has been taken through a series of exploratory discussions. The next step is to accelerate scientist-to-scientist exchanges at the working program level.

II. Scope of the Forestry Program

In 1973, a seven-man U.S. team visited the U.S.S.R. to discuss a program of forestry exchange. This was followed in 1974 by a meeting in Washington, D.C. between a Soviet delegation headed by G. Vorobyov, Chairman, State Forestry Committee, U.S.S.R. Council of Ministers and a U.S. delegation headed by John R. McGuire, Chief, Forest Service, U.S. Department of Agriculture. The report of this joint Working Group signed by the leaders of the two delegations on October 30, 1974, affirmed understandings that were reached in earlier meetings concerning the scope of the information exchange program.

Five forestry problem areas were identified. These were:

1. Effective methods and means of detection, prevention, and control of forest fires.
2. Integrated control of forest insects and diseases.
3. Classification of forest biogenesis and determination of their biological productivity potential.
4. Development of improved technological processes of forest harvesting.
5. Reforestation and afforestation.

After initial discussions, the program was limited to the five areas of responsibility. In the U.S.S.R., concern for utilization of forest products is the mission of two other ministries not currently involved in the program. Forestry science research in the U.S.S.R. is the responsibility of both the Academy of Sciences and the State Committee of Forestry. To date only the State Committee has been involved in the exchange. In the U.S., forestry research programs are pursued by several universities, the U.S. Forest Service and forest industry.

The forestry information exchange program was funded directly by the parties involved. No NSF funds were available. The Forest Service funded the forestry exchange program under its regular research budget. The burden of support was in a number of cases actually assumed by specific research projects of the several regional forest experiment stations. Some scientists spent most of their travel budget to participate in the exchange so that their work at home suffered.

III. Observations of Panel Reviewers & Participant Scientists

1. Funding has limited results in the forestry exchange program. The annual expenditure level was \$25,000 for travel; and about \$100,000 for salaries.

2. Participation in the program included 19 scientists--14 from the Forest Service, 4 from universities and 1 from industry.

3. Most involvement to date has been on a onetime basis as the program is just getting underway and funds are limited.

4. The cooperative effort up to this point has consisted largely of exchange trips and discussions. U.S. scientists have gone to the U.S.S.R. or Soviet scientists have come here. This kind of exchange was useful, even necessary to get to know each other. It is felt, however, that for most of the program areas identified in the original Agreement, enough of the contacts have taken place for scientists to now initiate specific projects. Some additional trips still may be necessary for definition of program areas and to discuss potentials for other research.

5. The program areas selected and agreed upon in the original Memorandum of Understanding largely reflect areas of primary concern to the U.S. Forest Service and their U.S.S.R. counterparts.

6. There was considerable sentiment that the preparation of U.S. scientists before they went to the U.S.S.R. could be improved. Many felt they could benefit by a much better and more meaningful briefing from the State Department. Debriefing after the trip was virtually nonexistent, consisting in one case of a meeting with the Agricultural Attache at the request of the participants. Some participants mentioned that the group meetings which were held by the NAS Panel (in lieu of telephone conversations after each had received the questionnaire) were their first opportunity to exchange impressions and experiences. Before these meetings, this had been limited to one-to-one exchange whenever the situation arose. It was felt that a well-organized debriefing some time after a visit would be informative.

7. The number of people who participated in the exchange program is small. To get views of the 19 participants, the NAS Panel organized three group meetings...two in Washington, D.C. and one in Spokane, Washington. The first group of participants met with Messrs. Bethel, Dickerman and Schreuder in Washington, D.C., the second group with Messrs. Bethel and Schreuder in Spokane, while Dickerman interviewed others in the Washington, D.C. area. Reactions from the scientists and the administrators who had gone to the U.S.S.R. ranged from, "The Soviets pumped me for all I knew" to cautious optimism, "We have made the contacts, we feel there is something to learn, we now know the mission counterpart scientists, a sabbatical-type exchange is in order." Language was a formidable barrier. Working scientists in the U.S.S.R. often did not know of the U.S. visit prior to the arrival of the U.S. visitors. Vice versa, when Soviets were coming to the U.S., their U.S. hosts did not know who was coming, what backgrounds would be represented, whether they were scientists, administrators or both, and often not even when exactly they would be coming. Most agreed that the present mode has limited productivity from a

scientific point of view. Strong preference was expressed to organize future trips and contacts on a scientist-to-scientist basis.

IV. Program Subjects and Their Status

1. Development of effective methods and means of detection, prevention, and forest fire controls.
 - a. Development of techniques and tactics of forest fire control: U.S. scientists felt that there was little to learn from the Soviets.
 - b. Detection of forest fires with the use of infrared equipment: This is an area of potential mutual interest which has remained largely unexplored. Because satellite systems are involved, potential military sensitivities may make cooperation doubtful.
 - c. Development of mathematical models for forest fire behavior: the Soviets are largely at par or ahead of Americans and it is felt that the U.S. could benefit by cooperation and joint research projects. A joint paper has been written and will be published. This seems to be an area meriting further cooperation. U.S. scientists have expressed readiness for joint work.
 - d. Fire control equipment development: The U.S. has little to gain, though the existing U.S. fire control specialists did pick up a new parachute idea for smoke-jumping purposes.
 - e. Fire management: It was felt that since the U.S.S.R. is one of the few countries (together with Canada, France, and Australia) that shares problems similar to those encountered in the U.S., it was of considerable interest to keep in contact. In addition, the U.S.S.R. is a country which has developed fire management techniques to some extent independent of Western developments. This makes their hypotheses, approaches and results of considerable scientific interest.
2. Integrated control of forest pests and diseases.
 - a. Integrated control of Gypsy Moth. The Soviets express considerable interest and appear to be well-informed about the assessment and forecasting methods for Gypsy moth (population dynamics). They were also interested in the work on sex-attractants and microbial control. It was felt the U.S. could benefit by joint work. There is considerable interest in the U.S. to maintain contacts because the Soviets appear to be the best source of parasites of the Gypsy moth.
 - b. Though not specified in the initial Agreement, some information exchange took place on the Tussock moth. A U.S.S.R. delegation visiting the U.S. was interested in the viral control work. U.S. entomologists indicated several opportunities for joint research in this area

and for further exchange of information about ongoing studies.

3. Classification of forest biogeocoenosis and determination of their productivity.

- a. Development and specification of classification of forest biogeocoenosis: The Soviets have developed a one-system approach. In contrast, in the U.S. there are a number of systems, each being tried. The U.S. scientists expressed the feeling that the Soviet system has much to offer and should be followed up by planned studies and exchanges.
- b. Development of potential productivity of forests: One U.S. scientist has been involved in this. This area should be expanded to biome productivity level. The Soviets appear to have done some unique work on the productivity of worldwide ecosystems. The U.S. can gain by further association with this research.
- c. Influence of forestry activities on dynamics of forest biogeocoenoses: under the U.S./U.S.S.R. Environmental Agreement a U.S. tundra ecologist has been to the U.S.S.R. three times. There is an opportunity to learn from the Soviets about the impacts on tundra from forestry operations. To achieve this, there is an urgent need for better coordination of activities carried on under the several major U.S./U.S.S.R. exchange agreements.

4. Development of improved technological processes and means of mechanization of forest harvesting.

The U.S. has probably little to learn in this area. The Soviets, on the other hand, are interested in this program area. It was included in the original Agreement largely at their insistence. It is an area which could be used in a quid pro quo negotiation.

5. Reforestation and afforestation.

- a. Introduction, selection, breeding and production of tree seeds. This is an area which has already seen some concrete results from the exchange program: the U.S. and the U.S.S.R. now are engaged in a modest but potentially important seed exchange program. Some interest has also been expressed in the Soviet tree selection and tree breeding programs. A continuation in this area is encouraged.
- b. Establishment of shelterbelts in various natural conditions and their tending. The main U.S. work in this area dates from 1930. The Soviets have been involved since the early 1800's. It was felt that the U.S. could learn quite a bit in this area, and should develop several joint projects to test basic ideas which have grown out of Soviet experience.

**Review of the Activity Under the
Working Group on Metrology**

**Solomon J. Buchsbaum, Panel Member
Donald Langenberg, Special Reviewer**

A. Nature and Magnitude of Effort

Most of the work of the group on metrology lies in three general areas: 1) intercomparison of national measurement standards; 2) exchange and evaluation of standard data, including basic data relevant to the fundamental physical constants; 3) basic research relevant to the development of new standards or improvement of existing standards. The first cooperative topics chosen were in the first two categories. Several from the third category were added later.

The following is a listing of the individual topics within the Working Group on Metrology:

1. Intercomparison of pressure standards.
2. Intercomparison of transportable volt standards.
3. Intercomparison of standards for ionizing radiation.
4. Intercomparison of measurements of laser wavelengths.
5. Intercomparison of standard thermocouples.
6. Intercomparison of thermoelectric voltage converters. [This topic was dropped by the Working Group on Metrology and transferred to an international framework (i.e., CODATA).]
7. Refinement of the values of fundamental physical constants.
8. Development of automated information systems for standardization.
9. Cooperation in the exchange and evaluation of standard reference data.
10. Methods of radiometric measurements.
11. Coordination of U.S. and U.S.S.R. time scales by means of transportable clocks and by new methods utilizing radiation signals from satellites or from natural cosmic sources.
12. Exploration of new possibilities for improvement in the electrical base units, using quantum effects in superconductors.
13. Analysis of the relative merits of methods for high voltage measurements, based upon the Stark Effect, the Kerr Effect, and other phenomena.

It is estimated within the activities of the Working Group on Metrology that some 4 or 5 scientists from the American and Soviet sides have visited the other country each year since the inception of this cooperation. The financial expenditures on the U.S. side, since the metrology cooperation was commenced, have been on the order of \$15,000-20,000 each year for approximately three years.

B.

1. With one exception, interviewed participants in the Working Group on Metrology could identify no specific contributions to U.S. science and technology from the Agreement activity. The exception was in the area of standard reference data. Here the Soviets have provided very good data for incorporation in data evaluations and subsequent publication in tables and handbooks. As a specific example, thermodynamic data on ethylene were provided prior to publication in the Soviet Union. Also, U.S. and Soviet temperature scales were compared and found to agree.

2. The consensus is that the Agreement does significantly facilitate keeping abreast of Soviet work in metrology. The most generally mentioned mechanism was the establishment of personal contacts through exchange visits. These contacts lead to personal correspondence and more timely exchange of information on research plans and results.

3. Interviewed participants generally felt that the Agreement has succeeded in fostering contacts in SGT between Soviet and U.S. workers. Although almost none could describe direct and immediate effects of these contacts on their own work, almost all felt they had benefited from substantially increased knowledge of the Soviet system in general, and the working styles and environments of their counterparts in particular. Most felt their participation had been worthwhile; some felt the benefit to be rather marginal.

C.

1.a. Possibilities for new project activities. The following were mentioned:

- Methods for radiometric measurements.
- Synchronization of U.S. and U.S.S.R. time scales.
- Research on methods for coupling electrical and mechanical base unit standards, using superconductivity.
- Methods for the measurement of high voltage.
- Joint data analysis for determination of fundamental constants.
- Fundamental research related to the maintenance of basic standards.

- Cooperative load sharing in the analysis of candidate data for standard reference use.

According to a recent status report on the Agreement, the first few have already been incorporated in the joint work plan.

1.b. Suggestions for revised modes of cooperation.

Several interviewed participants described in very strong terms a problem which results from the operation of the Metrology Working Group by one lead agency on each side, the National Bureau of Standards (NBS) in the U.S. and the State Committee for Standards (Gosstandart) in the U.S.S.R. Gosstandart has several institutes, including VNIIMS in Moscow and the Mendeleev Institute (VNIIM) in Leningrad. Although VNIIMS has a respectable basic research effort, it does not match that of NBS; it is a new laboratory, and Gosstandart is reported to be actively engaged in strengthening its basic research capability, to complement its existing apparently high capability in maintaining and disseminating the classical ("old-fashioned") basic standards. At present, however, the natural counterparts of most NBS participants concerned with advanced standards research and development are outside Gosstandart's organization, in Academy Institutes, etc. Lack of communication between Gosstandart and these other institutions (intended or unintended) limits the effectiveness of SET Agreement exchanges by impeding or failing to facilitate contacts between the appropriate people on both sides. NBS is now discussing with the Soviet Academy means for cooperation under the SET Agreement, in order to formalize contacts with research institutes under the Soviet Academy of Sciences, where some of the best Soviet work in modern metrology appears to be conducted.

2. Problems of program management.

Interviewed nonmanagerial participants were all generally satisfied with the program management on our side, but dissatisfied with management on the Soviet side. In addition to the compartmentalization problem discussed in the previous section, the extreme slowness of Soviet responses was mentioned by several participants--six-month turnarounds on correspondence, etc.

D. Candidates for New Projects

None outside metrology were specifically suggested, but one participant with interests in laser and x-ray physics indicated that Soviet work in laser physics led the world in some areas. Institutes mentioned were the Institute for Solid State Physics, Novosibirsk, the Institute for Spectroscopy, Moscow, the Lebedev Institute, Moscow State University, and an institute in Kiev. It may be possible to define nonsensitive areas for a collaborative effort in laser physics.

General Remarks

Those interviewed noted that the Soviets send their very best people to visit NBS; however, their attendance at international conferences is undependable, often late. Their lack of regularity in

attending such conferences appears to represent a significant loss to the Soviet work in metrology. The mechanics of the exchange would benefit greatly from faster response to letters and a more expeditious carrying out of commitments. This Working Group operates under the principle of "receiving side pays"; Soviet visitors are the only ones for which NBS has such a mechanism.

Supplementary Information

The Special Reviewer for Metrology interviewed the following NBS personnel:

A.O. McCoubrey, Chairman of the Working Group

R.D. Deslattes, Project Coordinator, Intercomparison of Laser Wavelengths.

B.N. Taylor, Project Coordinator, Refinement of Physical Constants.

D.R. Lide, Jr., Project Coordinator, Standard Reference Data.

D.G. McDonald, Participant (cryoelectronics).

M.A. Olien, Participant (cryogenic reference data).

V.D. Arp, Participant in the U.S./U.S.S.R. Energy Agreement (cryogenic helium heat transfer).

R.P. Reed, Participant in the Electrometallurgy Working Group of the WT Agreement [alloys for cryogenic applications (LNG)]

Arp's comments were quite consistent with those of the metrology group, although his participation was under the Energy Agreement. Reed's views differed substantially from those of the metrology participants. The differences will be described below.

In addition to the points made above, the following results of these interviews seem relevant.

1. With very few exceptions, Soviet work was viewed as below U.S. work in quality. "Extremely variable" was a common description.

2. Despite several concrete examples, benefits to the U.S. participants and their institutions were most often characterized in general terms: "Improved knowledge of Soviet system, laboratories, and people, enabling us to read between the lines of their publications better." "Personal contacts leading to better and more timely awareness of Soviet work." To discussion question G, asking for assignment of value weights to 1) direct topic of Agreement, 2) byproduct information, and 3) general information, the replies clustered around 1) 33%, 2) 0%, 3) 67%.

3. Almost all of the participants said their attitude toward participation in the exchange had not been influenced by issues like restricted emigration and human rights in the U.S.S.R., but almost all

believed the quality of the exchange indirectly suffered from these problems.

4. Several participants cited difficulties in getting any real work done during exchange visits, through direct discussions with the scientists actually doing the work. "The Soviet managers either do all the talking or inhibit the exchange by monitoring discussions between us and their underlings." "Too much time is wasted on touring, wining, and dining. We need less hospitality and more laboratory give-and-take."

5. Many participants felt the major impediments to real effectiveness of the Agreement were the compartmentalization and apparent lack of internal cooperation and communication within the Soviet system, and the barriers to free flow of information and "the right people" between the two countries. Several suggested we should really try to "put the screws" to the Soviets on these points in the forthcoming negotiations.

By chance, the Special Reviewer interviewed one NBS staff member (R.P. Reed) whose participation was not in metrology but in electrometallurgy. It is perhaps useful to mention that the Reviewer found striking differences between the views of Reed and his metrology colleagues. In discussion question G, Reed placed most of the weight on "scientific and technical value directly aligned with the explicit topic of interaction," while the others most heavily weighed the more general "understanding of some aspect of the Soviet structure and methods." Reed noted that U.S. work had been directly affected by the exchange through the establishment for the first time of a cooperative group in the U.S. (NBS, Lehigh, RPI, ARMCO, ALCOA) to match the capabilities of the Paton Institute, and gave specific examples of work which may (although it has not yet) directly affect U.S. technology.

Review of the Activity Under the Working Group on Microbiology

Walter Gilbert, Panel Member
William Philips & Marvin Johnson, Special Reviewers

The microbiology program has five sub-projects, recently increased to six. These projects are: 1) the use of microbes to produce proteins, ultimately for human or animal consumption (single-cell protein), 2) the computer control of microbial growth and fermentation, 3) the molecular biology and genetics of industrial micro-organisms, 4) the use of enzymes for industrial production or in agriculture, 5) the microbiological control of agricultural pests, and 6) geo-microbiology, the use of microbial flora to detect oil or minerals (not yet implemented).

It is immediately obvious that all these projects are couched toward the production of elements of commercial importance. This direction, toward applied science and technology, has meant that there was a serious mismatch between the Soviet and American sides. On the

Soviet side, the development of commercial (industrial) opportunities is a government function, while in the U.S. it is a private function. Thus, this Agreement attempted to match government funding agencies, such as the NSF, with its access to academic research, with the government ministry running the microbiological industry of the Soviet Union. The Americans had access at home to research opportunities, but had no access abroad to their academic or academician counterparts. The Soviet participants apparently hoped for items of direct commercial interest, but they were prevented from obtaining such items or knowledge because the major route to specialized industrial knowledge is through the direct purchase of technology. However, exchange between individuals in the U.S.S.R. and this country does serve an educational function, teaching the Soviets how to find what they want in the U.S. system and conversely exposing Americans to the peculiar details of the Soviet system. One might argue that even the small amount of exchange created by these agreements serves a very useful purpose in enabling some knowledge of the functioning of the Soviet system to emerge. The genetics group points out that they have located some genetics work in the Soviet Union of which they were completely unaware before. (In part, this fact also reflects the fact that the Soviet scientists are not totally knowledgeable about the details and diversity of work going on elsewhere in their own country. They tend to operate on a "need-to-know" basis.)

Not much actual Soviet-American exchange was created by the microbiology group. The Working Group held a total of five meetings, alternating between the U.S.S.R. and the U.S. (This means that a group of ten people has made several trips to the U.S.S.R., and their Soviet counterparts, constant from year to year, made several trips to the U.S., including brief visits to laboratories.) Two meetings have been held in the Soviet Union, each involving about ten additional Americans traveling to the U.S.S.R. Several meetings have been held in the United States, and two further meetings are to be held in the Soviet Union within a few months. All of these meetings are rather small, involving six to ten foreigners and a group of twenty to fifty people from the host country. The cost of such meetings is modest, running between \$20,000 and \$50,000 per meeting. Such meetings are reasonably productive in the exchange of information, especially if the meeting proceedings are published. In a few cases under this program, some documents have been produced. There has not been any serious exchange of Soviet or American scientists or postdoctoral students. However, one or two Soviets are expected to arrive in this country next year for nine-month periods, whose visits were originally devised for this program (however, they will, in fact, finally come to the U.S. under the aegis of other exchange programs, not this one) and one American graduate student is to go to the U.S.S.R. in a year. There is one single instance of joint collaboration in a program in that, in one case, an American went to Moscow to learn a specific technique, brought it back and set up research in this country using that technique.

Among the subfields of this Working Group, only enzyme technology seems to be advancing rapidly in the Soviet Union, judging from the results U.S. visitors to the U.S.S.R. under the Working Group have seen (Some U.S. participants within the microbiology program reported to our Panel that they did acquire new information in the U.S.S.R. about the existence of light- and sound-induced enzymes.) This description would suggest that a low level of exchange has been

achieved, the major exchange consisting of the people and scientists involved in the administration of the program, who have made several visits to other countries. A slightly greater number of scientists, on the order of twenty, from the U.S. have visited the U.S.S.R. Presumably, the program would increase in scope if contact could be made within the more academic communities on the Soviet side, and if the Soviets would relax their barriers enough to allow more scientists out to study in the U.S. The flow of knowledge is essentially from the U.S. to the Soviet Union. In these fields, we appear to have the high technology and the high science; our only gain is the opening up of Soviet society and the education of ourselves as to the nature of that society and of individual Soviets as to the nature of the American society.

The Striking Cost of This Program

Although the actual exchange on this program has been modest, and the amount of exchange work practically non-existent, the Working Group on Microbiology represents the greatest element in budgetary support from the National Science Foundation. This program was supported at the following levels:

Fiscal year 1974 -- \$1.4 million

Fiscal year 1975 -- \$1.8 million

Fiscal year 1976 -- \$1.8 million

These numbers bear no resemblance or relationship to the actual amount of exchange. The funds went for research grants given to individual American scientists, working on a variety of topics that were seen in some sense as related to the Soviet-American science and technology exchange. These grants did not involve Soviet co-workers; they did not support Soviet postdoctoral studies here; and they were not explicitly joint Soviet-American projects. Although in many cases, the grants clearly represent pure research that would have been supported in its own right by the National Science Foundation, in other cases the grants, even though they would have gone through the normal NSF application and competition process might not have been seen as suitable to be supported by the Foundation if the Foundation had not decided that grants in these areas should be issued.

The moment one attempts to direct money into too specific a field through the research grant mechanism, the mechanism becomes perverted and people of lower ability and grants of less intrinsic merit get supported because they work in certain directions. The proper way to direct work to unique fields to achieve specific goals is the contract mechanism. This mechanism identifies the goals, and the administrator strives to achieve these goals by hiring scientists to work in defined directions. For specified applications in applied science, the contract mechanism is appropriate. (However, it has often been wasteful. The individuals letting the contracts are rarely so inspired as to create the new knowledge required.)

On this program, many of the grantees are clearly of high quality and their grants would have been funded under any auspices, but there may also be grants which would only be funded through a special

pleading. We were given two arguments justifying grants in this program. One was that the U.S. had to do the research in order to have something to talk about with the Soviets. There is no provision in the Agreement or in the work of the Joint Commission that would enable it to specify what research work should be done in the U.S.S.R. or the U.S. The group here does not know that any types of research were turned on in the Soviet Union because of the joint Soviet-American program. The original Agreement imagines that certain research, normally being done in both countries, could be aided and furthered by cooperation between the countries. It envisages also (Article 3C): "Joint research, development and testing, and exchange of research results..." but it is hardly "joint research" if the U.S. participants are unaware of work initiated on the other side.

A second reason given was that some of these fields, like the production of single-cell proteins, or the genetics of industrial microorganisms, would not normally be supported by the NSF because they were too commercially oriented. The review panels in the NSF presumably would decide that such projects are not sufficiently worthy to be supported as pure science but should be supported by industry. In general, this is a true argument: in many cases industry is not pursuing such items because they do not believe that there will ever be any commercial application. In some cases, as for example in the single-cell protein, specific knowledge within industry of the applicability or the potential usefulness of such projects has led industry to drop them. The argument that such projects should be funded by the government, for example, that we should have governmental investment in the general problem of producing food from microorganisms, may be perfectly valid but if so the money to carry out such projects should be explicitly identified by the government and supported on the basis of the potential contributions rather than being funded by the granting agencies as part of U.S./U.S.S.R. cooperation.

The degree of confusion that exists in the granting agency can be illustrated by the description we were given of the genetics program; it is clear by looking at the grants that some genetics tied to microorganisms of industrial interest has been done, but that most of the genetics grants would normally be supported in their own right as part of the strong American genetics program. In fact, the Foundation is planning not to support, under the science and technology exchange, any further genetic grants because there is already a mismatch in this field which would be exacerbated by continued support.

The Foundation money should have been used to support direct cooperative research, involving both Soviets and Americans. This could have been the visitation of Soviet scientists here, postdoctoral fellows, plus some laboratory support, as those scientists visit American laboratories being supported normally because their research is of direct interest to the U.S. Alternatively, it could involve the support of Americans in the U.S.S.R. Such funds might have been less productive of results in U.S. science, but they would have introduced real interaction at the working level.

What is to be Done?

In any field of science, exchange with other scientists always turns out some items of interest.

The great weight of scientific work throughout the microbiological field is being done in the U.S.; the wave of modern biology is dominated by American work. We can learn small things from the Soviets; in this field the Soviets can learn modern science from us. The bureaucratic nature of the Soviet society makes the cooperation extraordinarily difficult. Even though we are hampered in some specific ways by details of our government bureaucracy, especially in programs connected to the government and depending upon the government for funding, Soviet scientists live in a world in which every act is controlled by the bureaucracy and every bureaucrat lives in fear of doing something wrong. The benefits of an exchange program in this field lie in bringing some fresh air into the Soviet society through greater contact with the outside.

If the benefits of the exchange program are solely in the act of exchange, they flow from the program only as the number of people who share experiences in the two countries grows. The knowledge they bring back includes certain technical advances as well as a general improvement in the knowledge of the world. However, this knowledge can be obtained rather inexpensively on the scale of governmental costs.

Any funding for the program should be funding for joint projects or for the reciprocal visits of scientists. To the extent that the program is viewed as tied to development of materials of commercial importance, it should involve the Commerce Department or the Agriculture Department. In any case, the benefits of contact should extend beyond small closed groups, especially at the stage of exchange. To the extent that the program is seen as involving a science exchange, it must be broadened on the Soviet side to include Soviet academicians and the scientists who work for the Academy of Sciences of the U.S.S.R. in Moscow.

The use of money should be restricted directly to the elements of exchange: only cooperative research, with carefully defined involvements, should be supported. Research that does not involve actual cooperative efforts on both sides should be supported only in free competition with the normal research of the country.

Review of the Activity Under the
Working Group on Physics

Hans Frauenfelder, Panel Member
Marshall Baker, Edward Frieman, Special Reviewers

A. Nature and Magnitude of Project

In 1972, at the time of the signing of the S&T Agreement, it was already clear that in several subfields of physics the prospects for carrying out joint research with the U.S.S.R. were good. For example, in solid state theory, there existed a number of problems of considerable fundamental interest and practical importance, and both U.S. and Soviet physicists had been making major contributions toward their solutions. Moreover, through the first three joint U.S.-Soviet symposia in condensed matter theory (sponsored by the National Academy of Sciences and the Academy of Sciences of the U.S.S.R.), the physicists of the two countries had been in good contact with each other, and were thus in an excellent position to plan possible joint research activity. The Joint Commission delegated the responsibility for organizing joint research in physics to the two Academies, and discussions between representatives of the Academies began in the summer of 1973. The initial rounds of discussions did not prove fruitful, indeed, it was only in the fall of 1976, after some three and a half years of planning talks, that representatives of the two Academies were able to reach agreement both on the basic principles for the organization of joint research and on a specific set of research projects.

A number of activities are now scheduled to take place during the summer of 1977. A joint research group on condensed matter physics is scheduled to meet at the Aspen Center of Physics on July 4-August 29, 1977. This joint working seminar is unique in a number of ways. The U.S.S.R. and U.S. participants, who are listed on the following pages were jointly agreed upon by the U.S. and Soviet scientists who organized the research group. The participants are outstanding and the Soviet Academy agreed six months in advance to send the individuals that are listed. New knowledge and insight may emerge from this meeting and that it may be a point from which many new interactions will follow.

In the second sub-project, a three-week joint research seminar on cosmic x-ray sources is planned to be held in the U.S.S.R. in August 1977. Some 15 U.S. scientists have agreed to participate, and it is expected that they will be joined by 25-35 Soviet colleagues.

A group of six American scientists expects to visit Moscow in June 1977 to discuss the possibility of joint research on problems relating to laser interaction with matter.

Thus, in the period October 1, 1976 - September 30, 1977, it is expected that the level of U.S. activity in joint efforts with their Soviet colleagues will amount to some 35 man-months. The Working Group leader anticipates a possible increase in this level of activity

to as much as ninety man-months for the period 10/1/77-9/30/78 and 131 man-months for the period 10/1/78-9/30/79.

Support for the activities of the Working Group in physics has come in the form of a grant from the NSF to the NAS. Total project costs for the current period are estimated to be \$88,400. Because of an apparent misunderstanding (during the fall of 1976) of the progress made in planning for these activities, NSF did not budget funds for support of work in physics for FY 77-78 or for FY 78-79. The NSF has requested supplemental funding in the amount of some \$15,000 for FY 77-78, and the Panel member and Special Reviewers for the Working Group on physics under the S&T Agreement, were informed by NSF representatives that, given support of the activity in physics by the U.S. side of the Joint Commission, funds to support the present and projected levels of activity should be forthcoming.

U.S.-U.S.S.R. JOINT RESEARCH GROUP
ASPEN, COLORADO
July 4-August 19, 1977

- I. Executive Committee
David Pines, University of Illinois
C. Herring, Bell Labs
- II. General Arrangements in Aspen
Elihu Abrahams, Rutgers University
- III. Program Coordinators
J.R. Schrieffer, Chairman, University of Pennsylvania
P.W. Anderson, Bell Labs
C. Pethick, University of Illinois
- IV. Research Subgroups: Tentative Participants:
 - A. Superfluid ^3He
U.S.
W.F. Brinkman, Bell Labs, Chairman
P.W. Anderson, Bell Labs
C. Pethick, University of Illinois
J. Serene, S.U.N.Y., Stony Brook
U.S.S.R.
G.B. Volovik
I.A. Fomin
V.A. Nisnev
 - B. Electron-hole Droplets
U.S.
T.M. Rice, Bell Labs, Chairman
P.W. Anderson, Bell Labs
W. Kohn, University of CA, San Diego
P.A. Lee, Bell Labs
T. McGill, Cal. Tech.
R. Markiewicz, University of CA, Berkeley

U.S.S.R.

L.V. Keldysh

Experimental

U.S.

G. Thomas, Bell Labs

U.S.S.R.

Ya. Yb. Pokrovskiy

V.B. Timofeyev

C. C.D.W., I-D, Solitons and Structural Phase Transitions

U.S.

E. Abrahams, Rutgers University, Chairman

R. Bhatt, Bell Labs

D.R. Hamann, Bell Labs

R. Klemm, Iowa State University

J.A. Krushaensel, Cornell University

T.M. Rice, Bell Labs

J.R. Schrieffer, University of Pennsylvania

U.S.S.R.

L.P. Gorkov

A.I. Larkin

Experimental

U.S.

A.J. Heeger, University of Pennsylvania

J. Wilson, Bell Labs

U.S.S.R.

I.F. Shchegolev

D. Superconductivity and Electron Tunneling

U.S.

J.W. Wilkins, Cornell University, Chairman

E. Abrahams, Rutgers University

P.W. Anderson, Bell Labs

E. Frange, University of Maryland

J.R. Schrieffer, University of Pennsylvania

U.S.S.R.

E. Other:

Scaling Critical Phenomena and Particle Physics

U.S.

**B.W. Lee, FNAL, Chairman
J. Sak, Rutgers University**

U.S.S.R.

A.A. Migdal

Spin Effects--Semiconductors

U.S.

A.W. Overhauser, Purdue University

U.S.S.R.

M.I. Djakonov

More details concerning the history of the physics projects and their expected development are given in the progress report available at the U.S. Department of State entitled "JOINT U.S.-U.S.S.R. RESEARCH GROUP IN PHYSICS," April 7, 1977.

In the following, the current status of the physics project is assessed. The remarks are mainly based on interviews conducted by M. Baker, E. Frieman, and H. Frauenfelder with about 20 scientists who have taken part in a number of exchange programs with the U.S.S.R. While some of the remarks given below apply to work under the S&T Agreement, others stem from different interactions with the U.S.S.R. As in any discussion of joint work with the U.S.S.R., the difficulties peculiar to the U.S.S.R. system occupy a great deal of space. It should be noted that the joint working seminar at Aspen was designed and organized with an understanding of many of these difficulties and it is hoped that most of them can be avoided.

This last point is perhaps worth expanding upon. At a meeting in October 1976 between Dr. David Pines, U.S. Working Group Chairman, and Lt. Conyers Herring, on behalf of the NAS, and Acting Chief Scientific Secretary G.K. Skryabin and Mr. A.A. Kulakov, head of the Soviet Academy's Foreign Department, agreement was reached on the basic principles under which the research work would be organized. Two aspects of that agreement, which were subsequently ratified in an exchange of cables between Soviet Academy Chief Scientific Secretary G.K. Skryabin and NAS Foreign Secretary George Hammond, are especially noteworthy:

i. There should be mutual agreement both on specific research topics to investigate and on specific participants in the research program.

ii. In view of the need for detailed advance discussion and exchange of correspondence among the participants concerning the research to be carried out, and given the very full schedules of scientists in both countries, it is essential that agreement on all aspects of the research group (research topics, participants, conditions of organization, etc.), be reached at least six months in advance of the start of the work of the research group.

Some of the interviews we conducted were with scientists from fields other than solid state or astrophysics in order to gain insight into other fields and examining possible new areas for sub-projects.

B. Contributions Made to Science and Technology as a Whole

1. Quality of the U.S.S.R. work in solid-state physics. The level of the best work in solid state theory in the U.S.S.R. is outstanding and at or near the frontier. It has strongly influenced the thinking and the work of the U.S. solid state theorists. However, some of the respondents expressed the feeling that the level of some of the Soviet work may have decreased in recent years. Two reasons are given: a) the first-rate group is aging; and b) there is very little contact between the theorists and the experimentalists in the U.S.S.R.

2. Contact. Contact between the U.S. and the U.S.S.R. theoretical solid-state physicists has been excellent. This contact has been important because Soviet papers are often hard to read and personal contact is necessary to come to a complete understanding, and it seems that some of the best U.S.S.R. people cannot publish.

3. Benefits. One of the main benefits is the contact with a group of first-rate theoretical physicists with a very strong mathematical background. In the past, the U.S. theorists have learned a great deal from this group. Some of the interviewed American scientists expressed the opinion that the benefit is less strong at the present time. A definite assessment of the relative strength of the U.S. and the U.S.S.R. effort will be easier after the Aspen meeting.

In all remarks, the value and importance of the personal contact with the brilliant top theorists of the U.S.S.R. is stressed. This contact is essential for rapid progress here. Since information flows much more rapidly in the U.S. than in the U.S.S.R., the contact benefits the U.S. far more than the U.S.S.R. This feature alone would make continuation of the physics project of the S&T Agreement worthwhile.

Additional benefits accrue from the general stimulation and the progress in mutual understanding. Again, because of the rapid exchange of ideas within the U.S., this interaction greatly benefits the U.S. Strong opinions are voiced that the physics cooperation under the S&T Agreement should be continued.

4. Problems. The main problem was stated by one of the interviewed scientists as follows: "The main barrier to better technical interaction is the Soviet government and its behavior. The only satisfactory solution would be normal scientific contact such as is usual with other nations, namely unrestricted exchange of individuals without government intervention. The bilateral format is very bad and only acceptable because it appears to circumvent the Soviet behavior."

In detail, some of the stated problems are:

a. Barriers to free exchange. Probably the best known fact about the exchange is the difficulty of some of the best U.S.S.R. scientists in traveling abroad. Even when they have accepted a major commitment, they may not arrive on time or ever. The negotiating power available under the exchange Agreement should be used to obtain a free flow. If people other than those earlier promised are proposed for travel to the U.S., they should not be accepted. If the ones agreed upon earlier are not coming, a part of the Agreement should be terminated. Contact with the Soviets in the field of solid state theory (and also some others, like relativistic astrophysics), is irreplaceable. Everything should therefore be done to enhance free exchange.

b. On the U.S. side, the problem of funding is not clear. Three levels can be distinguished:

1. Seed money. There should be some funds to explore and test new areas of collaboration and exchange.

2. Initial grants. Initial grants for true collaborative work should be established under a peer review system. A clear mechanism for applying for such grants should exist.

3. Continuation grants. There is, in general, an unfortunate tendency to abandon successful work in order to start new projects. There should be a mechanism of continued funding for successful projects, so that they do not add to the pressure on ongoing work in other agencies.

c. Security. In some instances, a proposed collaboration may skirt a classified area. A mechanism should exist to review and guide the proposed work.

d. Reciprocity. One main problem lies in an inherent asymmetry. U.S.S.R. scientists like to visit the U.S. and it is not difficult to find good ones who like to come for an extended period of time. Leading U.S. scientists, on the other hand, are generally reluctant to spend more than a few weeks in the U.S.S.R. Moreover, there is no way in which a U.S. scientist can be forced or induced to accept an assignment. There does not appear to be an easy way to overcome this asymmetry.

C. Candidates for New Projects

The two sub-projects listed initially--solid state theory and astrophysics--are now well on the way and should be retained. In addition, a number of new areas have been proposed. We list here some of the promising ones where considerable strength exists in the U.S.S.R. and where an exchange would therefore lead to some benefit.

1. Laser interaction with plasma. A U.S. Working Group will visit the U.S.S.R. Possible joint research will be explored.

2. Elementary Particle Theory. Some of the most important developments in elementary particle theory during the last few years are due to young Soviet physicists, some of whom have not visited the U.S. Collaboration under auspices other than the S&T Agreement has been tried but has not been particularly successful, in large part because the Soviets have usually not sent the desired people to meetings and conferences. A joint program under the S&T Agreement could complement the ERDA program; the leverage existing under this Agreement could be used to strengthen the contact with this group of young brilliant theorists, who are for the most part employed in institutes of the Soviet Academy. Such an interaction would greatly benefit U.S. elementary particle physics.

3. Exploratory Work. It seems particularly important to have a way to test a new proposal for contact which will advance physics in both countries, without formally submitting title and subject to Joint Commission approval, which could only be obtained after evaluation on both sides. In such a mechanism, the following steps could be performed:

a. Interaction between individual scientists or groups of the two countries to explore and outline an area of mutual

interest where strength is equally present in both countries, but where the areas of expertise differ.

- b. Submission of a proposal to NSF, with peer review. When the NSF asks for further information, presumably implying positive reviews and explicitly stating a date by which further material must be submitted, a written agreement should be obtained from the U.S.S.R. counterpart. Topics worthy of consideration under this rubric include gravitational wave astronomy, metallic hydrogen, the mathematical theory of non-linear systems, computational physics, and biomolecular physics.

**Review of the Activity Under the
Working Group on Science Policy**

**Donald F. Hornig, Panel Member
John P. Hardt and John W. Lewis, Special Reviewers**

I. Introduction

Science policy is a subject area which is quite different from those concerned with specific scientific or technological topics. The purpose of the exchange was not, therefore, to advance a science, since even among U.S. experts there is no consensus on the principles and operating procedures of science policy. Basically, since it is concerned with the allocation of manpower and resources, with priorities of effort, with organizational structures, and the management of research and development which affects national security and the economy, it is inherently sensitive and touches politics.

The original purposes of the exchange were two-fold: 1) to develop a comparative basis for the approach to common policies so that both sides could profit from the experiences of the other and 2) to develop a better understanding of their system, its problems and its organization. To this end four subgroups were established:

Planning and Management of Scientific Research and Development

Financing Research and Development

Training and Utilization of Scientific and Engineering-Technical Personnel

Systems of Stimulating Development of Fundamental Research

The joint Working Group began its work in September 1974. Subsequently some 50 Americans and 60-70 Soviets have been involved in the exchanges. About 11 million on the U.S. side have been committed for activities in this science policy and cooperation, and \$750,000 have been expended to date on the work of the four groups.

II. The Science Policy Program

The program originally envisioned an initial exchange of questions and answers, followed by survey reports to be completed by the end of 1975. A series of case studies was planned in the areas of management of R&D and the stimulation of fundamental research. As regards financing, the goal was to begin with the exchange of statistical data, followed by comparative analyses and meetings of study groups. The work would then be completed with a summary report. Similarly, the manpower sub-group expected to exchange instructional data in preparation for in-depth studies. An extensive program of visits to laboratories took place in the U.S.S.R. within the fundamental research group activities.

Some original expectations were not realized, particularly as regards the written material which was to be exchanged. By and large, the American submissions were made at the agreed-on time and most of them were of good quality. However, the Soviets have not produced adequate written material for the finance effort, and a report on the training of scientists and engineers was only submitted this year. A satisfactory Soviet report on the utilization of manpower is not yet available. The case studies in connection with R&D management and fundamental research have indeed been carried out, although they were delivered very late in the program. On a more positive note, a large number of laboratories and installations have been visited on both sides and joint meetings were held in 1974 and 1976.

III. Evaluation of the Science Policy Program

In order to evaluate the program some 33 participants who could be reached by phone were interviewed, most of them in some depth, by the Panelist and two reviewers. The assessments varied widely, ranging from feelings that the results did not justify the effort expended to a feeling that quite a lot had been achieved. These assessments varied both according to the subgroup to which the individual was attached and the background of the individual. The participants included practicing scientists, research managers, students of science policy and Soviet specialists, and the perceptions of each group tended to differ.

Nonetheless, there were certain generally shared perceptions. It was almost unanimously agreed that the impact of the exchanges on our knowledge of the art and practice of science policy and its problems was modest. For the most part it was not felt that the case studies, data or written material provided by the Soviets expanded the totality of U.S. factual knowledge of the Soviet Union. At the same time, most of the participants, and particularly those most versed in Soviet affairs, felt that an understanding of the Soviet Union had been enhanced by the discussions and meetings. They uniformly felt that they had gained new insights into the philosophy, institutional structures, and practices of the Soviet government in the areas of science and technology. Three of the participants expect to incorporate the results in a book. In particular, U.S. science policy experts have become familiar with aspects of the Soviet system as a result of this interaction.

Above all, the participants felt that a beginning had been made at building a relationship between both the people and the organizations involved on both sides. Almost all felt that in a sensitive area progress had been made in establishing which activities were practicable and which were not.

Most importantly, substantially everyone interviewed recommended that "science policy" be continued in some form as part of the bilateral programs, building on our experience to date.

In retrospect, most of the participants felt that the initial expectations and plans were unrealistic and did not take adequate account of the problems the Soviets would have in assembling data, preparing documents and securing the necessary clearances.

A number of those interviewed stated that the science policy field seems to have been an even more problematical one for the Soviets. It is an area whose potential benefits were, it seems, unclear to at least some senior Soviets in 1972-73. U.S. participants have the impression that collaboration on this Agreement inside the U.S.S.R. has had its strong critics and opponents. In addition, it also seemed to some U.S. participants that the Soviets have operated under real constraints--"funds are apparently limited and staff devoted to these agreements and other services supporting them also seem limited." An awareness of and appreciation for these dimensions and limitations were considered essential in making any meaningful evaluation.

In the hard science areas, exchanges have existed for some time between Americans and Soviets. A number of those interviewed had participated in them and stated that the interacademy contacts and activities provide a basis for governmental S&T projects in the hard sciences. In respect to science policy, however, long and sustained experience and a history of contacts did not exist; the science policy program has brought together people who for the most part had not met before. While in some of the scientific areas, the agreements can be seen as add-on projects to already existing fields of cooperation, in science policy the task has been one of building an initial dialogue and bridge. A real "experiment," it is in many ways more complicated than, say, joint research or a scientific project in chemical catalysis where principles can be readily agreed upon in advance and where clear procedural and methodological rules are "readily understood" by both sides. In science policy, the two sides were searching for common "problems" of mutual interest and some basic principles and practices that were tailored to each country's different political, social, and cultural conditions, values, and approaches. Unlike scientists working in their own disciplines, students of science policy did not speak a common cross-cultural language, their concepts and definitions differed, and their approaches were obscured by non-scientific issues and values.

U.S. scholars still know very little about Soviet governmental decision-making practices. (One said that after three trips he had detected on the Soviet side "few checks and balances, no peer review, and no serious mechanism for evaluation," and he guessed that normal bureaucratic motivation was more prominent than substance in the evolution of Soviet "science policy." For all the money the U.S. has invested in Soviet studies, key questions basic to an understanding of

the Soviet political-technological system remain unanswered. Most felt that the U.S. has "a tremendous knowledge gap" about this area of the Soviet system, and this, they argued, is where the Agreement may have had--and should continue to have--benefit for the U.S. While American scholars know a great deal about Soviet attainments in, say, electrometallurgy, because of the general nature of knowledge in this area, they still know very little about the internal workings of Soviet policy-making, of any Soviet ministry or state committee, or even of a scientific research institute or enterprise.

In addition to a technology gap the Soviets also appear to have been aware and concerned about their "management gap." A small circle near the top of Moscow's political pyramid seems to believe that perhaps the best way to bridge the hardware gap is through a major advance in software and in management know-how. This may account for their interest in the science policy program and, as one person said:

There was a vast change in Soviet willingness to provide information on science policy in this area and it became clear over time that to be involved became a great plus for Soviet scientists. They wanted to know how we went from discovery to production. Once they saw we wouldn't provide anything useful unless they did, their reports on science policy improved considerably.

While others did not share this judgment ("Soviet cooperation has been late and incomplete"), most felt the Soviets are anxious to investigate American methods of planning and management and to identify U.S. advances that might help improve their own practices and performance. Conversely, the science policy program was said to provide an opportunity for U.S. specialists to learn more about this "management gap," about Soviet practices and their weaknesses and strengths. It also apparently provides a window through which U.S. scientists can glimpse important modifications in Soviet procedures, organizational arrangements, and incentive schemes.

Most felt that collaboration on science policy can be effectively pursued through these bilateral exchange arrangements. The Soviet Academy of Sciences is no doubt a center of excellence within the Soviet system, and the West can learn much about Soviet science, science planning, and management through the Academy, but there are strong jurisdictional boundaries in the Soviet Union and "one cannot penetrate the industrial R&D process through the Academy." This is the functional and policy domain of the State Committee for Science and Technology and the ministerial system. Students of science policy thus must work with these institutions, with all their rigidities and compartmentalization. In short, there really is no alternative to this kind of governmental program to learn about Soviet industrial R&D. Moreover, this purportedly is a universe with which the U.S. has had little contact in the past and where American knowledge is more limited. All remarked on the compartmentalization of the Soviet system and how important it was to have access to all parts in order to "understand how things really work." Many stressed the value of this interaction to the Soviet Union in overcoming its own compartmentalization.

By its very nature, the 1972 S&T Agreement was a "mixed bag," and this unevenness characterized the science policy joint Working Group. Two sub-groups (Financing Research and Development; Training and Utilization of Scientific and Engineering-Technical Personnel), for example, proved somewhat sterile exercises. "Meaningless" statistics and "well-known canned materials were exchanged by both sides," it was alleged. One scientist stated: "The more materials the Soviets provided my subgroup, the less interested I became"; but another replied:

It pays to keep communications open. We did learn--through toughness and patience--about the meanings of their concepts and criteria for occupations, educational degrees, research, curriculum, and so on. I think in time we can get at a comparison of the two systems.

One participant said that he had profited from the Soviet "negative example": "Although we did make certain contacts that were helpful [to our industry], we mostly learned about horrible bureaucracy and the oppressiveness of planning."

All regarded American hard-headedness as a *vincit quia non* of any future benefits accruing to the U.S. The important point, it was emphasized by one participant, is that a mixed assessment occurs not so much because of the actual results--both successes and failures--but because of the inherent complexity of science policy. To be sure, some working subgroups, notably those dealing with manpower and financing, reportedly encountered strong difficulties and yielded little actual benefits. The two subgroups on "planning and management" and on "fundamental research" were more successful in carrying out a set of activities and producing a variety of products. Both within each subgroup as well as across all four subgroups we uncovered divergent perspectives and evaluations, apparently not so much because of their specific activities as because of the types of individuals involved. On the U.S. side, there were represented Soviet area specialists, men and women with strong experience in government R&D administration, some science policy experts in universities, and experienced industrial R&D specialists. Each had their own interests, priorities, and objectives not to mention their own individual outlook on this particular undertaking. Each necessarily adopted a somewhat different view of the costs and benefits of the program. Thus, any unity of opinion on this score would be quite unexpected. Indeed, one or two found an important benefit of this experience to be the opportunity to broaden their knowledge and perspective through collaboration with such diverse individuals.

In sum, most felt that the exposure to American openness and candor had been a useful experience for the Soviets and that, whereas in the early stages the Soviets were unresponsive, the example of our openness and the nature of our reports seemed to convey an idea about the kind of information which was useful in such an exchange, and the quality of their product improved with time.

Most of those interviewed agreed that contact between high level individuals and organizations responsible for planning and managing R&D in the two countries was fruitful and would continue to be if the contacts were focused on topics of genuine interest to both sides.

IV. Future Collaboration in Science Policy

It has been mentioned that there was unanimous agreement that the exchange in "science policy" should be continued but modified. It remains true that it is important to understand the workings of the Soviet system and there are no obvious alternatives to replace the particular insights afforded by this exchange.

Secondly, an understanding of alternative ways of doing things, particularly in a system so different from ours, provides useful experimental data in considering alternative policies here and may suggest new approaches to some problems even if we have no interest in emulating Soviet practices in general. We can learn from mistakes as well as from successes.

These very general grounds provide the main basis for continuing the collaboration.

V. Recommendations

1. Further cooperation should build on the efforts thus far. The effort in fundamental science has been fruitful. Visits to laboratories and discussions should continue beyond the exploratory stage and should be directed toward well-defined goals.

2. The major Soviet interest appears to be in the management of R&D and particularly in the process by which research advances are put into practice. In this area, a good start has been made and it was felt it would be productive to continue, providing the topics were sharply defined. Considering the lack of progress, it is recommended that the manpower and financing sub-groups be reconsidered as independent efforts and possibly terminated. A number of participants believe that they should be included among the topics considered by a group studying planning and management.

3. It was generally agreed that future groups should include participants with a wide variety of backgrounds and that they should all include one or more individuals with knowledge and experience in Soviet affairs.

4. Preparations for all U.S. groups should be substantially upgraded by compiling bibliographies of the participants on both sides, providing them with background briefings and assembling a coherent record including relevant trip reports.

5. Arrangements should be made for more extended, in-depth visits, not only to laboratories but to scientific-production associations, for example.

Review of the Activity Under the
Working Group on Water Resources

William C. Ackermann, Panel Member
Theodore M. Schad & James Wallis, Special Reviewers

Our review was based upon the general Panel briefings and discussions of April 7 and 8, 1977, by a number of background reports and communications provided by interview of a substantial sample of U.S. scientists and engineers who were involved in the exchange program in our area, and by discussion among the Panelist and Special Reviewers.

Some 60 U.S. scientists and engineers were involved in the water resources exchange. Among these, the Panelist and Special Reviewers held a personal, group discussion session on April 8 with 6 participants from the Washington, D. C. area including William Butcher, who chaired the U.S. Working Group on Water Resources. Beyond this, we selected 21 additional representative participants for telephone interviews with the suggested discussion outline, of whom we actually were able to contact 17. Thus, we talked with 24 out of approximately 60 participants. A reasonable range of agreement among those contacted gives us confidence in the adequacy of our sample and basis for our conclusions.

The following material is organized in accordance with the "Outline for Report" of the Review Panel, starting with Topic II and omitting V, appendices.

II. Organizational arrangements and administrative concerns relating to the activities within the S&T Agreement

A. General problems in interactions between the U.S. and U.S.S.R. scientific communities under this Agreement. Problems of interaction within the water resources area were probably not unique. They included the usual language barrier in spoken communication, and our lack of translation capabilities to utilize their reports obtained through exchanges. Although access to their top people and institutions and experimental sites was eventually achieved, it was a tedious and trying process. However, access to plastic manufacturing plants and large scale field installations has been difficult or impossible as of the date of this report. Attitude of Soviets was generally friendly, but was initially cautious, tended to be limited to balanced trade-offs at best, and was clearly biased to areas of their interests.

B. Problems of asymmetry. In one area of water resources, there was reasonable correspondence of science, technology, and interest--that of use of plastics in construction. This is the only area in the water resources Working Group where mutually advantageous exchange is taking place. In the general area of planning, the national approaches are hopelessly different; so little progress resulted. In another area--automation and remote sensing--our technology is so far ahead of theirs that there was no profit to the U.S. In the area of cold

weather construction, institutional mismatches have prevented substantive progress to the present.

C. Funding considerations and related concerns. The manner of funding within water resources on the U.S. side was certainly a major irritant and deterrent to program success. Government agencies, i.e. the Bureau of Reclamation, Corps of Engineers, and Soil Conservation Service were required to support the program from internal funds, which typically were diverted from their own programs of preference and higher priority. Similarly, universities were asked to absorb the costs of their personnel. Industry was pressured to contribute funds and materials.

III. Speculative analysis of the Soviet perception of the S&T Agreement

A. Initial expectations of Soviet scientists and administrators. It seems clear that the Soviets for the most part negotiated a set of water resources programs from which they could profit. They were interested in U.S. advanced technology--computer models and programs, automation equipment, and materials. In the one area of high potential profit for the U.S.--cold weather construction--they seem to have delayed progress in the exchange because of bureaucratic isolation or reluctance to share.

Soviet attitudes were far more cautious or constrained, gradually warming upon further acquaintance. They were far less open than the Americans.

B. Possible prospects for change within coming years. There are major areas of water resources science and technology which were not included in the Agreement--such as navigation, flood control, water supply, flow forecasting, etc.

However, if any new programs are developed, and despite whatever the Soviet pressures may be, these should not be agreed to unless there is at least an approximate match of scientific and technological advancement, and the specific programs and projects are fully agreed upon in advance as likely to return mutual benefit.

IV. Summary of Conclusions, Findings, and Recommendations

A. Nature and magnitude (number of people, funds) of effort under the individual projects. The joint water resources program of 4 principal areas evolved from a longer list on both sides, and was resolved in an effort to balance mutual self-interests. Water resources was on Dr. Edward David's original list.

The cost of the U.S. program in water resources is not known, but is estimated by project leaders to be in the order of \$100,000 per year, which is small--being perhaps 0.05 percent of what the U.S. is spending in R&D in the water resources area. However, absorbing these costs was painful, it was universally agreed, because they were required to be absorbed within relatively small agency programs. Particularly difficulties were encountered in travel budgets.

The experience from the U.S. side was not uniform within water resources, and thus each of the 4 program areas will be discussed separately--describing the scope of intended cooperation and summarizing the results in each. Following these four sections, some general observations and recommendations will be offered.

Water Resources Planning, Use, and Management

This area was on the U.S. list. It was extremely slow in taking form, and in the end produced little of value to the U.S. side. The major specific problem (in addition to the usual delays, poor communication, lack of translations and funding) was a virtual mismatch of national approaches. The U.S., with the Bureau of Reclamation as a lead agency, tends to approach this area with elaborate and sophisticated methodology--modelling, benefit/cost analysis, and environmental impact statements. The Soviets apparently do not. If their national objectives are to grow rice to feed their people, or cotton for foreign exchange, they simply build a dam or create an irrigation project to accomplish this national objective.

Some benefits may derive in this program area in the field of waste water for irrigation, although the national objectives are generally opposite--ours being waste disposal and theirs being water for irrigation. Also, the Soviet monitoring for environmental effects is much less than our requirements.

The related subject of irrigation water quality may yield small benefits to us, and a final report on the exchanges is to be completed in May of 1977.

Also to be completed in 1977 is a report on "Systems for Planning and Managing Water Resources in River Basins" as a terminal effort. No further exchanges are anticipated.

The Soviets are preparing a publication on "Design and Construction of Large Canals"; we are preparing one on "Large Pumps and Pumping Plants." There are small exchange visits planned this spring in relation to these (perhaps) terminal efforts.

In summary, the field of planning, use, and management seemed attractive to us initially, but because of inadequate prior assessments of relative approaches and technologies has in fact yielded little benefit to the U.S. The program area is being phased down (or out) and should be.

Cold Weather Construction Techniques

This second area of exchange activity has led to one visit in each direction and some exchange of publications which are essentially not yet translated on our side.

The major problem and reason for lack of progress seems to have been an institutional mismatch. Our program under the Corps of Engineers was attached to a Soviet institution concerned with agriculture. However, on the other side virtually all cold weather construction is in hydro-plant construction--and thus, in a different Soviet bureau. The activity is now being transferred from the SGT

Agreement to the Energy Agreement, where it is thought some progress may occur.

The area of cold weather construction is one in which the U.S. had an initial keen interest and where the Soviets were believed to be more advanced. There is some suspicion that they have actually procrastinated and finessed us out of a useful exchange.

Methods and Means of Automation and Remote Control in Water Resources Systems

This third area of exchange, with the Bureau of Reclamation as the lead agency, suffered from a serious mismatch of technology, with the U.S. being many years ahead, and therefore with little to learn.

The program area is being brought to a "diplomatic" close with the completion of a joint glossary of terms and a manual of methods.

Plastics in Construction

This final program area is judged to have been the most successful and is programmed to continue to 1980. Progress is the result of a much better match of mutual interest and technology, and has led to joint projects of testing materials. The area includes soil stabilizers which is emerging as mutually beneficial, plastic films where our technology is more advanced but they apparently have more installation, plastic pipe where the U.S. is more advanced, and polymers in concrete where the Soviets are believed to be further along.

This area of plastics is judged to be useful, mutually beneficial, and is recommended for continuation. It would, in all probability, continue outside the Agreement or under Section 4.

Some Unorganized Observations

1. There was inadequate preparation for the trips in advance, so that much of the time in the U.S.S.R. was spent in "trying to figure out what we were there for" as one participant put it. This was particularly true from the viewpoint of participants in the early planning visits.

2. There has been inadequate follow-through upon return from the U.S.S.R. Participants return to their desks with large amounts of literature, in Russian, that they don't have funds for translating. They pick up their regular duties, and have little time to make the results of their findings available to colleagues or others that might be able to use them. This lack of sustained U.S. interest may in part be explained by the fact that the Soviets showed the U.S. visitors little that was technically new or surprising--U.S. technicians in manufacturing and construction tended to find Soviet work to be very unsophisticated.

3. There has been a tendency to send U.S. officials, or "dignitaries" on the exchange visits, rather than workers in the field. The visits tend to be ceremonial, and the technical and scientific findings, if

understood, may not filter down to the U.S. technicians that might be able to use them.

4. Most of the people queried visited the Soviet Union on only one occasion; several of them felt that if they went back a second or third time they would be better oriented and might learn more of value. (This was expressed by technical workers, rather than officials who participated.)

5. Soviet objectives and modus operandi are so different from those in the U.S. that much of what they consider advanced technology is not applicable to U.S. conditions.

6. In some instances, U.S. personnel (particularly at the Bureau of Reclamation) appeared to have the attitude that they knew so much more than the Soviets that there was no way they could learn anything.

7. Generally, our translators and interpreters are not technically knowledgeable and we lose much of technical value in translating both oral and written material.

8. Soviet planning, economic analysis, and river management are so far behind the U.S. and we probably cannot learn much from them and the exchange in these fields should be discontinued.

9. There was general agreement that the Soviet participants got more out of the exchange than our participants, as they seemed to know exactly what they wanted, were familiar with U.S. literature; in short, they had done their homework in advance of their visits. Also, we have given them a great deal of detailed technical data, while they have primarily given us general descriptive data. (Possibly because they knew just what they wanted in advance, while we did not.)

10. Two of the participants felt the whole program was a waste of U.S. technical effort, and the funds expended would be better spent if applied to research in U.S. laboratories. One of them felt the program should not be renewed, the other, however, felt that it was very worthwhile from the viewpoint of international relations, and that there was a good possibility that continuation would have a favorable result to U.S. science and technology.

11. Aside from the cold weather--permafrost--construction methods, our agency people felt they had generally been permitted to see everything they wanted to, with a few exceptions where bureaucratic frustrations prevented them from seeing the inside of certain installations. However, the U.S. plastics and construction people from the private sector did not feel that they had been able to see comparative Soviet facilities.

12. One participant had visited the Soviet Union numerous times before 1972 on visits arranged independently or by the National Academy of Sciences (NAS). He felt that those exchanges had been more worthwhile than the more recent exchange under the 1972 Agreement. He felt frustrated working through the State Department, and would prefer direct agency-to-agency arrangements, or working through the NAS. Soviet advances cited from earlier exchanges included high voltage transmission lines (direct current), large size hydroelectric

generating units, and use of heavy explosives in excavating large canals, something that we have been afraid to try in the U.S.

13. Although the benefits to U.S. S&T are very small, the expense is also small, and can be justified on diplomatic grounds if more carefully structured and visibly and separately funded.

14. To date, the Soviet benefits certainly exceed ours. To date, the exchange has resulted in no identifiable U.S. benefits.

15. Most participants felt the effort was personally worthwhile, enjoyed the experience. They also felt the U.S. effort was well organized and run--but we do not agree because of inadequate preparation, lack of follow-through, and lack of fiscal and subject matter records.

Some Final Recommendations

Despite the quite poor experience in water resources under the exchange, we are not prepared to "write off" water resources as a possible future field of potential benefit to the U.S. through science and technology. However, an essentially new start must be made, and thorough exploratory studies made to answer relative mutual advantage. There will have to be a willingness for hard bargaining--with definite goals; otherwise the U.S. will become locked into a potentially unproductive undertaking.

VIII

CANDIDATES FOR NEW PROJECTS UNDER THE S&T AGREEMENT

We have recommended an exploratory process of considerable duration, complexity and cost for the establishment of any area of joint research and cooperation. It is incompatible with that conclusion to seriously propose and to try to analyze new fields in a few-week period. Therefore, what follows are to be regarded as suggestions for input to this evaluation process. For this reason, this section has not been subjected to the NAS review process. These areas have been proposed to us by the participants whom we interviewed (mostly within the fields of existing Working Groups), and responses to our solicitation of 500 industrialists by U.S. Joint Commission member Dr. Herbert Fusfeld, or stem from Panel members themselves. Suggestions clearly unsuitable have been deleted.

The problem is that suggested fields for cooperation may very well properly fall within one of the other ten U.S./U.S.S.R. agreements for cooperation. The S&T Joint Commission support office on the U.S. side will be the proper focus for communication with the Executive Secretariats of the other U.S./U.S.S.R. Joint Committees and indeed some of the exploration may in fact be done within the S&T Joint Commission structure for proposals which will be lodged under the other U.S./U.S.S.R. Joint Committees. By September 1, 1977, an inquiry by this Panel to officers of professional societies associated with the National Academy of Sciences-National Academy of Engineering-Institute of Medicine should result in additional proposed fields of cooperation.

(CONCRETE SUGGESTIONS WILL BE PROVIDED SUBSEQUENTLY)

APPENDIX A

**AGREEMENT BETWEEN
THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND
THE GOVERNMENT OF THE
UNION OF SOVIET SOCIALIST REPUBLICS
ON COOPERATION IN THE FIELDS OF
SCIENCE AND TECHNOLOGY**

The Government of the United States of America and the Government of the Union of Soviet Socialist Republics;

Recognizing that benefits can accrue to both countries from the development of cooperation in the fields of science and technology;

Wishing to assist in establishing closer and more regular cooperation between scientific and technical organizations of both countries;

Taking into consideration that such cooperation will serve to strengthen friendly relations between both countries;

In accordance with the Agreement between the United States of America and the Union of Soviet Socialist Republics on Exchanges and Cooperation in Scientific, Technical, Educational, Cultural, and Other Fields, signed April 11, 1972, and in order to develop further the mutually beneficial cooperation between the two countries;

Have agreed as follows:

ARTICLE 1

Both Parties pledge themselves to assist and develop scientific and technical cooperation between both countries on the basis of mutual benefit, equality and reciprocity.

ARTICLE 2

The main objective of this cooperation is to provide broad opportunities for both Parties to combine the efforts of their scientists and specialists in working on major problems, whose solution will promote the progress of science and technology for the benefit of both countries and of mankind.

ARTICLE 3

The forms of cooperation in science and technology may include the following:

- a. Exchange of scientists and specialists;
- b. Exchange of scientific and technical information and documentation;
- c. Joint development and implementation of programs and projects in the fields of basic and applied sciences;
- d. Joint research, development and testing, and exchange of research results and experience between scientific research institutions and organizations;
- e. Organization of joint courses, conferences and symposia;
- f. Rendering of help, as appropriate, on both sides in establishing contacts and arrangements between United States firms and Soviet enterprises where a mutual interest develops; and
- g. Other forms of scientific and technical cooperation as may be mutually agreed.

ARTICLE 4

1. Pursuant to the aims of this Agreement, both Parties will, as appropriate, encourage and facilitate the establishment and development of direct contacts and cooperation between agencies, organizations and firms of both countries and the conclusion, as appropriate, of implementing agreements for particular cooperative activities engaged in under this Agreement.

2. Such agreements between agencies, organizations and enterprises will be concluded in accordance with the laws of both countries. Such agreements may cover the subjects of cooperation, organizations engaged in the implementation of projects and programs, the procedures which should be followed, and any other appropriate details.

ARTICLE 5

Unless otherwise provided in an implementing agreement, each Party or participating agency, organization or enterprise shall bear the costs of its participation and that of its personnel in cooperative activities engaged in under this Agreement, in accordance with existing laws in both countries.

ARTICLE 6

Nothing in this Agreement shall be interpreted to prejudice other agreements in the fields of science and technology concluded between the Parties.

ARTICLE 7

1. For the implementation of this Agreement there shall be established a U.S.-U.S.S.R. Joint Commission on Scientific and Technical Cooperation. Meetings will be convened not less than once a year in Washington and Moscow, alternately.

2. The Commission shall consider proposals for the development of cooperation in specific areas; prepare suggestions and recommendations, as appropriate, for the two Parties; develop and approve measures and programs for implementation of this Agreement; designate, as appropriate, the agencies, organizations or enterprises responsible for carrying out cooperative activities; and seek to assure their proper implementation.

3. The Executive Agent, which will be responsible for assuring the carrying out on its side of the Agreement, shall be, for the United States of America, the Office of Science and Technology in the Executive Office of the President and, for the Union of Soviet Socialist Republics, the State Committee of the U.S.S.R. Council of Ministers for Science and Technology. The Joint Commission will consist of United States and Soviet delegations established on an equal basis of which the chairmen and members are to be designated by the respective Executive Agents with approval by the respective parties. Regulations regarding the operation of the Commission shall be agreed by the Chairmen.

4. To carry out its functions the Commission may create temporary or permanent joint subcommittees, councils or working groups.

5. During the period between meetings of the Commission additions or amendments may be made to already approved cooperative activities, as may be mutually agreed.

ARTICLE 8

1. This Agreement shall enter into force upon signature and shall remain in force for five years. It may be modified or extended by mutual agreement of the Parties.

2. The termination of this Agreement shall not affect the validity of agreements made hereunder between agencies, organizations and enterprises of both countries.

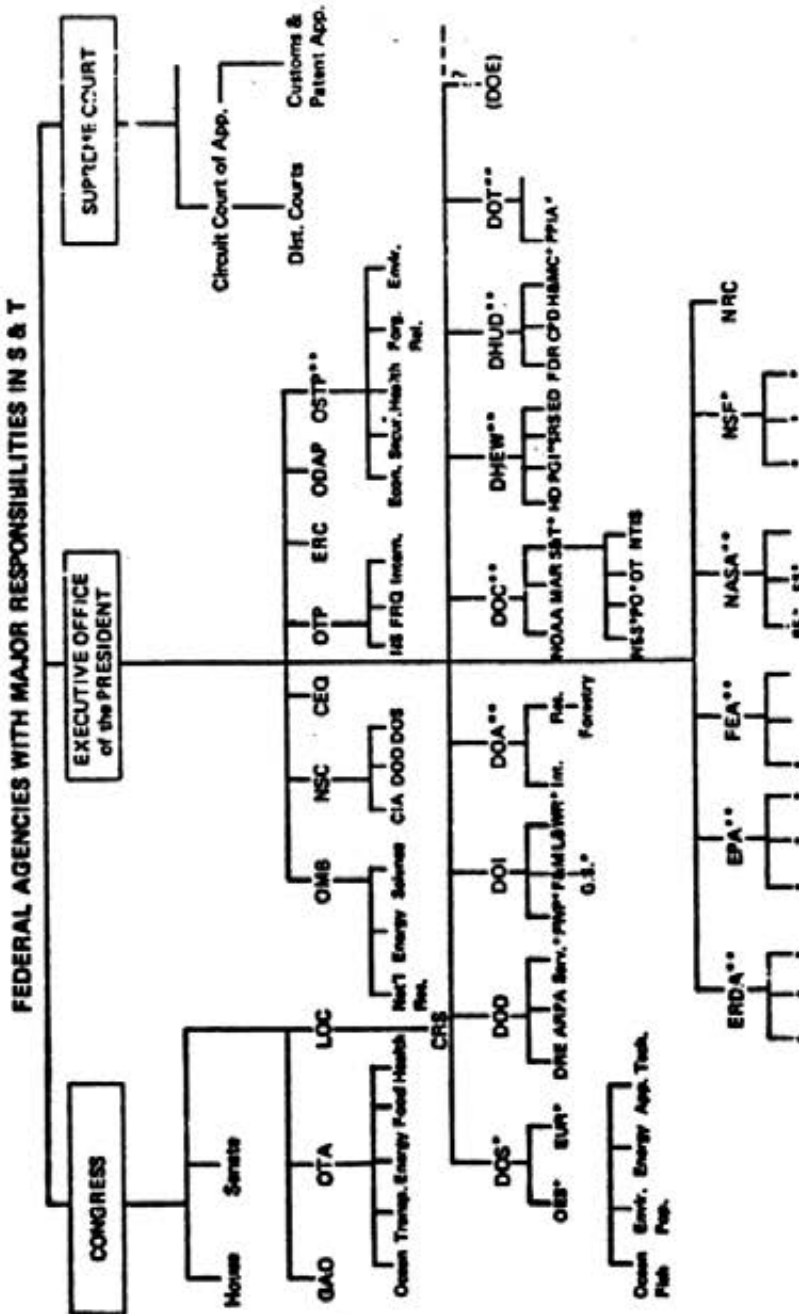
DONE at Moscow this 24 day of May, 1972, in duplicate, in the English and Russian languages, both equally authentic.

FOR THE GOVERNMENT OF THE
UNITED STATES OF AMERICA:

/s/ William P. Rogers
Secretary of State

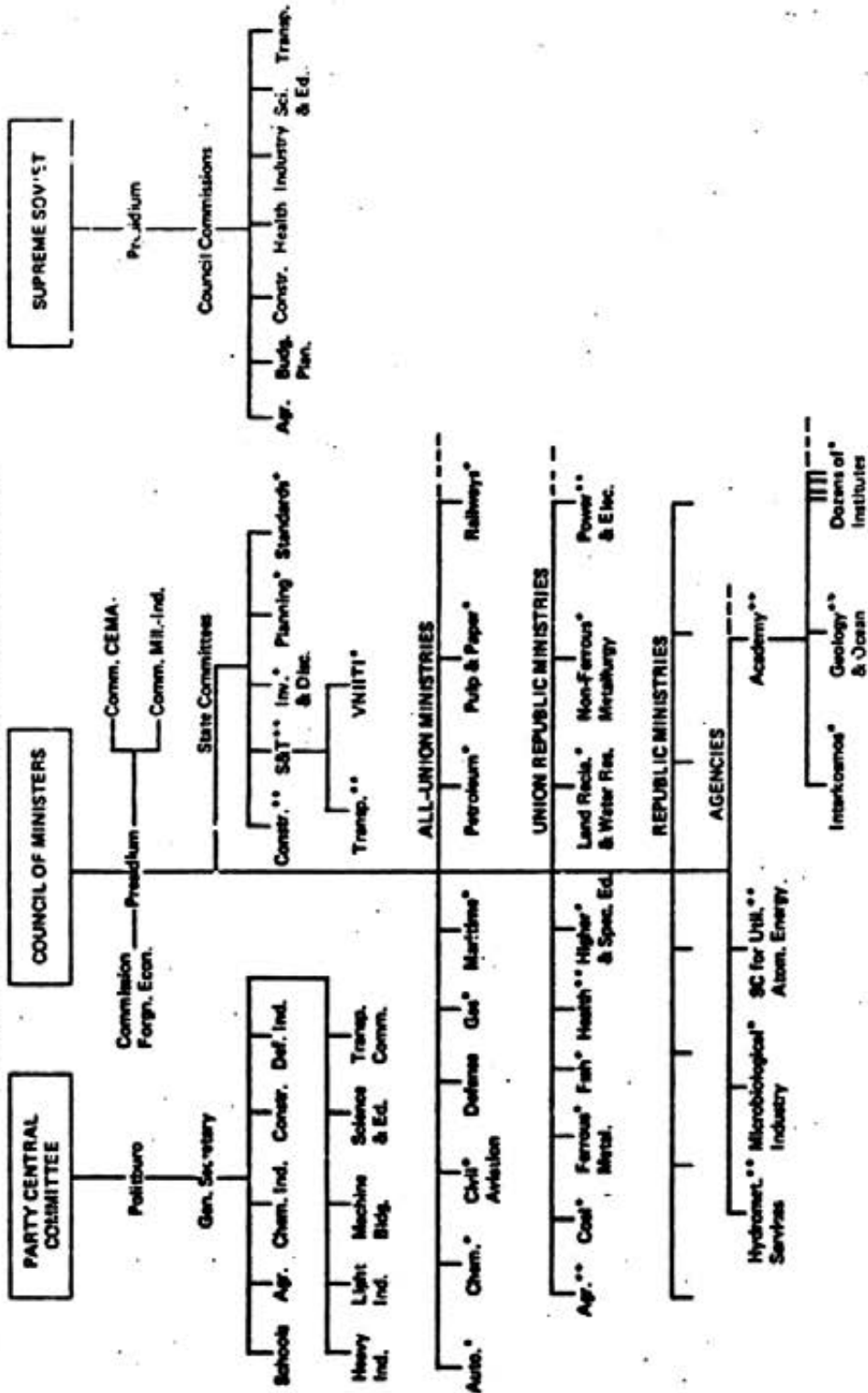
FOR THE GOVERNMENT OF THE UNION
OF SOVIET SOCIALIST REPUBLICS:

/s/ V.A. Kirillin
Chairman of the State
Committee of the Council
of Ministers of the U.S.S.R.
on Science and Technology



**Lead Agency for a U.S.-U.S.S.R. Summit Agreement
 *Responsible for Projects under Joint U.S.-U.S.S.R. Work

SOVIET AGENCIES WITH MAJOR RESPONSIBILITIES IN S & T



**Lead Agency for a U.S.-U.S.S.R. Summit Agreement
 *Responsible for Projects under Joint U.S.-U.S.S.R. Work

APPENDIX B
(COMMITTEE PRINT)

**REVIEW OF
U.S.-U.S.S.R. COOPERATIVE AGREEMENTS
ON SCIENCE AND TECHNOLOGY
SPECIAL OVERSIGHT REPORT NO. 6**

**SUBCOMMITTEE ON
DOMESTIC AND INTERNATIONAL
SCIENTIFIC PLANNING AND ANALYSIS**

of the

**COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

NINETY-FOURTH CONGRESS

SECOND SESSION

Serial VV

NOVEMBER 1976

Printed for the use of the Committee on Science and Technology

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WASHINGTON: 1976

RECOMMENDATIONS

The Subcommittee, having received and reviewed the public testimony and statements from witnesses on the U.S.-U.S.S.R. Cooperative Agreements on Science and Technology, makes the following recommendations:

RECOMMENDATION 1

THE U.S.-U.S.S.R. COOPERATIVE AGREEMENTS IN SCIENCE AND TECHNOLOGY SHOULD BE EVALUATED ON THE BASIS OF THE SCIENTIFIC AND TECHNOLOGICAL BENEFITS THEY YIELD TO THE NATION

The Cooperative Agreements in Science and Technology were entered into initially for the political purposes of reducing tensions and furthering international relations between the United States and the Soviet Union. However, their success both in terms of those objectives and in terms of furthering the application of science and technology to common problems in the two countries will ultimately depend on the benefits they yield to the United States and the Soviet Union. The agreements should therefore be evaluated on how well they serve to bring about and further an equal and reciprocal exchange of new and useful science and technology.

RECOMMENDATION 2

THE AMERICAN SIDE OF THE COOPERATIVE AGREEMENTS PROGRAM SHOULD INSURE THE COORDINATION AND REVIEW OF THE SCIENTIFIC AND TECHNOLOGICAL ACTIVITIES OF THE JOINT COMMISSIONS BY A CENTRALLY-PLACED, COMPETENT AUTHORITY WITHIN THE EXECUTIVE BRANCH

Organizationally, the eleven U.S.-U.S.S.R. Cooperative Agreements appear to lack an overall, designated scientific authority to whom the co-chairmen for the American side can report on purely scientific developments, or a visible source to whom the Congress can turn for program accountability. Above the co-chairmanship level, scientific leadership appears to be obscure. It would seem that from the nature of the program, a central coordinator of sufficiently high rank to effect science policy, but technically broad in competence to advise on matters of scientific substance, is required. The Director of the Office of Science and Technology Policy is well qualified to carry out this function and should be considered for this task.

RECOMMENDATION 3

UPDATED STATEMENTS OF OPERATIONAL AND ADMINISTRATIVE PRINCIPLES SHOULD BE PROVIDED BY THE AMERICAN CO-CHAIRMEN OF THE JOINT COMMISSIONS FOR THE GUIDANCE OF THE EXECUTIVE SECRETARIES AND OTHER ADMINISTRATORS IN THE RESPECTIVE LEAD AGENCIES AND FOR THE PARTICIPATING SCIENTISTS

The program has not as yet realized its potentials. Some of its shortcomings are attributable to the inadequacy of the current structure under which the overall science and technology program operates, including lack of sufficient and proper operational guidelines, staffing, and funding. Although the U.S.-U.S.S.R. science program is relatively new, for which some justifiable allowance should be made, it would appear reasonable to expect that during the four years which have elapsed since the initial agreements were signed, a body of administrative principles and problem-solving experiences should have emerged on the American side which could be "codified", shared with, and provide guidance to, the Program's administrators and scientists at all levels of the agreements.

RECOMMENDATION 4

ALL CURRENT PROJECTS SHOULD BE CRITICALLY EXAMINED ON A PERIODIC BASIS TO INSURE THAT THE SCIENCE AND TECHNOLOGY COOPERATIVE AGREEMENTS PROGRAM AS A WHOLE IS PROCEEDING ON A RECIPROCAL AND MUTUALLY BENEFICIAL BASIS AND IN THE MOST EFFECTIVE MANNER

Periodically, and no less than annually, all individual Working Group projects, now numbering about 150, should be subjected to a critical evaluation. The principle of reciprocity should be broadly applied. There may be individual Working Group projects where one side gains more than the other while in other projects the reverse may be true. But on balance, the entire program should be evaluated to insure that both nations give as much as they receive. The benefits gained by each nation should consist of scientific and technological knowledge which is helpful and useful in advancing research and development objectives. Resources should be concentrated on projects which offer a demonstrably greater potential for more meaningful scientific or technical returns. Such evaluation will insure that worthwhile projects will not suffer at the expense of marginal projects.

RECOMMENDATION 5

NEW PROJECTS TO BE CARRIED OUT UNDER THE EXISTING COMMISSIONS AND THEIR WORKING GROUPS SHOULD BE CAREFULLY SCREENED TO INSURE THAT ONLY THOSE WITH A HIGH POTENTIAL FOR SUCCESS ARE INITIATED

In reviewing proposals by American or Soviet scientists for the initiation of new projects, the United States side of the Joint Commissions should exercise a more discriminatory

project selectivity, particularly in favor of projects where mutually keen interest is demonstrated, where the scientific problem presented is one in which both sides have strong activity, and where the prospects for success appear good.

RECOMMENDATION 6

PROJECTS WHICH BECOME INOPERATIVE THROUGH LACK OF PERFORMANCE BY THE SOVIET SIDE SHOULD, FOLLOWING REASONABLE REQUESTS FOR COMPLIANCE, BE PROMPTLY TERMINATED IN A FORTHRIGHT, BUSINESSLIKE FASHION

As a case in point, under the Agreement on Agriculture, the Soviet side told its American counterparts at a joint workshop that the U.S.S.R. had conducted little, if any, short-run forecasting. The Department of Agriculture, however, believed that in such a highly controlled economy there had to be some activity which was roughly comparable to short-term forecasting as practiced in the United States. Subsequently, it was discovered by the U.S. side that, in fact, work of this kind was being conducted and the individuals in the U.S.S.R. in charge of this activity were identified. When such a situation develops, it should lead to immediate requests for cooperation on the part of the Soviet side. But if the project does not become operative, it should be promptly terminated in a manner which makes it clear that the lack of full, forthright compliance in accordance with the language and intent of the agreement is the cause.

RECOMMENDATION 7

LEAD AGENCIES OF THE EXECUTIVE BRANCH RESPONSIBLE FOR THE SCIENTIFIC CONDUCT ON THE U.S. SIDE OF THE SCIENTIFIC AGREEMENTS SHOULD SUBMIT REQUESTS FOR ADEQUATE FUNDS TO CARRY OUT THEIR COMMITMENTS UNDER THE AGREEMENTS TO THE PRESIDENT FOR INCLUSION IN THE ANNUAL FEDERAL BUDGET

The haphazard funding procedures currently employed by the Federal departments and agencies involved in this bilateral program has increasingly impeded the performance of the participants and has adversely affected the progress of many projects. Because of the failure to provide line-items in lead agency budgets for this international program, funds now must be transferred from domestic programs to support projects of the former. If the lead agencies are to fulfill their assigned missions under this program, then adequate funding commensurate with their responsibilities should be provided.

RECOMMENDATION 8

DEPARTMENTS AND AGENCIES OF THE FEDERAL GOVERNMENT SERVING AS LEAD AGENCIES FOR INDIVIDUAL U.S.-U.S.S.R. AGREEMENTS SHOULD SELECT THE PERSONNEL TO STAFF BOTH THE POST OF EXECUTIVE SECRETARY AND THE OTHER STAFF POSITIONS IN THEIR OWN SECRETARIATS FOR THOSE AGREEMENTS

The Executive Secretaries for each of the agreements are, with one exception, selected, employed by, or detached to, the designated lead agencies. The exception is the Agreement on Scientific and Technical Cooperation, for which the National Science Foundation currently is the designated lead agency. However, the Executive Secretary for this agreement is located in the Department of State. This anomaly removes the secretariat from the staff of the lead agency and excludes the NSF from membership on the Executive Secretaries Committee, which is chaired by the Department of State. To effect sound scientific guidance over the Scientific and Technical Cooperative Agreement the NSF should appoint its own Executive Secretary. The Department of State should continue to provide foreign policy guidance for the overall program through the U.S. co-chairmen and by its chairmanship of the Under Secretary's Committee of the National Security Council and the Executive Secretaries Committee.

RECOMMENDATION 9

IN KEEPING WITH ITS OVERSIGHT ASSIGNMENT THE HOUSE SCIENCE AND TECHNOLOGY COMMITTEE SHOULD BE FURNISHED ON A CURRENT AND CONTINUOUS BASIS WITH ADEQUATE DOCUMENTATION BY THE EXECUTIVE BRANCH ON THE STATUS OF THE U.S.-U.S.S.R. COOPERATIVE AGREEMENTS ON SCIENCE AND TECHNOLOGY

The first hearings on this subject were held by this Subcommittee's predecessor in June 1972, one month after the signing of the first of a series of bilateral agreements between the U.S. and the U.S.S.R. on science and technology. The second and most recent hearings on these agreements were held in mid-November 1975, three and one-half years later. From the Subcommittee's viewpoint, the informational gap which had developed during the interval between hearings was evident during the latter hearings. In order to be better informed at subsequent hearings and to avoid an informational catch-up situation as had prevailed, it is recommended that the Committee be provided reports on this program in order to assure it an informed foundation for carrying out its Congressional oversight responsibilities in the future.

APPENDIX C

LIST OF PANELISTS AND SPECIAL REVIEWERS

**BISE Review Panel on the U.S.-U.S.S.R.
Agreement in Science & Technology**

Richard L. Garwin* **, Research Division, IBM Corporation, Thomas J. Watson Research Center (Panel Chairman)

Applications of Computers to Management

Victor Vyssotsky, Executive Director, Circuit Provisioning Systems Division, Bell Laboratories (Panelist)
Ivan Selin, American Management Systems (Special Reviewer)
John Donovan, Sloan School of Management, Massachusetts Institute of Technology (Special Reviewer)

Chemical Catalysis

F.A. Cotton*, Department of Chemistry, Texas A&M University (Panelist)
Jule Rabo, Union Carbide Corporation (Special Reviewer)
Gabor A. Somorjai, Department of Chemistry, University of California (Special Reviewer)

Electro Metallurgy

Arden Bement, Advanced Research Projects Agency (Panelist)
George Dieter, Carnegie-Mellon University (Special Reviewer)
Joseph Klein, Cabot Corporation (Special Reviewer)

Forestry

James Bethel, Dean, College of Forestry Resources, University of Washington (Panelist)
Gerard Schreuder, College of Forestry Resources, University of Washington (Special Reviewer)
M.B. Dickerman, Society of American Foresters (Special Reviewer)

Metrology

Solomon J. Buchsbaum* *, Vice President for Network Planning and Customer Services, Bell Laboratories (Panelist)**
Donald Largenberg, Department of Physics, University of Pennsylvania (Special Reviewer)

Microbiology

Walter Gilbert*, The Biological Laboratories, Harvard University
(Panelist)
William D. Phillips*, DuPont Company (Special Reviewer)
Marvin Johnson, Department of Chemistry, University of Wisconsin
(Special Reviewer)

Physics

Hans Frauenfelder*, Department of Physics, University of Illinois
(Panelist)
Marshall Baker, Department of Physics, University of Washington
(Special Reviewer)
Edward Frieman, Department of Physics, Princeton University (Special
Reviewer)

Science Policy

Donald F. Hornig*, Aiken Computation Laboratory, Harvard University
(Panelist)
John P. Hardt, Congressional Research Service, Library of Congress
(Special Reviewer)
John W. Lewis, Department of Political Science, Stanford University

Water Resources

William C. Ackermann***, Chief, Illinois State Water Survey (Panelist)
James Wallis, IBM Corporation, Thomas J. Watson Research Center
(Special Reviewer)
Theodore M. Schad, Environmental Studies Board, National Research
Council (Special Reviewer)

David Pines*, Ex-officio, Chairman, Board on International Scientific
Exchange, University of Illinois, Urbana
George S. Hammond*, Ex-officio, Foreign Secretary, National Academy
of Sciences

Staff:

Alan Campbell, Executive Secretary, Board on International Scientific
Exchange, Commission on International Relations, National Academy of
Sciences
Charles Trumbull, Professional Associate, Commission on International
Relations, National Academy of Sciences

*NAS member
**ION member
***NAE member

APPENDIX D

BOARD ON INTERNATIONAL SCIENTIFIC EXCHANGE

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Emil L. Smith*, UCLA School of Medicine
Daniel D. Tosteson**, Pritzker School of Medicine, University of
Chicago
Bernhard Witkop*, National Institutes of Health
Richard L. Garwin* ***, International Business Machines Corporation
Seymour H. Lipset*, Stanford University
Dorothy Zinberg, Harvard University

Ex-Officio

George S. Hammond*, University of California at Santa Cruz
Rustum Roy**, Pennsylvania State University

Staff

Alan Campbell, Executive Secretary, Board on International Scientific
Exchange, National Academy of Sciences

*NAS member
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