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Intelligence Report

The Soviet Attempt To Improve Applied R&D

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CENTRAL INTELLIGENCE AGENCY

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INTELLIGENCE REPORT

THE SOVIET ATTEMPT TO IMPROVE APPLIED R&D

INTRODUCTION

1. Soviet leaders have long been dissatisfied with the rate of technical progress in the USSR. According to Kosygin, "the sluggishness and disorganization in connection with creation and introduction of new technology is a large defect in the practice of our work." M. M. Golanskiy, Deputy Director of the Central Economics-Mathematical Institute, described the technical level of Soviet industry relative to that of the United States as follows: "There is a [technological] gap and it is becoming wider. It seems to me that technologically the United States is disappearing beyond the horizon." The official position on technical progress was summarized by Leonid Brezhnev, as follows:

> The Communist Party and Soviet government are devoting unabating attention to all-out development of Soviet science and technology. Under today's conditions, this is without question one of the most important areas in building Communism.

2. Trends in industrial productivity indicate that Soviet leaders have genuine cause for concern. Growth in factor productivity has declined steadily since the late 1950s. During 1956-60, factor productivity in industry grew at an average annual rate of 5.3%; the comparable figure for 1965-69 is 1.4%. According to a previous report,* the slump in productivity growth is the result of the USSR's traditional strategy of growth, which relies on large injections of fixed capital to boost output. Technical progress, in the form of more efficient equipment and processes, has been insufficient to offset the sharply diminished returns to new investment.

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*ER IR 70-10, Investment and Growth in the USSR, *March 1970, SECRET.*

Note: This report was prepared by the Office of Economic Research and coordinated within CIA.

3. The declining growth of productivity inspired a wide range of measures aimed at reforming the institutions and organizations responsible for technical progress in the civilian economy. Some reforms, such as Khrushchev's massive regional reorganization in 1957, affected the organization of civilian research and development (R&D). Other reforms altered the allocation of research responsibilities among ministerial organizations and institutes of the USSR Academy of Sciences. The most important attempt to enhance enterprise incentives to adopt new technology was the industrial reform of 1965. Profits were established as the key indicator of enterprise performance, and enterprise managers were expected to embrace new technology as a means of lowering production costs and raising profits.

4. On balance, the reforms up to and including the industrial reform of 1965 left the Soviet R&D effort with (a) a competent, largely isolated military R&D sector which traditionally has received priority allocations of manpower and materials; (b) first-rate basic research carried out mainly by institutes of the USSR Academy of Sciences and Union Republic Academies of Sciences; and (c) an inefficient applied civilian R&D network which has been characterized by its inability to bridge the gap between research laboratory and production line. It is with the problems and prospects of civilian applied R&D that this report is concerned.

5. Today, technical progress in the civilian economy is administered by a large, dispersed bureaucracy coordinated at the top jointly by the State Committee for Science and Technology (GKNT), Gosplan, and the USSR Academy of Sciences. With the help of the GKNT, the Academy of Sciences and the industrial ministries each supervises a full-fledged system of research institutes, design organizations, and experimental facilities. R&D is also carried out in higher educational establishments (VUZY) which are supervised partly by the USSR Academy of Sciences and partly by the Ministry of Higher Education. The bureaucracy includes coordinating bodies at all levels that try to keep open the channels linking the theoretical and applied research with users of new technology. Other coordinating bodies are charged with developing lateral communications among institutes belonging to the ministries, the USSR Academy of Sciences, and the higher educational establishments. (For a description of the organization and administration of civilian applied R&D, see Appendix B.)

6. There are presently about 5,000 scientific establishments in the USSR, of which 80% are under the jurisdiction of ministries and state committees.* The remaining 20% are under the jurisdiction of the USSR Academy of Sciences or the Union Republic Academies. In 1969 these establishments employed most of the more than 883,000 scientific workers, almost half of whom worked in establishments of ministries or state committees.** Scientific establishments of the Acad-

*Including research institutes and their branches, scientific stations, laboratories, observatories, certain libraries, museums, and the like.

**The USSR defines "scientific workers" to include all academicians who are full or corresponding members of an Academy of Sciences; all holders of the degree of doktor of science or kandidat of science; all holders of academic titles of professor, docent, senior research associate, etc., all persons conducting scientific-research or scientific-pedagogical work in higher educational establishments; and all specialists doing scientific work in industrial enterprises and design organizations. This term includes not only scientists as the term is used in the United States, but also economists, historians, engineering scientists, philologists, architects, artists, etc.

emy of Sciences employed about 11% of all scientific workers, one-third taught and carried out research in VUZY, and the remaining 6% worked in industrial enterprises and design organizations.

7. This report deals with attempts made after the industrial reform of 1965 to restructure the civilian applied R&D sector. The first part of the report treats briefly some of the specific problems in the applied R&D sector. Next the report describes what is known about the effectiveness of 11 official decrees which were issued between 1966 and 1970 in an attempt to reform applied R&D. Finally, the prospects for future revolution or radical reshaping of the applied R&D system are appraised.

SUMMARY AND CONCLUSIONS

8. Because productivity gains in the Soviet economy have fallen off sharply in the last decade as the result of diminishing returns to new investment, Soviet leaders have indicated that future policy with regard to economic growth will center on raising the rate of technical progress. Despite the attention paid to technical progress, however, applied R&D in the civilian economy sector has continued to stumble.

9. Many of the specific problems in Soviet applied R&D are the result of the Soviet reliance on central planning and control. Goals for research institutes and for enterprises are imposed from above, and there is little lateral communication between researchers, designers, and users of new technology. The users of new technology cannot control the design of the new equipment they receive, and researchers are cut off from feedback on the success or failure of their inventions. The planning system also hinders the diffusions of new technology. Assimilation of new machinery is often planned enterprise by enterprise, and innovations rarely reach all potential users.

10. The incentive system prevailing in applied R&D works against rapid assimilation of new technology. Bonuses for researchers and designers generally do not depend on successful use of a new product or process. Enterprises are rewarded mainly for fulfilling output, profit, and sales plans. In contrast, the financial rewards to enterprise managers for raising the quality of output through use of technically advanced capital equipment are relatively small.

11. Applied R&D work suffers from a lack of physical facilities. In many ministries the facilities for development and testing are inadequate. The inflexibility of the system for supplying instruments compounds the problem. Finally the scientific education system is unresponsive to changes in demand for different kinds of specialists, and the curriculum for engineers is overspecialized and too lengthy.

12. In the five years following the industrial reform of 1965, 11 decrees were directed at improving applied R&D. The decrees touch on scientific education, R&D management, diffusion of new technology, and allocation of laboratory equipment. The content of the decrees ranges from vague declarations of intent to specific instructions. An important example of the latter is the instruction to ministries to make engineering facilities at enterprises available to research institutes for testing purposes.

13. The decrees attack the problems of applied R&D in a contradictory manner. Some of the provisions extend the role of central control and planning while others grant more autonomy to directors of scientific organizations. Five-year and annual plans for research work and for utilization of research results in production are to be devised by all branches of industry in republics, scientific institutions, and enterprises. "Coordinated plans" which cover all aspects of a project—from research to use in the economy are to be drawn up for important scientific projects. The most important scientific projects will have 10-15 year forecasts. Central control is further extended by a system of personnel evaluation which is to take place every three years. The evaluation will be carried out by an independent commission.

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14. The decrees, however, also provide more freedom for R&D organizations to determine their own course of action. Many of these provisions are similar to those of the 1965 reform which applied to industrial enterprises. All R&D organizations are encouraged to do contract work and may keep most of the profits for their own use. Directors of R&D organizations were given more latitude to determine expenditures on wages and equipment as well as the structure of their staff.

15. Other important provisions of the decrees recommend that integrated research, design, and testing facilities be formed; that research institutes, higher schools, and enterprises receive experimental facilities on a top priority basis; and that economic incentives of R&D organizations depend on the effectiveness of the new development in the economy. The piecemeal, seemingly contradictory nature of the decrees illustrates the experimental nature of Soviet attempts to find the best way of managing applied R&D.

16. Thus far the degree of implementation and the effectiveness of the decrees are difficult to assess because the evidence is scattered and fragmentary. Overall, the provisions of the decrees seem to have been introduced sporadically. Uniform, industrywide reform seems to be confined to the Electrotechnical Industry, which has had some success in reducing the gap between research laboratory and production line. While it is too soon to assess the long-run effects of reform in the Electrotechnical Industry, the conditions created by the reforms favor technical progress. Vertical integration of research institutes, design organizations, and industrial enterprises is said to have aided coordination and communication considerably. Planning and financing geared to projects rather than institutes has probably also helped.

17. Elsewhere, effects of reform seem to be negligible. The organization and planning of applied R&D has not changed as a result of the decrees. Vertical integration in response to the October 1968 decree has occurred in only three ministries. Planning of applied R&D is still done largely on an institute basis. Efforts to improve incentives in the research institutes have also been largely barren. Only one ministry and one research institute are known to have carried out personnel evaluation experiments. Furthermore, most institutes still pay bonuses for fulfilling output plans rather than for successful assimilation of their research results in industry.

18. A major reason for the lack of movement in the applied R&D sector is the failure of most industrial enterprises to participate actively in the R&D process. Enterprise incentives to assimilate new technology have not changed appreciably over the past five years. Half-hearted tinkering with enterprise incentives has been overwhelmed by insistence on central direction of the economy. The chief engineer of the Gor'kiy Motor Vehicle Plant describes the end result this way:

> The introduction of an important, significant invention calls for new materials, new equipment, additional items. But in order to get them, one has to go through all levels of planning all the way up to Gosplan USSR, and years are spent going through these levels. It is sometimes the case today that less time is spent on finding an engineering solution than is spent on convincing people, ordering things, having things confirmed, and on getting them.

19. Despite the lack of success thus far, piecemeal reform in applied R&D probably will continue. Soviet leaders are unlikely to admit that central planning

and bureaucratic control are the real obstacles to technical progress. Further reform will almost certainly involve additional vertical integration of research institutes, design organizations, and enterprises. Athough imports of technology will not provide a longrun solution to the problems in applied R&D, such imports can be expected to continue. Efforts to break down enterprise resistance to new technology probably will take the form of new bonus systems and a wider use of the new pricing methodology.

DISCUSSION

PROBLEMS OF APPLIED R&D IN THE CIVILIAN SECTOR

20. Most of the shortcomings in Soviet civilian R&D stem from the incompatibility of the R&D process with centralized direction and bureaucratic management. The civilian R&D sector suffers from the absence of market pressures more than any other sector of the economy. Under central control and planning, there is inadequate competition among research and design organizations. And without the "money votes" of a market system, potential consumers of new technology cannot easily communicate their needs to research organizations—much less enforce their wishes. As a result, priorities are established from above, and the civilian R&D sector sees only dimly the technological needs of industrial enterprises.

21. The civilian R&D sector must function without the coordinating, driving influence of an entrepreneur. Industrial enterprises also suffer from a lack of entrepreneurial leadership but to a lesser extent than groups conducting civilian R&D. In applied R&D, the entrepreneur's initiative and willingness to take risks is crucially important.

22. The nature of the applied R&D process makes the planning of R&D an ungainly activity. In the first place, planners cannot predict easily the duration, the cost, or the outcome of the research process. Also, planners have no truly meaningful measure of R&D "output" with which to compare the performance of various firms. Arbitrary measures of output must be used. As an example, "output" in design bureaus is sometimes measured in terms of the number of blueprint pages produced. Despite these difficulties, civilian applied R&D is centrally planned, institute by institute, and a large share of the materials for carrying on R&D are allocated centrally. Moreover, a sharp separation of civilian research from military-research, to which approximately 75% of centrally allocated R&D funds are devoted, restricts dissemination of research results to the civilian sector. As a result of these management shortcomings, civilian R&D is characterized by the following disabilities.

Faulty Coordination and Communication Among Researchers, Designers, and Customers

23. Since these groups are often physically and administratively separate, researchers usually do not assist designers in translating the results into working drawings and experimental models. Designers are not intimately involved with development and experimental production at industrial enterprises, and, conversely, enterprises that are to receive the new equipment do not oversee its development closely. Thus the enterprise must assimilate the equipment with a minimum of help from designers and developers. This sort of fragmentation compounds the difficulty the central authorities have in overseeing the innovation process.

24. Discussions of coordination problems abound in the Soviet press and in reports of Western scientists who have visited the USSR. One American, for

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example, was told by O. G. Gazenko, former chairman of the International Bioastronautics Committee, that coordination of the design and manufacture of equipment for the Soviet space program suffers because all space research and design work is carried out at research institutes and not at the industrial facilities. Gazenko noted the advantage the United States derives from having unified design and production facilities.

25. Even joint ventures by research institutes and industrial enterprises do not always result in continuing and direct contact between institute and enterprise personnel. For instance, when the Paton Institute for Electrowelding and the Zlatoust Metallurgical Plant tried to collaborate on the application of Paton technology in the Zlatoust plant, formidable coordination problems resulted. First, the Central Research Institute for Ferrous Metallurgy had to specify which of the plant's processes needed replacement. This institute also had to set a price on any new equipment to be installed. Furthermore, the Chelyabinsk Research Institute, which had been working with the plant, had to approve any Paton technology before it could be installed. As a result, Paton technology was absorbed very slowly, and the Paton Institute received little direct information on the success or failure of its new technology.

A Scientific Education System Out of Tune With the Needs of Research Institutes and Enterprises

26. Complaints about the system of educating scientists and engineers center on its inflexibility. There is a shortage of new graduates in some fields (especially computer technology) and an over abundance in others. Because the system trains too few laboratory technicians relative to the number of scientists, the scientists must do too much routine work. The whole higher education system is short of qualified teachers. One survey by a section chief of the USSR People's Control Committee found that just 30% of VUZ instructors have advanced academic degrees and that this figure is as low as 10% in remote areas.

27. The curriculum in scientific fields is frequently criticized for rigidity and excessive specialization and standardization. Mikhail Lavrent'yev, head of the Siberian Division of the USSR Academy of Sciences, contends that the scientific curriculum is 10-20 years behind the current level of scientific knowledge. Furthermore, G. Migirenko, a Novosibirsk professor, further alleges that the scientific curriculum does not involve students sufficiently in practical work.

28. Nevertheless, problems in training scientists and engineers are perhaps the least serious of those that plague civilian R&D in the USSR. Many of the problems in training personnel discussed above are not unique to the USSR. Personnel imbalances, shortages of good teachers, and lagging scientific curricula exist in the West as well. Market economies, however, respond more readily to shifts in the demand for scientific and professional personnel.

A General Neglect of the Development Stage

29. The overriding emphasis on production in the USSR has led to inadequate investment in development facilities for constructing and testing phototypes and for carrying out experimental production. As a result, industrial enterprises frequently are assigned to carry out development, although they are often poorly prepared for the task. One enterprise spent a year designing and manufacturing equipment to carry out experimental production of an automatic switch.

30. The shortage of development facilities means that many new products reach mass production slowly or not at all. Interested consumers of the product often can obtain it only through a contract with the designers for a custom-made version. Uncoordinated central planning can keep new products from reaching mass production even when experimental facilities are available. In the case of one Special Design Bureau subordinate to the Ministry of Instrument Building, affiliation with an experimental factory did not help get new, highly rated designs into mass production. The factory was producing an entirely different line of instruments and would not fulfill its output plan if capacity had to be used to test new designs.

31. The allocation of noninvestment funds also favors research at the expense of development. According to a GKNT section chief, in 1966-69 only 27% of centrally allocated, noninvestment R&D funds went for development (*razrabotka*). In contrast, the US government spent 66% of its noninvestment R&D allocation on development in 1968.

Inadequate Incentives at All Levels

32. Research institutes and design bureaus in general are not directly concerned with the introduction of their research into industry. A research institute earns bonuses by completing its planned research topics within specified financial limits. Although research institutes and design bureaus increasingly contract directly with enterprises, they still receive almost 40% of their funds from the state budget. Individual scientists are permitted to assist with development, but official pay scales for this service are very low. Institute directors often work around the system in order to pay contractors additional amounts.

33. At the enterprise level, managers are slow to adopt technically advanced equipment and processes received from the applied R&D sector for several reasons. In the first place, blueprints received from research or design organizations are often deficient in some respect. The manager frequently must transform these blueprints into new equipment without help from the designer. Meanwhile, if production is interrupted for retooling, the enterprise may fail to meet its output plan. Penalties for underfulfillment are severe, and technical progress seems not to be an adequate excuse.

34. When an enterprise has retooled and is ready to produce a new product, it faces additional problems. The enterprise may be dealing with unfamiliar suppliers. If so, raw materials may not be delivered on schedule, and the output plan will be threatened. The enterprise and the ministry sales organization must also solve the problem of distributing the new output. Inefficiency on the part of sales organizations can cause underfulfillment of the sales plans.

35. The Soviet system for setting prices on industrial commodities reinforces the reluctance of enterprises to undertake production of new products. Prices for new products often are set at the level of average cost in the first year of production. These costs usually fall rapidly in subsequent years. Therefore, enterprises that weather the years of retooling, trial production, and initial series production can reap increasingly large profit thereafter, until the price of the new product is lowered.

36. If enterprises were motivated by expectations of future profits, this pricing system might stimulate production of new products. However, an enterprise is

oriented, above all, to its current output and profit plans. Enterprise performance indexes do not take potential profits into account. Therefore, an enterprise that is comfortably producing an old product at a high, or simply adequate, profit rate is not tempted by future profits to retool and risk underfulfillment of the output plan. A failure to fulfill this year's plan is penalized; a failure to introduce new technology is not.

Administrative Problems Within the Research Institutes

37. Directors of research institutes are plagued by personnel problems and by difficulties in obtaining scientific equipment. Directors find it difficult to get rid of incompetent scientists. Furthermore, special research groups formed to perform a specific task tend to overstay their time and grow even larger. The central bureaucratic control of scientific research causes highly qualified scientists to spend inordinate time filling out forms, requisitions, and reports for higher authorities.

38. Management must cope with vexing supply problems. Planning requires that all material for future projects be ordered well in advance—even before the list of projects is complete. Institute reactions to the supply situation make the problem worse. G. Mchedlishvili, a department head in the Institute of Physiology of the Georgian Academy of Sciences, complains that the shortage of certain instruments and chemical reagents leads to hoarding of supplies that may never be needed. The supply agencies, in turn, often sell those instruments most in demand through "tie-in" sales which require the institute to purchase additional equipment it does not want. Worse, certain supply houses will sell instruments only to institutes of certain ministries, leaving other institutes without equipment. As a consequence, scientists waste valuable time fashioning their own equipment or contracting with industry for the production of custom-made equipment.

OFFICIAL VIEWS OF THE R&D PROBLEM

39. Soviet leaders themselves describe the applied R&D problem in a contradictory manner. First, there is the official party-government analysis which proceeds on the assumption that central planning is wholly compatible with efficient R&D. Current difficulties are seen officially as the result of inadequately coordinated central plans. On the other hand, official publications also cite the lack of incentives in research institutes and the lack of influence of customers as primary causes of the research-production gap, and some of the blame is laid on deficiencies at the enterprise level. A. M. Birman, prorector of the Moscow Institute of the National Economy, blames the lack of stable long-run plans, the lack of funds with which to buy new equipment, and improper pricing of new products.

40. Unofficially, however, there is growing awareness that centralized planning and control may not be compatible with efficient R&D. Dzherman Gvishiani, Deputy Chairman of the State Committee for Science and Technology, admits that "it is not easy to plan scientific and technical development, because we are not able to predict the results of fundamental research." Other highly placed officials have indicated that competition plays an important role in the R&D process. N. Lebedinskiy, a Gosplan official, says that, as a result of competition, the United States has an advantage over socialist countries in the introduction

of new technology. The need for competition was also stressed recently by K. D. Kalantarov, Director of the Medical Research Institute of the Ministry of the Medical Industry: "The reason it takes five to ten years for our factories to mass produce an advanced instrument . . . is our system itself. It allows for neither competition nor worker incentive plans."

SOVIET ATTEMPTS TO OVERCOME THE DEFECTS IN APPLIED R&D

41. Eleven decrees issued between September 1966 and December 1970 form the core of the most recent reform with respect to civilian R&D. The decrees tackle problems in the areas of (a) training and assignment of scientific personnel (four decrees); (b) management and operation of research institutes (four decrees); (c) design and estimate work (one decree); (d) diffusion of new technology among branches of industry and construction (one decree); and (e) scientific equipment for research and design organizations (one decree).*

42. As is the case with most Soviet decrees, the 11 decrees considered here contain a good deal of fairly general rhetoric and vague exhortations, such as "Executives of ministries and departments have been instructed to increase the responsibility of enterprises, research, and drafting-design organizations for fulfilling the established plan to produce new types of output and elaborate technological processes." The decrees, however, also contain operational, direct orders for someone to do something or at least strong suggestions that such orders have been given. This report deals only with the operational portion of the decrees.

43. To repeat, the decrees are uncertain and often not very specific. Some, such as the ones on diffusion of new technology and scientific equipment, do little more than articulate some of the serious problems that exist in applied R&D. Furthermore, the decrees offer contradictory approaches to the problems, although this is not surprising in view of the leadership's uncertainty over how to improve applied R&D. For example, the decrees call for both market elements and tighter central planning. Provisions granting research managers more autonomy can be found side by side with provisions strengthening and extending the role of bureaucratic direction. Gvishiani, the GKNT Deputy Chairman, illustrates this approach to the management of R&D in his pronouncement:

> Centralized management of science should be combined with a certain flexibility of organizational forms of administration which would ensure planning and control, unhampered research, freedom of opinion, and creative initiative.

In other words, the leadership is striving in the R&D area for the same conflicting goals as those vainly sought in the 1965 economic reform—a release of individual initiative without a weakening of central control.

44. To some degree the decrees are an extension of the economic reform to the R&D sector. Indeed, one purpose of the most recent decree is to extend the economic reform to scientific organizations. Other examples include the granting to research managers of more freedom to maneuver within the overall constraint of a given wage fund, the earmarking of some profits for the research organiza-

**Each of the decrees except one was a joint resolution of the Central Committee of the Communist Party and the USSR Council of Ministers. The Council of Ministers alone issued the decree on scientific equipment. For a complete description of all 11 decrees, see Appendix A.*

tion's own use, and some tinkering with charges for the use of fixed capital. Economic reform in the sense of wider use of economic levers and freedom for management is not the predominant aspect of the decrees, however. Instead the overall impression is one of experimentation in various directions—trying out new methods of organization and reshuffling the roles of the principal elements of Soviet R&D. There is a strong emphasis on increasing the participation of both universities and enterprises in applied research. Various kinds of associations of laboratories, design bureaus, and serial production plants have been initiated or proposed by the decrees. Nevertheless, both the experimental and the economic reform aspects of the decrees clash directly with the other theme running through the decrees—the reliance on new and stronger top-level controls to resolve problems of coordination in the R&D process. Thus the reforms in R&D mirror the general Soviet indecision regarding how best to manage the economy.

Description of the Decrees Related to Applied R&D

45. The seven decrees which pertain to the management and operation of applied R&D were issued successively in April 1967, September 1967, October 1968, June 1969, September 1970 (two), and December 1970.

46. The decree of April 1967 extends aspects of the economic reform of 1965 to the R&D sector by giving managers of research institutes more freedom to decide how the institute's funds will be spent. The major provisions are: (a) directors may now work out staff structure and change wage rates within the overall limits of the wage fund, (b) directors are free to work out administrative expenditures within the framework of total planned expenditures, (c) up to 75% of profits from contract work may now be spent on new equipment and facilities, and (d) directors may sell obsolete and unused equipment and purchase new equipment with the proceeds. Thus this decree tries to introduce flexibility into research institute management by reducing aspects of central control.

47. The September 1967 decree, which elaborated on some features of the 1965 industrial reform, includes one provision applicable to R&D. It permits the interest charge on fixed capital to be waived for research institutes, design bureaus, and experimental production units serving entire branches.

48. The most important decree on R&D, however, was issued in October 1968 and reflects a different approach. This decree, instead of emphasizing decentralization and special privileges, concerns itself equally with planning and control and new rules. Hoping to strengthen control over the science sector, the decree provides for additional plans. Besides the present five-year plan for scientific research projects, there are to be national, multi-year "coordinated plans" as well as annual plans for introducing new machinery and equipment into the economy. The decree defines coordinated plans as those which "embrace a whole complex of projects starting with research and ending with practical application of research results." In addition, all branches, republics, scientific institutions, and enterprises are to have five-year and annual plans for research work and for utilization of research results in production.

49. At the same time, the decree attempts to strengthen the role of incentives in applied R&D. It provides for widespread planned competition among research

institutes. To this end, projects are to be assigned to several institutions, and the best solution is to be chosen for implementation. A "new system of economic incentives and material rewards" based on the economic effectiveness of the new technology is to be introduced in research, design, drafting, and technological organizations and enterprises of the Ministry of the Electrotechnical Industry. Other industrial ministries are allowed to extend the "new system" to a few research and design organizations. Institutes in this experiment are to receive bonuses deducted from the profits of enterprises using equipment designed by the institutes.

50. In perhaps its most widely reported provision, the October 1968 decree approaches incentives in applied R&D with a stick rather than the carrot of revised bonus schemes. It calls for a quality certification system for all employees in research and design organizations and an evaluation of the work of R&D organizations subordinate to the ministries and the Academy of Sciences. The certification of institutions is to be conducted at least every three years by the hierarchy supervising these institutes. Three-year personnel certification is to be carried out by groups of scientists and Party and trade union officials, and these certifications are to affect bonuses and dismissals.

51. To improve coordination with prospective users of new technology, the decree allows Academy of Science institutes to perform contract research and gives research institutes the same responsibility for quality and meeting schedules as enterprises selling goods and services on contract. The decree stipulates that enterprise consumers of new technology are to be determined in advance so that they can help with documentation and development. The most promising efforts to improve coordination, however, involve new forms of organization which have been borrowed from industry. According to the decree, integrated scientific institutes will perform both research and design work. In addition, associations of industrial enterprises and research institutes, while maintaining their financial independence, will cooperate closely in research and development, and more closely knit specialized *"khozraschet"* associations of enterprises and design bureaus will be formed. Meanwhile, research institutes are to be transferred from ministerial jurisdiction to the jurisdiction of major industrial enterprises where feasible.

52. Finally, the October decree outlines an agenda for future reform. First, GKNT, Gosplan, the Ministry of Finance, and the Academy of Sciences are jointly charged with developing a workable way of measuring the effectiveness of research work. Second, the decree states that new development facilities will be provided on a top-priority basis. A statute on prototype testing procedures, additional incentives to master new technology, and a new methodology for price formation on new products are also promised.

53. The decree of June 1969 applies to design-drafting organizations. To insure that new enterprises are equipped with technically advanced equipment, the decree simply forbids construction using outdated designs. The focus is on forcing the design bureaus to work more efficiently and to be more responsive to their customers. The decree states that (a) beginning in 1971, customers will pay for design work only after it has been entirely completed or at specific stages; (b) also beginning in 1971, the volume of project design work will be set at a certain percent of the value of capital investment; and (c) cost estimates will include

a 5%-10% reserve which can be spent only with the permission of the customer. At the same time, however, the decree offers bonuses to design organizations which help to start up the units they design, permits the design organizations to contract for extra work above and beyond their set plan, and standardizes pay rates in the design bureaus. Machine building and metal working (MBMW) ministries are to work out five-year plans with their customers, specifying delivery times for the equipment sold while informing other design organizations of new equipment under development so that the new equipment can be incorporated in new designs throughout the economy.

54. Two decrees were issued in September 1970. One is concerned with inadequate diffusion of new technology among organizations of industry and construction. The chief complaint is that new products and processes do not reach all potential consumers. The decree contains few real, operational provisions to promote diffusion. Organizations of industry and construction are (a) "to adopt measures" to facilitate exchanges of information; (b) to produce complete documentation of technology successfully introduced so that other enterprises can benefit; and (c) to prepare suggestions to improve the state system of scientific-technical information during 1971-75.

55. The other decree of September 1970 tackles a critical problem of research institutes and design organizations—the shortage of laboratory equipment. Two steps are taken. First, engineering facilities and enterprises are to be put at the disposal of certain unspecified research institutes, presumably those designing laboratory equipment. Second, the GKNT and the Ministry of Instrument Building, with the concurrence of the USSR Academy of Sciences, are to approve assignments for developing instruments for scientific research and for putting them into series production in 1971-75.

56. A December 1970 decree specifies the rights and duties of the various organizations engaged in R&D. This decree, promised in the October 1968 decree, covers all independent organizations that conduct scientific research, design, drafting, or technological work. Thus the decree appears to cover organizations of the Academies of Sciences as well as those subordinate to industrial ministries.

57. Section III of the decree contains most of the provisions that deal directly with accelerating technical progress; the other sections deal mainly with legal and administrative matters. The avowed purpose of the decree is to extend to scientific organizations provisions of the industrial reform of 1965 and to extend to design and technological organizations rights previously granted only to research institutes. Therefore, many of the provisions of Section III are taken directly from earlier decrees. For example, the financial authority that was extended to research institute directors in April 1967 is now extended to directors of all organizations covered by the new decree. Similarly, the right of organizations to sell unused equipment is extended to all R&D organizations, as are the rules for promulgating long-range (10-15 year) plans which were set out in the October 1968 decree.

58. The new decree, however, is more concerned with coordination in R&D than were earlier decrees. Organizations subordinate to industrial ministries are instructed to assist enterprises in mastering new technology. In addition, all research organizations engaged in basic research are instructed to participate in

introducing the results of their research into practice. Furthermore, organizations of "general scientific configuration" (presumably those organizations subordinate to Academies of Sciences and to State Committees) are instructed to assist branch (of industry) organizations and enterprises in the execution of important projects.

59. The statute also centers on the use of foreign innovations. Organizations covered by the decree must submit recommendations for obtaining promising foreign licenses and prototypes of foreign scientific equipment and supplies. Organizations must also earmark those Soviet licenses suitable for export. In a more general (and inscrutable) sense, all R&D organizations are to engage in scientific-technical cooperation with foreign countries in order to solve important branch and interbranch problems.

Description of the Decrees Related to Training of Scientific Personnel

60. The four decrees directed at the training of R&D personnel were issued in September 1966, November 1967, and in September 1969 (two). The first two decrees deal mainly with scientific education while the others tackle more general problems in the education and placing of personnel. The general aim of these decrees is to make the scientific education system more responsive to the needs of organizations hiring scientific personnel.

61. The decree of September 1966 seeks to improve the training of specialists and to involve higher educational establishments (VUZY) more extensively in civilian research. The decree provides that enterprises are to be assigned to schools as bases for practical training of students and that managers of enterprises are to accept instructors as apprentices to familiarize them with production.

62. Other provisions aimed at raising the quality of instruction within the schools include a greater teaching role for experienced researchers from the Academy of Sciences, research institutes, and design bureaus, as well as a promise of facilities to upgrade instructor qualifications. Teachers doing research are to have their teaching loads lightened.

63. Seeking to raise the participation of VUZY and technical institutes in contract work, the decree calls for special bonuses for school personnel who create and apply new technology. Furthermore, 75% of profits from contract research can be kept by the school and used for expansion. Additional financial support may be provided by ministries that are allowed to donate 2.5 million rubles each per year to higher educational institutions.

64. The decree of November 1967 complains of the current level of quality of graduate dissertations and directs the supervising ministries to "take steps" to remedy the situation. Enterprises and others interested in research results will help evaluate dissertations. The only specific, operational provisions in the decree grant enterprises the right to set up classes to help specialists prepare for graduate study entrance exams and to give preference for admission to graduate study to specialists who pass the exams. Scientists are to be sent to staff research institutes and higher schools in remote areas.

65. One of the decrees issued in September 1969 is intended to raise the number of advanced production workers studying at higher educational institutions. To do this, the decree set up special departments at VUZY, industrial

enterprises, construction projects, transportation and communication organizations, and farms. These departments, staffed by instructors of higher and specialized secondary educational institutions, are to conduct an 8-10 month course to prepare students for study in VUZY. All students must have at least one year's practical experience. At the end of the course, students who pass final exams will be admitted to first-year VUZ study. Evidently, VUZ entrance exams are waived in their cases. The decree goes on to specify who may apply, what facilities enterprises must supply, and rates of pay for full-time students. By increasing the number of science students who have practical experience, the quality of applied research in VUZ laboratories is hoped to be raised.

66. Shortly after the decree was published, N. F. Krasnov, First Deputy Minister of Higher and Specialized Secondary Education, elaborated on some of its provisions. The preparatory departments are for individuals who did not go directly from secondary schools to VUZY. Thus the departments are open to demobilized soldiers and to workers and collective farmers who have worked at least one year; these individuals presumably need refresher courses to qualify for VUZ entrance. Krasnov also indicated that a student's course of study would prepare him for entrance into a specific VUZ.

67. The other decree of September 1969 is an effort to improve the placement of graduate students. The State Committee for Science and Technology, the Academy of Sciences, and the Ministry of Higher and Specialized Secondary Education are to compile long-run and annual plans for the assignment of these students. First priority in staffing goes to remote schools, research organizations, and enterprises. The decree restates the old rule that students must work for three years wherever they are sent.

IMPLEMENTATION AND EFFECTIVENESS OF THE DECREES

68. Evidence on implementation of the decrees is found mainly in scattered and fragmentary reporting of the Soviet press. A fairly complete documentation of the experiment in the Electrotechnical Industry has been presented, however, by Aleksei Antonov, Minister of the Electrotechnical Industry. Reports of Western visitors to the USSR also provide some insight into the current status of the reform. This section presents available evidence on how successful the decrees have been.

69. In general, the decrees seem to have been applied only sporadically in the civilian R&D sector. Some provisions of the decrees have been carried out in isolated research institutes, but uniform, industry-wide implementation seems to be confined to the Electrotechnical Industry. Furthermore, many promised reforms, such as the statute on prototype testing procedures, do not appear to have been issued. Indeed Soviet officials and economists generally are not impressed with the pace of reform over the last five years. The well-known liberal economist A. M. Birman comments that "there is no breakthrough in the acceleration of technical progress." In speaking of the October 1968 complaint that scientific work is not concentrated on the most important scientific problems, V. P. Yelyutin, USSR Minister of Higher Education said, "we are still slow to eliminate this shortcoming." Official opinion as reflected in *Pravda* is that "the turn toward scientific and technological progress is being made slowly in a number of branches of the national economy."

Better Coordination

70. Some attempts have been made to improve coordination among research institutes, design bureaus, and enterprises. Experiments which call for vertical integration of research, design, and development facilities have been carried out in the Electrotechnical Industry, the Petrochemical Industry, and the Shipbuilding Industry. Cooperative arrangements have also been made between several branches of industry and various institutes of the Siberian Division of the USSR Academy of Sciences. Each of these arrangements is discussed in more detail below.

71. As part of the experiment outlined in the October 1968 decree, extensive organizational reform has been carried out in the Electrotechnical Industry. Fifteen "head" institutes, two of their branches, and two "specialized" institutes were combined to form 17 integrated institutes with research, design, and experimental production facilities. In addition, an unspecified number of research institutes and corresponding enterprises were combined into four production associations with research and (probably) design facilities.

72. Design bureaus in the Electrotechnical Industry have also been reassigned and resubordinated. Various enterprises have been given jurisdiction over 21 design bureaus which before were subordinate to the ministry. Ten design bureaus have been transferred to what Antonov calls "scientific and technological centers." Design and development facilities have been created at eight large enterprises where these facilities did not exist. The Ministry retained control over ten design bureaus which serve groups of enterprises. Finally, 16 plant research laboratories at large enterprises have been accorded the status of "scientific organizations."

73. *Pravda* provides information on vertical integration in other branches of industry. The Ministry of the Petrochemical Industry has created a large design association which includes several design organizations and their branches. The Ministry of the Shipbuilding Industry is presently organizing a production association containing the Scientific Research Institute of Shipbuilding Technology, experimental production facilities, and three serial production enterprises.

74. The promising organizational link between the industrial ministries and the Siberian Division of the USSR Academy of Sciences is known as "dual subordination." In this system, ministries create and finance research institutes, design bureaus, and experimental production facilities near the Academy institutes in Novosibirsk. Personnel of the Siberian Division plan the scientific activities of ministerial research, design, and experimental facilities and are responsible for the application of the new technology. The ministries, however, retain administrative control over the facilities they have built. According to Mikhail Lavrent'yev, the head of the Siberian Division of the USSR Academy of Sciences, dual subordination of design and experimental facilities will permit scientific ideas of the Academy institutes to "ripen, acquire flesh, and be transformed first into blueprints, mockups, models, and then into experimental models which it will be possible to transmit for further assimilation." Lavrent'yev also intends to use these facilities for training apprentice engineering students at Novosibirsk University. As of March 1970, eleven all-union ministries were building or acquiring design and experimental facilities near Novosibirsk.

75. Contract work, which forces coordination between customers and producers of new products and processes, has increased over the past five years. A GKNT section chief reported that between 1964 and 1969, budget allocations as a share of total non-investment science expenditures fell from 71% to 64%. Moreover, substantial amounts of contract work are being performed by higher education establishments. In 1968, contract work provided 78% of all financing for scientific research projects carried out in VUZY under the Ministry of Higher and Secondary Specialized Education. In 1969 these VUZY performed 430 million rubles worth of research work, of which 325 million rubles represented contract work.

Planning

76. As suggested above, fragmentation within the civilian R&D sector makes planning difficult. Ideally, the work of diverse research institutes, design organizations, and experimental factories should be planned so that a new design can proceed smoothly from one phase to the next. Plans of the consumer enterprise should allow for any retooling. Of equal importance, plans for constructing new enterprises and plans for annual investment in industry should make use of developed and available innovations.

77. As part of the reform, the Electrotechnical Industry has improved considerably the planning of research, design, and development work. In compliance with the June 1969 decree, the Electrotechnical Industry has prepared five-year plans for design, manufacture, and delivery of new equipment. Although all machine building ministries were to prepare these plans, only the Ministry of Tractor and Farm Machine Building and the Electrotechnical Industry have done so.

78. In the Electrotechnical Industry, the focus of planning has been shifted from an institute basis to a project basis. The planning period is now the length of time the project will take, rather than a rigid calendar period. For each project, a head organization is chosen to assume responsibility for the project. All institutes, design bureaus, and enterprises involved in the project are stipulated in the project plan—including the manufacturer of the finished product.

79. New financial regulations in the Electrotechnical Industry reinforce the changes in the planning system. Funds are allocated to projects rather than to institutes and the sources of funds have been reduced to two: the centralized ministry fund which is formed from 13% of all types of profit in the ministry's enterprises and organizations and contracts with organizations outside the ministry. For a project within the ministry, funds are allocated from the central fund to the head organization which, in turn, pays for contributions to the project by other organizations.

80. Although Soviet leaders appear to be pleased with the results of the experiment in the Electrotechnical Industry, other branches of industry apparently have made little headway in coordinating the planning processes. Where planning is still on an institute basis, complaints such as those of A. Yamnov, the CPSU Central Committee section chief for Heavy Industry are common. Yamnov said in early 1970 that research is not geared to industrial needs, partly because production organizations do not establish precise objectives for research institutes. There is also unjustified duplication among research projects which are chosen on the basis of the presence of certain specialists rather than on the

basis of industrial needs. Finally, special groups formed to study a given problem frequently duplicate the work of existing organizations.

81. In late 1969, O. S. Sitnikov, the Deputy Director of the Institute of Economics of the Byelorussian Academy of Sciences, described the efforts to plan construction of new enterprises and to introduce technically advanced equipment into existing enterprises. In surveying conditions in Byelorussian industry, Sitnikov found that "almost all new plants were constructed according to the same principles as the old ones and old technological principles . . . were also preserved at reconstructed and expanded plants." Sitnikov probably identifies a situation typical of most of Soviet industry.

82. Existing industrial enterprises, however, were given a new mandatory target in 1970—the goal for technical progress. The measure of technical progress is a new indicator known as the indicator for "technical-economic development." It attempts to measure (a) the volume of production produced according to the "highest achievements of foreign and domestic technology"; (b) the amount of old equipment replaced; and (c) the pace of mechanization, automation, and product quality. Presumably this goal is secondary to the profit and sales indicators. It is too soon to observe any effect the new indicator may have had.

Incentives at Research Institutes

83. The chief provision of the decrees bearing on incentives calls for payments to scientists to be based on the practical effectiveness of their work. These payments are being made in only a few places, and the whole incentive system seems to be up in the air. According to Sitnikov, "it remains vague whether to pay a premium in relation to the economic effect of development or fulfillment of the quarterly plan." Sitnikov concludes that "a majority of planning and design organizations pay premiums for fulfillment of the plan and only a few pay for the effectiveness." Where incentive payments are based on effectiveness, efficiency probably has improved. In evaluating a year's experience on what he calls "a new system of planning and economic stimulation," Yu. Kess, assistant director of scientific work at the Tallin Scientific Research and Planning Technological Institute, declared that bonuses based on the effectiveness of the work stimulated responsible planning practices. Several projects were changed because their effectiveness was suspect. Enterprises, he said, are much more disposed to introduce new technology if the institute has carried out all testing and development.

84. The GKNT has put into effect some sort of regulation for evaluating completed scientific-technological work (as promised in the October 1968 decree), but nothing is known of its provisions except that it fails to say how bonus payments should be calculated. A new system for calculating bonus payments (presumably based on effectiveness of new technology in use) was to have been applied to research and design organizations of the Ministry of Instrument Building, Means of Automation, and Control Systems, but the fate of this measure is unknown.

85. The Ministry of the Electrotechnical Industry has put into effect a system of bonus payments financed from the savings resulting from use of new equipment. However, A. I. Antonov complains that the new bonus funds are insignificant in comparison with bonus funds from other sources. Antonov, never-

theless, boasts that the time required to research, develop, and introduce new technology has been cut in half as a result of the financial and organizational experiments.

86. The most publicized provision of the reforms designed to improve incentives, the three-year certification of research institutes and their personnel, is not practiced widely, according to the Soviet press. A *Pravda* editorial in early 1970 noted that "many ministers and heads of scientific institutes make little use of this possibility for improving the efficacy of the work of the scientific staff." Only the Ministry of Power and Electrification is known to have conducted an evaluation of the work of most of the institutes under its jurisdiction. *Pravda* singles out the Ministry of Ferrous Metallurgy, the Ministry of the Pulp-Paper Industry, and the Ministry of the Wood-Processing Industry as "feeble" users of the certification process.

87. A promising offshoot of the certification provision is a personnel evaluation experiment conducted in Moscow's Karpov Physical Chemistry Institute. In the experiment, each category of scientists and senior engineers was given a guaranteed minimum wage 25%-30% below the current wage. Supplements to the minimum wage were granted by the director of the institute for two years, based on the individual's contribution to science. The supplements could result in wages as high as 25%-50% above current levels. In practice, 60% of the Karpov scientists were left with their wages unchanged; 25% received higher and 15% lower wages. Most of those penalized were elderly senior scientists who had long since ceased to be effective but remained safely ensconced in high positions.

Incentives for Innovation at the Enterprise Level

88. Incentives for innovation within the enterprises have yet to be made compatible with incentives at research institutes. Enterprises are still reluctant to interrupt production in order to introduce new technology. This not only delays the introduction of new technology but also affects incentives of research institutes; the institutes on the new incentive system are penalized for footdragging by enterprises because their bonuses depend on enterprise savings resulting from the utilization of new technology. Nor is there any evidence that enterprises are exchanging new technology among themselves.

89. A new system of pricing new products—promised in the October 1968 decree and presented by Gosplan in mid-1969—stands out as the major effort made thus far to improve incentives at the enterprise level. Gosplan's methodology is devoted mainly to procedures for setting prices on new goods that are interchangeable with goods currently in production. For these products, upper and lower limits are established between which the wholesale price is set. The upper limit is the price at which the consumer is indifferent to the use of old and new products because the difference in their prices is just offset by differences in their effect on production costs. The lower limit is the price at which production of either the old or new products is equally advantageous to the producer in terms of the expected profits from their manufacture. By setting the wholesale price between the two limits, production as well as consumption is supposed to be stimulated. Finally, the new methodology establishes a sliding scale of prices by which prices are reduced gradually in relation to obsolesence of the product and to reduction in the cost of its production.

90. This pricing procedure departs from current practice in two important ways. First, the sliding scale of prices should reduce the present attractiveness of producing old products rather than new. Equally important, the utility of the new product to the consumer is taken into account in setting prices. From the consumer's point of view, higher prices are justified only for new products of higher quality or greater utility than the old products. If enforced rigorously, the new methodology should curb the present tendency of enterprises to raise product prices on the basis of minor design changes. Enterprises prefer to remodel, which adds more to cost than to utility, because remodeling involves fewer interruptions of production. The new system will not allow higher prices unless the new product is a genuine technical improvement over the model currently in production.

91. Gosplan intended the new pricing system to be a set of general guidelines for price formation on new products. At the time the guidelines were published, Gosplan promised more detailed instructions on price formation in each industry, but these instructions have not been published yet, at least not in open sources. Nor is there any evidence that the rules set forth in the pricing methodology are in use in any of the branches of industry. The Electrotechnical Industry, however, has a three-tier price system which attaches higher prices to new, high-quality goods and lower prices to lower quality, obsolete goods. It is not known whether the pricing system in the Electrotechnical Industry is related to Gosplan's pricing methodology.

Improved Experimental Facilities

92. The decree of October 1968 promised that more experimental facilities would be constructed. The decree "specifies measures for further equipping research institutes, higher schools, and enterprises in the next three or four years on a top-priority basis with experimental apparatus, testing units, and means of mechanization of scientific and engineering work." The goal is that "by 1972, results of research and design projects can be tested in one year."

93. As yet, there is no evidence that ministries are building development facilities on a top-priority basis. *Pravda* in November 1969 indicated that 9 of 32 research institutes under the Ministry of Ferrous Metallurgy have up-to-date experimental bases. The situation was no better in other ministries. Of 11 experimental shops planned for commissioning by the Ministry of the Petroleum Industry in 1969, only three were actually commissioned. A section chief of the State Committee for Science and Technology wrote, "many ministries continue to allocate an inconsiderable amount of resources for building empirical and experimental bases." V. A. Trapeznikov, deputy chairman of the GKNT, puts this allocation as low as 1% of investment funds for some ministries.

Equipment Shortages

94. Although the September 1970 decree on the provision of scientific equipment has 1971-75 as its time frame, steps have been taken to improve procedures for the allocation of the current supply of laboratory equipment. In September the state supply organization (Gossnab) set up three regional centers for the supply of scientific research institutes, design bureaus, and research sections of VUZY. One of the centers is located at the Odessa Polytechnical Institute; the locations of the other two are unknown.

95. The Odessa center allocates equipment and supplies normally distributed by Gossnab and Gosplan. The description of the center indicates that, at present, it lacks three important powers: (a) it cannot obtain instruments directly from manufacturers on short notice; (b) it does not have access to reserves of territorial directorates and consumer supply organizations; and (c) it allocates only those materials that have been ordered in advance. Without authority in these three areas, the centers probably can do little to improve the supply of scientific equipment.

96. Scientists are anxious to have a solution to problems in supply of scientific equipment. V. Arutyunov, Director of the All-Union Scientific Research Institute for Metrology in Leningrad, contends that the equipment rental system outlined in the October 1968 decree would save "tens of millions of rubles." According to his calculations, 15% of all instruments in all the research institutes and design bureaus of Leningrad are not used at all; one-third are used about once a year; and only half are used continuously.

97. Not all research institutes suffer from equipment shortages. While visitors have reported on poorly equipped laboratories in the fields of fluid dynamics and inorganic fluorine chemistry, well-equipped laboratories were found in institutes devoted to nuclear physics. The good fortune of these laboratories attests to the high priority of the sector or to the ingenuity of the laboratory director in working around the supply system.

The Reforms in Scientific Education

98. The problems in the training of scientists and technicians remain. Complaints in the Soviet press about the low quality of dissertations (probably for the *kandidat* degree), shortages of teaching personnel, and unsatisfactory curricula echo those printed five years ago. According to Soviet exchange students at the Massachusetts Institute of Technology, considerable dissatisfaction still exists in the USSR with the system for training scientific-technical personnel.

99. One of the few educational reforms mentioned in the Soviet press concerns the preparatory departments which were to be organized under the September 1969 decree. More than 190 VUZY have organized preparatory departments. According to the director of a scientific research institute in Tashkent, attendance at preparatory departments raised the rate of acceptance into higher educational institutions from 20% to 40%. However, there is no evidence that preparatory departments have been established at industrial enterprises, construction projects, and the other locations stipulated in the decree.

100. Some provisions of the September 1966 decree aimed at raising the quality of instruction are known to have been carried out at Kiev State University. The vice-chancellor for scientific work reported that the school received additional instructors and teaching assistants whose contribution allowed the teaching load of scientists doing research to be lowered by 100-200 hours per year.

101. Little headway seems to have been made in improving allocation of personnel. According to the September 1969 decree, the GKNT was to issue a statute on assignments for students who have completed full-time graduate study. This statute does not appear to have been issued. Furthermore, scientists are still reluctant to work in remote areas and in industrial enterprises. A deputy chairman

of Gosplan reported that as of late 1969, less than 1% of the *kandidats* of technological sciences and less than 0.25% of the *doktors* of technological sciences were employed at industrial enterprises.

PROSPECTS FOR FUTURE REFORM

102. Experiments in the management of applied R&D clearly will continue. Some of the reforms which were promised in the October 1968 decree but which still have not been issued probably will be forthcoming. In addition, a new decree being considered by the GKNT on prototype testing procedures may be issued. As for future innovations, Soviet scientists, planners, and economists have proposed solutions to problems which were either not covered or not treated adequately in the decrees.

103. One proposal made by a number of Soviet scientists concerns the planning of scientific research. Mchedlishvili of the Institute of Physiology of the Georgian Academy of Sciences urges that research be planned in stages without regard to calendar periods. Believing the year-by-year planning process to be incompatible with the nature of research, scientists generally single out present criteria for enterprise plan fulfillment as having an adverse effect on technical progress. Trapeznikov, GKNT's deputy chairman, for example, wants to use a technical progress indicator to evaluate the performance of industrial enterprises. Indicators of profit, output, and sales would be relegated to secondary importance.

104. Trapeznikov has also advanced the theory that restrictions on expenditures of the industrial ministries on research, design, and technological work should be removed. Ministries should be permitted to determine their own allocations to R&D within the overall limits of their total funds for wages and capital investment. This proposal resembles provisions of the April 1967 decree which gave similar freedom to research institutes.

105. In a recent *Pravda* article, however, K. Yefimov, chairman of Gosplan's Department for Planning the Introduction of the Achievements of Science and Technology into the National Economy, restated the traditional, official opinion that lagging technical progress is the result of "inadequately precise planning." Yefimov proposes a number of remedies, most of which reflect the principle that technical progress can be speeded through more efficient administration and planning. What is needed, he says, is: (a) a methodology for planning foreign trade in licenses; (b) diffusion of new technology through centralized state control and planning (Yefimov argues that ministries must not be given complete control over developing new equipment in their areas, as this hinders planned diffusion); (c) enterprise output indexes which reflect quality of output; and (d) further concentration of small and medium-sized firms in production associations.

106. Although he recommends two changes in enterprise incentives—that enterprises be reimbursed for losses during assimilation of new technology and that larger bonuses be given in enterprises for higher quality output—Yefimov is not concerned with solving other basic problems to create a favorable environment for technical progress. He does not mention, for example, the lack of communication between researchers, designers, and customers, and he ignores

the effect of price policy on new products and the lack of development facilities and laboratory equipment.

107. Schemes for altering scientific and technical education are plentiful, particularly those directed at the engineering curriculum which is said to be out of phase with the requirements of industrial enterprises and research institutes. One reform of engineer training was suggested jointly by the rectors of the Moscow Physical Technical Institute and the Moscow Engineering Physics Institute. They recommend a three-stage engineering curriculum. The first stage would be two or three years of general, theoretical engineering which would qualify students for roughly half of the existing engineers jobs while an additional two or three years would prepare engineers to work in production. The first two stages are approximately equal to the current engineering curriculum in VUZY; the final stage would prepare gifted students for scientific research.

108. Another educational reform has been suggested by the indefatigable A. M. Birman. He advocates the reduction (or elimination, it is not clear which) of budget financing of VUZY. Revenue would be derived from scientific research contracts, consulting fees from enterprises, and payments by enterprises for training enterprise personnel. According to Birman, this financial arrangement would make higher educational establishments much more responsive to current needs of science and industry.

109. An academician of the Siberian Department of the USSR Academy of Sciences has offered a solution to the problem of useless dissertations in scientific fields. He suggests that *kandidat* and *doktor* degrees be awarded for creation of new designs, machines, technologies, and the like rather than for dissertations.

110. Apart from piecemeal reform of organizations and incentives in civilian R&D, the USSR might pursue two other avenues to faster technical progress. One approach is simply to allocate more resources to civilian R&D. Trapeznikov, who claims that investment in R&D is three and one-half times more profitable than capital investment in plant and equipment, has called for doubling the investment in R&D. Apart from this proposal, expenditures on civilian R&D are growing rapidly. During 1966-69, expenditures on civilian R&D including investment grew at an annual rate of 9%. The comparable figure for 1961-65 was 7%. The total number of scientific workers in the USSR rose about two and one-half times between 1960 and 1969.

111. In the long run, such a policy would undoubtedly raise the rate of technical progress defined in a narrow sense. It would, however, take time to create new facilities and to train personnel. It is a moot question, moreover, as to how much of an increase in the scale of R&D could be managed by an already overburdened bureaucracy or whether diminishing returns to new R&D effort might not swamp the attempt. Still, the USSR is increasing resources in the R&D sector.

112. New technology also can be imported from Western countries. The latest decree indicates that greater efforts will be made in the future to obtain and assimilate foreign innovations. Although the USSR can purchase technical documentation for a new machine or process, Soviet scientists and engineers must translate the drawings into usable products. Few of the coordination and planning problems inherent in Soviet applied R&D are avoided by importation of technical drawings.

113. Alternatively, the USSR can purchase capital equipment directly. This system has its drawbacks in that great difficulty has been encountered in assimilating foreign equipment. To avoid this problem, the USSR has resorted to an another form of technological borrowing, the purchase of entire plants on a "turn-key" basis. A Western firm or group of firms is responsible for supervising construction of the plant, initiation of serial production, and training of Soviet personnel. In effect, the Soviet applied R&D sector is bypassed while Western entrepreneurs carry out much of the planning, coordination, and marketing.

114. "Turn-key" plants to produce investment goods theoretically could improve capital stock in Soviet industry. New machinery probably could be mass-produced in an imported plant in a shorter time than a design could be created and implemented by the Soviet applied R&D sector. However, there are difficulties even with "turn-key" plants. For one, the low quality of construction of these plants has prevented a number of them from reaching full capacity. Furthermore, industrial enterprises would be no more receptive to new machinery from this source than they are to domestic machinery. Beyond this, the USSR cannot depend on imported technology, because it is too expensive and because it involves acceptance of permanent technological inferiority.

APPENDIX A

ABSTRACTS OF DECREES RELATED TO APPLIED R&D, 1966-70

On Measures for Improving the Training of Specialists and Perfecting the Guidance of Higher and Specialized Secondary Education in the Country (*Pravda*, 9 September 1966)

1. Problems Cited

a. The Ministry of Higher and Specialized Secondary Education does not work systematically to raise the qualifications of instruction at educational institutions.

b. The Ministry fails to publish the necessary volume of textbooks.

c. Higher educational institutions with highly qualified scientific staffs are not concentrating on the most pressing national problems.

2. Measures Taken

a. A number of higher educational institutions have been transferred to the direct jurisdiction of the USSR Ministry of Higher and Specialized Secondary Education to write textbooks and to prepare study aids and the like.

b. The Ministry is charged with state inspection of all the country's higher educational institutions.

c. To improve practical training of future specialists, a procedure has been worked out for assigning enterprises and institutions to higher schools and *tekhnikums* as permanent bases for the students' practical training.

d. Managers of enterprises, higher schools, and research organizations are obliged to provide higher school instructors with a period of on-the-job familiarization with technology and production.

e. It is proposed that well-qualified specialists from the Academy of Sciences and branch research and design organizations teach in higher educational institutions.

f. Supplementary staffs of professors and instructors are to be established by the Ministry at the 25 leading higher educational institutions so as to lighten the teaching load of scientists in research.

g. Bonuses will be granted to professors and instructors for creating and applying new technology.

h. Higher educational institutions are permitted to spend 75% of their profits from contract work on expanding their own facilities.

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i. Each ministry and department, with the consent of the appropriate planning organs is permitted to transfer 2.5 billion rubles a year to higher educational institutions.

j. Specialized secondary educational institutions will be constructed and equipped through allocations to ministries and departments whose specialists are being trained.

k. A number of measures have been outlined for supplying higher schools with special instructional and scientific equipment.

On Expanding the Rights of Managers of Research Institutes (*Izvestiya,* 4 April 1967)

1. Problem Cited

Funds allotted for research work are not used effectively.

2. Measures Taken

a. Only total outlays and the wage fund will be fixed for institutions conducting research work planned by the State Committee for Science and Technology. The number of personnel and their average wages will not be established from above.

b. Institute directors can work out and confirm the staffing of the institute in conformity with the standard structure and staff. They can change wage rates within the bounds of the wage fund, using the official schedule of position pay rates.

c. Institute directors have the right to determine, within the total volume of outlays, expenditures on individual items of administration and management. Directors are permitted to economize on some funds, such as the wage fund, in order to increase expenditures on other items such as equipment and research materials.

d. Leaders of institutes have been granted the right to spend 75% of the profits from research work performed under contract for expansion of their facilities.

e. Research institutions are authorized to sell obsolescent and unused equipment and spend the receipts on new apparatus and materials.

Supplement to the October 1965 Resolution on the Socialist State Production Enterprise (*Ekonomicheskaya gazeta,* September 1967)

1. Problem Cited

Completion of work and the commissioning of important facilities must be accomplished more quickly.

2. Measure Taken

With the consent of the Ministry of Finance, ministries, departments, and Union Republic Councils of Ministers can waive the interest charge on fixed capital for experimental production units that work for a branch

as a whole. The charge may also be waived for research laboratories and design bureaus.

On Improving the Training of Scientific Cadres (*Izvestiya*, 26 November 1967)

1. Problems Cited

a. Research institutes and higher educational institutes are not selecting promising students for graduate study in the sciences.

b. Dissertations are often late; some are low in quality and do not contain material useful to science or practice.

c. The plans for the number of graduate students is consistently underfulfilled in certain branches of science.

d. The ministry awards academic degrees for work with no scientific or practical value.

e. Ministries and departments do not exercise sufficient control over higher educational institutions and research institutes.

2. Measures Taken

a. Executives of enterprises, research, and design organizations and higher educational institutions may set up classes for specialists who are preparing for candidate or entrance exams.

b. To raise the quality of dissertations, preference in enrollment for graduate study will be given to specialists who have passed candidate exams.

c. Executives of research institutes and higher schools are to intensify control over teacher training and accrediting.

d. Enterprises, institutions, and organizations having an interest in research results should help evaluate dissertations.

e. Remote research institutes and higher educational institutions are to be strengthened by sending highly qualified students to work in them.

On Measures To Raise the Efficacy of the Work of Scientific Organizations and To Accelerate the Utilization of Scientific and Technical Achievements in the National Economy (*Izvestiya*, 23 October 1968)

1. Problems Cited

a. Scientific institutions do not take sufficient responsibility for the level of performance of scientific projects, and enterprises do not take sufficient responsibility for producing new items promptly.

b. Specialization of scientific organizations is inadequate; competition is poorly developed.

c. The existing system of incentives for research and assimilation of results of research does not promote efficiency.

d. The supply of technical equipment to research institutes and VUZY is inadequate.

2. Measures Taken

a. Long-term (10-15 years) scientific forecasts will be made for the most important scientific problems.

b. Proposals to be drawn up on trends of scientific development will define the level of development by the end of the plan period.

c. Where necessary, pilot organizations will be appointed to deal with fundamental scientific problems.

d. Coordinated plans will be drawn up to solve basic scientific problems. There will also be annual plans for applying new technology in the economy.

e. Ministries, departments, and Union Republic Councils of Ministers may keep up to 2% of budget appropriations as an undistributed reserve to be used on the most important scientific problems.

f. Research institutions belonging to the Academy of Sciences, Union Republic Academies of Sciences, and to several ministries and State committees have been permitted to undertake contract projects above the planned volume of research expenditures.

g. The State Committee for Science and Technology, Gosplan, the Ministry of Finance, and the Academy of Sciences are to devise a system of planning and accounting indexes for scientific and technical development to be used in evaluating the actual economic effectiveness of applied research results.

h. Competition will be developed by assigning research to several organizations. These organizations will produce experimental models, the best of which will be used in production.

i. It is essential to determine beforehand the enterprises and construction sites which will use the results of the most important research. They will then work with the scientific institutions on technical documentation and preparation for production.

j. The State Committee for Science and Technology together with the ministries and Gosplan are to draw up a model statute on the procedure for testing samples of new types of equipment.

k. Additional proposals will be made to give enterprises and scientific institutions greater incentive to master new equipment.

l. Scientific institutions failing to meet the technical-economic indexes stipulated in contracts must pay for adjustments if the client wishes. Also, rules regarding responsibility for quality and the time limits of contract work have been made applicable to research organizations.

m. The ministries and Academies of Science will evaluate the work of subordinate organizations at least every three years.

n. Where necessary, the following forms or organization are recommended for ministries and departments: (1) integrated scientific institutions to

perform research, design drafting, and technological work; (2) scientific production associations, including research institutes with design, drafting, and technological subdivisions as well as enterprises; (3) specialized *khozraschet* technical-production associations; (4) research institutes at major industrial enterprises.

o. Executives of enterprises and organizations have the right to pay specialists with academic degrees the salary paid to scientific personnel at institutes.

p. In 1969, three-year certification of employees in research and design organizations will begin. Bonuses or dismissals may be affected depending on the evaluation, which is to be conducted by a committee of scientists, Party, and trade union officials.

q. Research institutes, higher schools, and enterprises will receive experimental apparatus and testing units in the next three or four years. Industrial output will not be assigned to experimental apparatus, and designs for new enterprises must provide for mandatory construction of the experimental laboratories, shops, and testing units necessary for researching, perfecting, and testing new products.

r. Economic incentives for research institutions, scientific subdivisions of higher schools and enterprises, and their employees will depend on the effect of scientific projects and new equipment on the national economy.

s. On 1 January 1969 a new system of economic incentives is to be introduced experimentally in scientific and production organizations of the Ministry of the Electrotechnical Industry. Other industrial ministries and the Ministry of Agriculture will be allowed to transfer one to three research or design organizations to the new system. Under the new system, the volume of research and design work will be planned as a function of commodity output. These projects will be financed exclusively from a fund formed from the profits which result from technical progress in the related enterprises and organizations.

t. The price committee of Gosplan is instructed to develop a system for pricing new products which allows part of the savings from inventions to go to the designers. Also, there is to be a procedure for reducing prices on obsolete products.

u. Contract profits and license revenues will form a development fund in each scientific organization to finance investment, equipment purchases, etc. Unused funds may be carried over to the following year and will not be confiscated.

v. Annual plans must provide for allocation of resources for scientific work. Instruments and materials may be exchanged among scientific organizations. The USSR Council of Ministers Committee on Standards, Measurements, and Measuring Instruments will rent measuring devices to scientific institutions. The Ministry of the Chemical Industry will sell laboratory chemicals on contract.

w. Within six months there will be a general statute on research institutes, design drafting, and technological organizations which will specify obliga-

tions and rights of these institutions. There will also be a statute on contract procedures.

On Improving Design and Estimate Work (*Izvestiya*, June 1969)

1. Problem Cited

There are serous shortcomings in the work of design organizations and in the expert examination of designs and estimates.

2. Measures Taken

a. Ministries and departments are to draw up integrated plans for research and design work on the creation of new processes on the basis of the five-year plans for capital construction.

b. Machine building ministries are to work out five-year plans for the design, manufacture, and delivery of equipment and are to stipulate the time periods in which customers are to provide technical specifications for the equipment. These ministries are also to develop and produce quickly new equipment stipulated by design bureaus.

c. Inclusive construction cost estimates are to be drawn up at the design stage. These estimates will include a 5% to 10% reserve for unforeseen costs. The reserve may be spent only with the permission of the enterprise being built.

d. After 1 January 1971, customers will pay for design work at completion or at specific stages of the work.

e. If they assist with the start-up, design organizations will receive up to 5% of all bonuses provided for commissioning construction units.

f. Ministries and departments must not permit construction of units according to outdated designs.

g. Beginning in 1971, the planning of the volume of design work in ministries and Union Republic Councils of Ministers is to be carried out in percentages of the volume of capital investments.

h. Ministries, departments, and Union Republic Councils of Ministers are granted the right to have several design organizations work on design solutions in order to find the optimum solution. These bodies are also allowed to accept above-plan contracts provided that the customers pay the wages, and they may authorize changes in standard designs to incorporate advanced processes.

i. The Statute on the Socialist State Production Enterprise (5 October 1965) will be applied to those *khozraschet* state design, surveying, and research organizations that work on capital construction projects.

On the Organization of Preparatory Departments at Higher Educational Institutions (*Pravda*, 6 September 1969)

1. Problem Cited

Enterprises, organizations, collective farms, and state farms have not sent enough advanced production workers to higher educational institutions.

2. Measures Taken

a. Preparatory departments are being established at higher educational institutions and at enterprises, construction projects, and farms to prepare students for entrance into higher educational institutions.

b. Persons with a secondary education who are production workers with at least one year's experience or who have been discharged from the armed forces are eligible.

c. Higher educational institutions, enterprises, construction projects, farms, etc., will provide all facilities and supplies for these preparatory departments.

d. Students will be paid by the organizations that send them at the same rate as first-year students in higher educational institutions.

e. Instructors will be drawn from higher and specialized secondary educational institutions.

On the Assignment of Persons Completing Graduate Study (*Izvestiya*, 27 September 1969)

1. Problem Cited

Too many graduate students evade the rule which requires them to serve three years wherever they are sent. By means of influence, many manage to get employment in good locations.

2. Measures Taken

a. The State Committee for Science and Technology, the USSR Academy of Sciences, and the USSR Ministry of Higher and Specialized Secondary Education are charged with drawing up long-run and annual plans for assignments of graduate students.

b. Union-Republic Councils of Ministers, Ministries, and Departments are required to submit applications for specialists to fill vacancies in their areas.

c. First priority in staffing goes to higher educational institutions, research institutes, and enterprises in remote areas.

d. All graduate students are to work three years in the organizations to which they are sent. No one will be hired elsewhere without papers certifying completion of the three years or an official exemption.

e. The State Committee for Science and Technology has been instructed to draw up and approve a Statute on the Assignment of Persons Completing Full-Time Graduate Study that will be binding on all ministries and departments.

On Development of Production of Instruments for Scientific Research (*Izvestiya*, 27 September 1970)

1. Problem Cited

The equipping of scientific organizations with the newest scientific instruments and measuring apparatus is a key condition for highly effective scientific research.

2. Measures Taken

a. Appropriate enterprises and engineering sections are to be built or reconstructed for the use of scientific research and project design organizations.

b. The State Committee for Science and Technology and the Ministry of Instrument Building, Means of Automation, and Control Systems will approve, with the concurrence of the USSR Academy of Sciences, assignments for development of instruments for scientific research and for putting them into series production in 1971-75.

On Mutual Use of Scientific-Technical Achievements by Ministries and Departments of the USSR and Enterprises and Organizations in their Jurisdiction (*Izvestiya*, 26 September 1970)

1. Problems Cited

a. There is insufficient mutual exchange of scientific-technical achievements among ministries, enterprises, and organizations in industry and construction.

b. Many new products and processes do not receive full distribution in the national economy.

2. Measures Taken

a. Ministries and departments in industry and construction are obliged to adopt measures for improved use of scientific-technical achievements of other branches of the national economy and for transfer of their own achievements to these branches.

b. Documentation for work implemented in enterprises and organizations of industry and construction must be complete in order to facilitate exchange among branches.

c. "Responsible organizations" have been charged with working out proposals to raise incentives for exchanging scientific-technical achievements and for using methods developed by others.

d. These same "responsible organizations" have been charged with preparing suggestions for further improvement of the state system of scientific-technical information in 1971-75.

General Statute for Scientific-Research Design, Design-Drafting and Technological Organizations

Section III "The Scientific, Scientific-Technical, and Economic Activity of Organizations" (*Economicheskaya gazeta*, No. 52, December 1970)

1. Problem Cited

None.

2. Measures Taken

a. Scientific research organizations with "general scientific configuration" shall:

(1) Conduct basic research, assess its possibilities for technical progress, recommend practical use for research results, and assist in implementing research results;

(2) Work out 10-15 year forecasts of principal scientific-technical developments;

(3) Study achievements of Soviet and foreign science and prepare recommendations for practical utilization of such achievements;

(4) Give scientific assistance to branch organizations and enterprises; and

(5) Bear responsibility for the technical level of their research and for its effective practical utilization.

b. Scientific research, design, design-drafting and technological organizations of "branch configuration" shall:

(1) Conduct basic and applied research in their fields and participate in its implementation;

(2) Design new enterprises and modernize existing ones, and develop new products, processes, machinery and equipment;

(3) Study the technical level of production in branch enterprises, study Soviet and foreign technical achievements, and recommend their use in branch enterprises;

(4) Participate in enterprise efforts to master new technology;

(5) Exercise author's supervision over assimilation of new technology into production; and

(6) Finance any corrections necessary to make work completed on contract meet specifications.

c. All organizations shall:

(1) Engage in scientific cooperation with foreign countries to solve important branch and interbranch problems;

(2) Conduct joint research and development with organizations of other countries that would actually do part of the work on a project;

(3) Conduct mutual exchange of scientific information, specialists, documentation, and prototypes with organizations of other countries;

(4) Submit recommendations for acquiring foreign licenses that would contribute to accelerating technical progress;

(5) File prompt reports on their projects so that scientific information materials will be up to date;

(6) Ensure wide use of domestic and foreign patent material by studying available patents before carrying out projects;

(7) Submit orders for equipment and supplies early while refraining from building up above-plan stocks of supplies;

(8) Cut administrative expenditures by automation and progressive methods of administration;

(9) Ensure the training of scientists and systematic improvement of workers' skills while creating the necessary conditions for workers to combine work and graduate study; and

(10) Be given incentives for fulfilling their jobs in accordance with current legislation.

d. Organizations which are the "head" organizations for their branches, production sectors, problems, basic assignments or topics shall:

(1) Coordinate scientific development; and check on fulfillment of assignments in subordinate organizations and any other organizations that are contributing to work for which the head institute is responsible;

(2) Obtain draft project plans from subordinate organizations and make recommendations concerning these drafts;

(3) Draft coordinated plans for work to solve problems in question; and

(4) Obtain detailed scientific-technical information from all organizations carrying out work under coordinated plans and compile summary reports.

e. An evaluation of scientific and technical activity of organizations shall be made according to established procedures at least once every three years.

APPENDIX B

ORGANIZATION AND ADMINISTRATION OF APPLIED R&D IN THE USSR

As the USSR defines it, applied research (*prikladnyye issledovaniya*) entails creation of new materials, products, and processes as well as improvement of existing ones. Applied R&D is carried out primarily in research institutes and design organizations subordinate to the industrial ministries. Important contributions, however, are made by higher educational establishments and occasionally by research laboratories at industrial enterprises. The USSR Academy of Sciences also has statutory responsibility for applied research in the technical sciences. The role of each of these institutions is discussed below.

Although ministerial research institutes do basic research in technical sciences, their main concern is with applied research. The "output" may be working drawings or an experimental model. Some ministerial research institutes have their own experimental-testing facilities and produce fully tested prototyes. Institutes equipped to carry out the entire R&D process are most often found where prototype construction involves great technical difficulties, as in electronics, or where a new process is to be used by many diverse enterprises, as in electrowelding.

The title "design organizations" covers numerous groups involved in various aspects of the R&D process. In general, "design bureaus" create new products. If they have experimental-testing facilities, design bureaus produce fully tested prototypes. Otherwise, working drawings are prepared for prototype construction. In these cases, testing and development are assigned to an industrial enterprise. Design bureaus can be independent *khozraschet* organizations or component parts of research institutes or industrial enterprises.

Other institutions that can be loosely grouped under the heading of design organizations are (a) "project technological organizations" which design new processes for given branches of industry, and (b) "project organizations serving capital construction" which design new enterprises and prepare construction plans.

Higher educational establishments also play a role in applied research and in basic research assigned by the Academy of Sciences in addition to their primary responsibility for scientific education. Higher educational establishments (VUZY) include universities which are concerned mainly with the basic sciences and higher educational institutions which are primarily occupied with applied research. Roughly two-thirds of the VUZY are subordinate to the Ministry of Higher and Specialized Secondary Education, while the rest are under the jurisdiction of nonindustrial ministries (Agriculture, Health, Trade, etc.) and other organizations.

VUZY do applied research for industry in "problem" research laboratories and in "branch-of-industry" laboratories. Problem laboratories work on specific problems of interest to industry or to another VUZ department. As of mid-1969, there were 400 problem laboratories under the USSR Ministry of Higher and Specialized Secondary Education. Branch-of-industry laboratories accept contracts from ministries or industrial enterprises to work on specific problems.

Education in the VUZY stresses engineering and the natural sciences. In 1965, 61% of scientific workers employed in VUZY were engaged in teaching and research in these fields. Programs leading to advanced degrees in the technical and natural sciences and assistance in VUZ research projects provide research experience for the students.

Since production is the foremost concern of industrial enterprises, the priority given to enterprise R&D is very low. Funds devoted to R&D at industrial enterprises are a very small share of total R&D expenditures. Highly qualified engineers prefer to work in research organizations where salaries are higher and equipment and working conditions are better. As a result, quality control is the main concern of many enterprise laboratories.

Despite all obstacles, enterprises do make a significant contribution to the R&D effort. In one survey of patents (author's certificates) issued during the last half of 1966, enterprises received more than any other single type of organization except for ministerial research institutes. Enterprises received more certificates than independent design bureaus and substantially more than either VUZY or organizations subordinate to the Academies of Sciences.

Statutory responsibility belongs to the Academy of Sciences for applied research in electrification, mechanization, and automation of production; chemicalization; new synthetic materials; radio electronics; new sources of energy; and new methods of energy conversion. Applied research is carried out in the Academy by the four sections of the Division of Technical Sciences. The Academy of Sciences is also partly responsible for translating the results of its basic research to new equipment and processes. The Academy must point out the technical possibilities of its fundamental research and indicate the best utilization of research results.

Past debate has centered on the best role of the Academy in applied research. At the present time the Academy institutes are concerned mainly with basic research. Before 1961, however, the Academy devoted a large share of its resources to industrial research projects.

ADMINISTRATION AND FINANCE OF APPLIED R&D

Industrial ministries supervise R&D and technical progress through their Technical Administrations. Each Technical Administration plans and supervises activities of research institutes within the ministry. Production Administrations within the ministry, oversee implementation of output plans, and compile plans for introduction of new technology in enterprises under their jurisdiction. Plans are cleared by the Technical Administration and sent for confirmation to the ministry. The Technical Administration also maintains a patents department.

To facilitate planning and coordination, each ministry has a Scientific-Technical Council made up of scientists, workers, Party members, and trade union representatives, The Council is responsible for determining a unified technical

policy for the ministry and for introducing new technology in enterprises under the ministry. The Scientific-Technical Council also sets up groups to work on the main problems of the industry.

On the national level, the State Committee for Science and Technology (GKNT), Gosplan, and the Academy of Sciences are jointly responsible for coordination of all science. The GKNT determines a unified state policy for scientific and technical progress and annually prepares a list of the most important research projects and research institutes. The GKNT also selects the most promising basic research of the Academy of Sciences and of VUZY for elaboration in industrial development facilities. The GKNT has numerous other responsibilities under its broad charter to ensure the introduction of new technology with maximum effectiveness at minimum cost. To implement its decisions, the GKNT has jurisdiction over 40% of the R&D budget.

Gosplan is responsible for long-term planning of research and development. Planning is believed to be carried out in the Department for Comprehensive Planning of the Introduction of New Technology in the National Economy. Gosplan also allocates material inputs to science with the help of the State Committee for Material-Technical Supply.

Ministerial research and design organizations are financed by state budget funds and by proceeds from research contracts with ministries and enterprises. Although many ministerial R&D organizations are on *khozraschet*, they are given budget funds for theoretical research or for research of national significance. As a group the industrial ministries receive 55% to 60% of their funds from the union and republic budgets, but this share varies among ministries. In 1966 the Ministry of the Chemical Industry received 72% of funds from the budgets while the Ministry of Energy and Electrification received only 56%.

Research departments of VUZY are financed in a similar fashion. Union and republic budget funds comprise about 75% of research funds. Contracts for research made between VUZY and industrial enterprises and ministries provide the remaining 25%.

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