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by

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Technological innovation has become a dominant issue on the Kremlin's political agenda in the 1970s. Early in the decade Brezhnev singled out the application of R&D results as the most important but also the most deficient aspect of Soviet science and technology policy. "If we examine all the links of the intricate chain that binds science to production, we shall easily see that the weakest links are those relating to the practical realization of scientific achievements, to their adoption in mass production." It was necessary, the General Secretary stressed, "to create conditions compelling enterprises to manufacture the latest types of products, literally to chase after scientific and technical novelties and not to shy away from them, figuratively speaking, as the devil shies away from holy water."[1] Similarly, five years later he told the Twenty-Fifth Party Congress, "Today the practical application of new scientific ideas is no less important a task than their development."[2] The main brake on Russia's technical progress is seen to be not the absence of scientific achievements—much less an inability to produce excellent science—but poor organization and management of technological application.[3] Indeed a major challenge of the day consists in formulating a science policy and appropriate institutional structures to promote the innovation process.

To be sure, the need to accelerate technological development and delivery is not a new theme in Soviet politics. The process of translating scientific ideas into new products and processes has long been a veritable obstacle course plagued by endless delays and difficulties. Khrushchev ranted almost as much as his successors about the "divorce of science from production" and the need for better coupling. Nor have the problems surrounding innovation, for the most part, changed fundamentally in the last decade. What has changed and broadened are Soviet perceptions of these problems and of the innovation process itself along with official

motivation to use science and technology as an instrument of policy and tool of economic progress.

Wrestling with the obstacles to innovation, Kremlin authorities have devoted particular attention to organizational problems and approaches. Admittedly, organizational structure is not the whole cause of the innovation problem. Non-structural factors, such as prices, decision rules, and incentives, play an important role in poor Soviet performance. "But part of the explanation," Berliner writes, "is due to strictly organizational matters—primarily the separation of R&D establishments from the enterprises that ultimately introduce the innovations."[4] Significantly, Soviet science policy analysts and administrators have become increasingly aware of the importance of linkage in moving ideas from the lab into use and of the need to structure more explicitly and effectively the vital interfaces in the transfer process. This essay takes as its subject some of the underlying assumptions and practical forms of the new architecture for integrating research and production that has evolved in the 1970s.

Technological Imperatives in A Revolutionary Age

The keen, almost consuming interest in accelerating innovation and change reflects the extent to which a perceived "technological imperative" has come to dominate and divide the Kremlin leadership in recent years. Two important cognitive discoveries have prompted this official concern. First is the rather belated awakening of the ruling elite to the full significance of the development and role of science and technology in the world, roughly since mid-century. These changes have been dubbed the "contemporary scientific and technical revolution," largely a euphemism for the computer age. The changing conditions and new demands associated with this new stage of industrial revolution are seen as placing unprecedented importance on scientific and technical progress. Such progress becomes not only the key force driving modern society forward but also a major arena of compe-

tition between the world's two opposing social systems. Underlying the notion of the STR is also implicit--and sometimes explicit--recognition of Russia's relative backwardness and growing technology gap with the West, especially the United States. As a letter of appeal from dissident but concerned Soviet scientists to Party and government leaders in March 1970 noted frankly with respect to the computer age: "We are simply living in a different era. The second industrial revolution came along and now, at the onset of the seventies, we see that far from having overtaken America, we are dropping further and further behind."[5] Thus, a "historic" task facing the USSR today, as defined by General Secretary Brezhnev at the 1971 party congress and reaffirmed by the 1976 congress, is "to combine organically the achievements of the STR with the advantages of the socialist economic system, to unfold more broadly our own, intrinsically socialist forms of fusing science with production."[6]

Second, there has also been growing realization that the Soviet economy is approaching the limits of "extensive" growth and entering a new era that calls for more "intensive" methods of development. Declining supplies of manpower and material resources require a basic shift in development strategy and greater emphasis on qualitative improvements rather than quantitative increases of inputs as the main source of future growth. Already at the end of the 1960s, Brezhnev declared firmly that intensification "becomes not only the main way but the only way of developing our economy." Moreover, in this approach he told the 1971 Party congress, "the acceleration of scientific and technical progress forges into first place both from the point of view of current tasks and of the long-term future." Premier Kosygin similarly insisted at the 1976 congress that without the faster transfer of science and technology into production "the economy can no longer successfully advance along the path of intensification and quality improvement."[7]

International and domestic pressures have combined, therefore, to make the acceleration of scientific and technical progress a major issue of the 1970s and

beyond. Just as he had defined this to be the "key task" of economic policy in 1971, Brezhnev also listed it first among the "key problems" of the period of the Tenth Five Year Plan (1976-1980). Indeed, he affirmed, "In our entire economic development perhaps no tasks are more urgent and more important."[8]

Two key factors of "intensification," two main levers for speeding economic development, have been singled out and stressed by Brezhnev: modern technology and modern management. Already at the turn of the decade he observed, "The solution to many of our economic problems should now be sought at the junctures between scientific-technical progress and progress in management."[9] Throughout the seventies the General Secretary has continued to emphasize not only their importance but also the impossibility of having one without the other.

Underlying these ideas is enhanced awareness of a direct correlation between technology and structure. Technical progress and organizational development are seen increasingly as being interrelated and interdependent. N. S. Kalita and G. I. Mantsurov, for example, note, "The level of organization and management of production to a significant—if not decisive—degree now predetermines the rates of scientific and technical progress." They acknowledge "a direct dependence between organizational and technical factors of production, between the nature of its structure and the rates of technical advance." Boris Milner, a top authority on industrial design, also observes that qualitative changes in organization and management "are becoming a premise and a result of progress in science and technology."[10]

Accordingly, the adoption of a new strategy for technological innovation is seen by some to require organizational and administrative adaptation as well. As Brezhnev noted in 1971, the new demands on organization and management "do not allow us to be satisfied with existing forms and methods, even where they have served us well in the past." P. M. Masherov, a candidate member of the Politburo, told the Party congress in 1971, "Still not all of our executives fully understand

that it is impossible to 'squeeze' the revolution in science and technology into the framework of old methods and organizational forms of work." Two specialists on innovation, P. Danilovtsev and Yu. Kanygin, similarly insist, "To attempt to put the research-production cycle into traditional forms of organization and management is like trying to use a steam-boiler to harness thermonuclear energy."[11] Experience has also demonstrated the difficulties of applying new techniques of planning and management, including computerized information and control systems, within established structures. More and more, then, there is movement toward the view, advanced by numerous Western writers on innovation, that "structure follows strategy," that organizational forms, to be effective and sound, must adapt to changes in technology strategy.

To phrase the issue somewhat differently, there is growing recognition in the USSR that the phenomenon designated the STR is not only a scientific and industrial revolution but a managerial revolution as well. The task of the times is to develop not just modern technological hardware but also a distinctive managerial software appropriate to Russia's conditions. Indeed, this is the essence of Brezhnev's call for combining the achievements of the revolution in science and technology with the advantages of the socialist economic system, for building and managing an effective innovation process in an intrinsically Soviet way. At issue, then, are really two broad categories of innovation—technological and administrative. The latter deals with changes in the methods of running business operations that make more effective use of resources. These may include changes in organizational structure, policies, and procedures. Administrative innovations are increasingly seen as necessary to supplement technological innovations.

What has been most notable about the contemporary scientific revolution and probably what characterizes it as a revolution has been the increasing speed with which theoretical discovery has found its way in practical application. Meanwhile, the slow and ineffective passage of ideas into practice remains the principal de-

ficiency of Soviet science and technology organization. Not more than 30 to 50 percent of completed R&D finds its way into production. The remainder is either not utilized at all or assimilated so slowly that it is already obsolete by the time of its introduction.[12] Enhanced interest in accelerating the development and transfer of technology throughout the economy has led to important reconceptualization of the innovation-diffusion process itself.

Changing Perceptions of Innovation

At the outset it should be mentioned that such notions as "innovation process," technology transfer," and "realization cycle," which figure prominently in Western writings, are relatively unknown in the USSR. Soviet analysts, on the contrary, tend to use terms like "research-production cycle," "scientific and technological complex of work," and "complex of pre-production work" to describe the sequencing, organization, and stimulation of scientific research and development. For the most part, their concepts have revolved around phase-dominant models of innovation with emphasis on separate functions and individual work efforts performed in isolation from one another and cut off from the application of results into production. Only recently have they begun to adopt a more process view of innovation with the focus on final results and overall integration.[13]

Also only recently has a predominantly linear-causal view of innovation been called into question. This model emphasizes a relatively simple and orderly forward flow of work from theoretical conception to practical use. The notion that innovation involves a complex and helix-like stream of events and stages with significant feedback coupling is not commonly held. Accordingly, various stages of work are planned predominantly in sequence rather than simultaneously and in parallel. The result is significant losses of time between phases and a lengthening of the process as a whole.[14]

Generally speaking, the Soviet approach to structuring the innovation cycle is premised on the image of technology transfer that prevailed largely in the West

until the early 1960s. According to this view, the transfer process is envisaged as "the passage of disembodied 'ideas and methods,' endowed with some quasi-independence in the manner of genes, from one state of existence or milieu to another." The underlying assumption is that technology is primarily "an assemblage of pieces of information which can be extracted or expelled from one sector of organized creativity and transposed to another to produce different outputs."[15] The whole process is reduced to clerical reporting, to a kind of mechanical transmission of documents and routing of information through formal communication systems.[16]

Basically, the research to production process has been broken up in time, task, and territory. Planning and financing are carried out primarily on an institutional basis by functional type of performer rather than by stages of the research-development-innovation cycle, much less by the cycle as a whole. Thus science and technology tends to be built around organizations instead of around programs and projects. Not only is the process structurally fragmented and shapeless; it also lacks basically a unifying goals framework. Coupling is loose and disjointed, and sometimes it is next to impossible to unravel the chain of events. Individual and institutional participants are not fully aware that they are involved in a connected process. Indeed, they tend to take a very narrow view of their roles, responsibilities and interests. As Berliner explains, their concern with the end result of work is a concern that ends with their stage of it.[17] The whole activity chain moves through different links without the integrating force of common purpose and sense of teamwork.

Technological innovation in the Soviet Union is distinguished, above all, by its inherently bureaucratic nature. The whole process takes place primarily through bureaucratic interactions between functional performers and higher ministerial authorities who serve as administrative "gatekeepers" at the critical transfer points. There is little direct interplay and collaboration among actual individual and in-

stitutional performers. External transactions between organizations are handled and mediated, for the most part, by various ministerial offices and departmental channels. Upon completion of its assigned work a research institute or design bureau, for instance, will report its results to one of the technical administrations, branch glavki or industrial associations to which it is subordinate. The latter, in turn, decides what should be the next phase of work, by whom, and where. The whole system operates by hierarchical referral and bureaucratic relay--situations are referred upward in the hierarchy for resolution. Communications and work must go up and down long organizational lines to get across the various functional interfaces in the cycle.

This bureaucratic structure and procedure affects the decision process in at least two important respects. First, the need to get endless approvals and agreements at various stages produces decision delays and prolongs the research-production cycle. The creation of a new machine, for example, requires typically 25 approvals at different levels. To build a new technological system of 10 to 15 machines may require as many as 400 to 500 favorable clearances.[18] In general these agreements are obtained sequentially and not in parallel.[19] Forward movement is constantly interrupted and stalled by numerous rounds of negotiation, by waiting for approval of reports by departmental and interdepartmental expert commissions, for the return of tests on prototypes, by the absence of supplies and financing, etc. Considerable time is spent on correspondence and on trips to ministries in pursuit of support for innovation. The path from conception to commercialization can be especially long and precarious if the technology entails new processes or products unrelated to established interests and activities or involves much inter-ministerial negotiation.

According to studies by the State Committee for Science and Technology it frequently takes as much time to secure agreements and to transfer documents from one organization to another as it does to conduct the necessary scientific develop-

ment.[20] That is, the bureaucratic process of moving research results consumes as much time as the research and development process itself. Even excellent ideas must "stand in line" to be included in the work plan of the organization designated to conduct the next phase of the process. They, too, sometimes fail to pass the approval stage. Among the nearly 700 completed R&D projects that were proposed by the Siberian Division of the USSR Academy of Sciences for practical use between 1960 and 1970 but were not introduced, about forty percent had become obsolete while waiting for higher approval.[21]

Secondly, the quality of decision-making is reduced, because structure forces decisions to the highest levels away from the information and knowledge that are most relevant to deal with them. Each additional level distorts objectives and misdirects attention. The vision of individuals and managerial units is directed toward separate efforts rather than on the overall enterprise, results, and performance. Every link in the administrative chain creates one more source of inertia, friction, and slack. All along the line there is constant danger a project will lose momentum and fall into incompetent or unsympathetic hands. Months of lost motion and dissipation of effort are frequently the result.

These factors assume special importance in the branch ministries where the quality of managerial personnel is appreciably lower than in the academy system. The management of academic science is exercised by scientists themselves, and it is not nearly as fragmented and hampered by departmental limitations as so-called "branch" or ministerial science. Research and development work in the ministries, on the contrary, is directed by people who are not scientists. "They themselves do not perform scientific research, and many of them have only a vague notion of how it is conducted."[22] To be sure, scientific and managerial competence varies across ministerial lines. Nonetheless, the traditional "production bias" of the branch ministries that discriminates against new technology and the relative lack of highly qualified personnel oriented to R&D issues and interests have not contributed to the cause of innovation.

Significantly, some of the traditional perceptions and assumptions regarding scientific and technological development which underlie the structural organization of and bureaucratic barriers to innovation are being increasingly questioned and replaced by a more dynamic and systems view. Established structural arrangements, in turn, are giving way to new organizational approaches and institutional frameworks. One of the major Soviet discoveries about innovation in the 1970s, in fact, is the importance of the "management connection." The very phrase "research-production" cycle is said to be somewhat of a misnomer, because action throughout must be negotiated and mediated. It is better to speak in terms of a system of "research-management-production," to use the words of some Soviet analysts. Such terminology, they note, conveys a more adequate image of this complex process. It also explicitly identifies and emphasizes the management function and linkage.[23]

Finally, it is important to mention the growing recognition in the Soviet Union of the need to make the management of R&D a distinct and separate form of managerial action and specialization. In the past innovation was not made a managerial responsibility. Both the researcher and manager have been characterized by non-innovative role definitions. The introduction of new technology fell entirely outside the normal duties of enterprise executives and workers. No explicit or uniform rules existed to regulate technological change. Each new product or process was introduced largely in its own way. Nor is this surprising since the introduction of new technology was an extraordinary event. Management was geared to repetitive and unchanging production operations.[24] Increasingly today, however, technological change—at least in certain sectors—is becoming a normal and continuous situation. To accommodate a more rapid rate of technological growth, some Soviet experts argue that a new kind of management is needed that is oriented to innovation. The management of R&D must be developed and included as an integral part of the system of managing the enterprise, the branch, and the economy as a whole. In addition, this new managerial function must be put on a par with the management

of production, of finances, and of supply.[25] More and more, then, Soviet specialists appear to be coming around to the view shared by numerous American writers that innovation cannot be a subordinate and part-time task. The problems and obstacles are too obstinate to yield to only occasional attention and half-hearted action.

Structuring and Managing the Research-to-Production Cycle: A Systems Approach

With gradual movement away from a strictly phase-dominant to a more process view of innovation, the need for a systems model of organization and management has become more and more apparent. The traditional approach to innovation, based upon extreme functional specialization by institutional performer, has left the process structurally fragmented. Structural barriers have been created all along the innovation chain. In essence, the research-production cycle has been unorganized and unmanaged.

To overcome the fragmentation of this cycle, special emphasis is now being put on the integrative aspects of management. The significance of integration has also risen with growing realization that innovation is increasingly a social and complex process. Expressing this view, E. Kosov asserts, "Scientific activity is not simply an act of creativity but a complex system of coordinating the activity of separate scientific organizations."[26] Yu. Kanygin also stresses the idea that innovation involves a series of several interdependent steps that must be successfully joined and coordinated.[27] This is the task of management. Its role in integrating people and processes so they can perform as a unified whole becomes not only more important but also more difficult. Gvishiani emphasizes, "The problem of ensuring continuity of the process at every stage of research and development work, including the introduction of results into mass production, is now being brought to the fore as the most complex organizational task. It is absolutely obvious that this process requires integrated management."[28]

Because it focuses attention on interrelationships, interdependencies, and integration, the systems approach is regarded by many to be a more viable conceptual framework for analyzing and solving structural design problems. Writing about the particular attraction of this approach, Gvishiani notes, "What interests us is its basic conclusion as to the need for a complex, all-round approach to management, and the disclosure of its integrative function."[29] Its emphasis on study of organization of the research-production cycle as a total system is new and underscores the emerging broader view of organizational structure as a means of facilitating decision-making, motivation, and control. The application of a systems model transforms the innovation process allegedly into "a unified and self-regulating dynamic system." The research cycle becomes "a continuous and goal-directed process."[30] Yu. Mikhnevich speaks, in fact, of the "structuralization" of the research to production process that underlines recent organizational reforms. Kanygin also observes, "This is a process whose effective management requires a definite structure; that is, a definite composition of elements and means of fusing them."[31] In effect, a systems approach to structuring organizations and guiding organizational processes toward innovation objectives is seen as the new cure for overcoming Russia's perennial linkage problems.

In line with this approach a variety of new structural configurations have sprung up since the late 1960s to promote technological innovation. While they assume generally the shape of large-scale research and production complexes, these new associational forms contain different combinations of scientific and engineering talents. The distinct kind of clustering of research activities and manufacturing operations depends largely upon the extent of involvement of the complex in the innovation process. This factor also determines which unit—research institute, design bureau, experimental plant, or production enterprise—will be the main link that bears the "structural load" of the final edifice. Each complex represents an attempt to build a unified organizational system rather than an unrelated or disjointed array of tasks, functions, and individual efforts. Basically, the new

integrated and integrating structures are designed to give institutional expression and coherence to the innovation process. Some science policy experts in Moscow argue, in fact, that only through such research and production complexes can the "research-to-production" cycle be effectively carried on from beginning to end.[32]

A major aim of these institutional reforms is to make the innovation process more managed and manageable. Stated somewhat differently, it is to create a managerial cycle whereby the development and application of new technology is more effectively controlled. Organizational separation and administrative fragmentation have resulted in both divided responsibility and diluted authority. The new complexes seek to concentrate managerial responsibility and authority for the R&D process as a whole, to centralize decision-making in order to achieve greater unity and order and to minimize the probability of conflict and delay. In short, the new arrangements seek to build a managerial structure that spans and links the various subsystems of the organization, a decision center that can act as a common superior and coordinating body for the complex as a whole. With the formation of such complexes all the organizational preconditions are supposedly laid for comprehensive systems planning and management of scientific and technical progress.[33] Much like Western organizations responding to new environmental uncertainties and complexities, then, Kremlin authorities are expanding organizational boundaries and bringing within internal control those forces creating complexity and anxiety. As Berliner notes, the new corporate form of Soviet innovation amounts essentially to an "internalization of what were formerly external transactions. It transfers certain flows of goods and services out of the domain of central planning into that of internal enterprise administration."[34]

A second and no less important objective of the new complexes is to establish a more effective framework for cooperation and interorganizational actions through

the creation of a unifying goals structure. The accent on objectives and end results in programmed-goals planning and systems management approaches currently in vogue is designed to help build commitment and a sense of common purpose that can fuse structure and people in cooperative joint efforts. Through the new complexes and associational forms the authorities hope to reshape the attitudes of R&D personnel and to create a coincidence of interest among all participants in the smooth and rapid transfer of technology. Instead of being guided by its own special interests and parochial perspectives, each unit is to be motivated by common objectives, by "only one concept: ours." The new complexes are seen as means by which to transform "awkward external cooperation into harmonious intrafirm cooperation."[35] Such integrating structures are expected to build a more favorable climate for innovation and to help get needed team play. Indeed, the Russian term most frequently used to describe these complexes—obedinenie—comes from the verb "to unite" or "to join." It captures the explicit design emphasis on integration and teamwork.

A discussion of the array of new partnership arrangements and structural designs coupling science with industry is beyond the scope of this essay. One piece of the emerging Soviet architecture of linkage does warrant detailed analysis, however. This is the so-called "science-production association" (nauchno-proizvodstvennoe obedinenie). According to one of the most informed American specialists on Soviet science policy, the creation of NPOs is "probably the most significant consequence" of recent Kremlin reforms from the perspective of the future organization of Soviet science.[36] Of all the new organizations, the NPO is singled out universally by Russian writers as not only the most comprehensive but also the most successful form of integrating and accelerating the research to production process. To what extent are these claims justified? Are the NPOs, in fact, effective models of systems organization, planning, and management? Do they really represent "the innovative organization"? What are their advantages and their de-

ficiencies? What obstacles impede their performance and institutional development? Are NPOs the answer to Russia's innovation problems? These are questions to which we now turn.

Organizing for Innovation: The Science-Production Associations

Science-production associations first appeared as a "qualitatively new form" of organization and management in 1967 and 1968. Special impetus to their creation was provided by the Party and government decree of September 24, 1968, which set in motion a major overhaul of Soviet R&D practices and structures.[37] By January 1, 1972 there were 63 NPOs. Five years later they numbered 128.[38] Though they exist in nearly all branches of industry, NPOs are concentrated mainly in machine building, especially the electrical engineering, electronics, instrument manufacture, and aviation sectors, as well as in the chemical and petrochemical industries. Associations have also been organized in agriculture, construction, transport, communications, geology, and other nonindustrial branches. Though they are now found in several cities of the USSR, NPOs continue to be located predominantly in Moscow and Leningrad.

Set up explicitly to organize innovation as a distinct and major task, the associations function as special nurseries for the creation and application of fundamentally new technology of the highest quality and in the shortest time possible. They give ideas "a ticket to life." At the present time, it is possible to differentiate within industry three basic types of NPO according to their final product: (1) those that specialize in developing primarily new products and technological equipment for their manufacture; (2) those that concentrate on creating new means of mechanization and automation of production, including management information systems; and (3) those that engage in the development of new materials and technological processes. The third type is less prevalent than the other two. A few NPOs, like "Mikrobioprom" (microbiological industry), "Soiuznauchplitprom"

(wood processing), and "Plastpolimer" (chemical industry), engage simultaneously in developing new products, new processes, and new kinds of equipment and automated devices.[39]

NPOs also differ in terms of the scope of their specialization and product use. The majority are of branch importance. However, some NPOs like "Plastpolimer" are primarily sub-branch in focus while still others are essentially interbranch in nature. The latter include "Soiuznauchplitprom" and "Soiuzsteklomash" (glass machine building), which develop articles used in construction, electronics, and defense as well as in the automobile, electrical engineering, instrument manufacture, light, food, chemical, and medical industries. Similarly, the All-Union NPO "Soiuztransprogress" was formed in 1974 to design, develop, and install transport container systems throughout the country.[40]

In general, numerous benefits are ascribed to these new integrated structures. The process of creating and applying new technology has been reduced in some NPOs by two and even three times.[41] The quality of research, development, and innovation is also higher. In the electrical engineering industry the share of output stamped with the seal of highest quality is 1.5 to 2.5 times greater in NPOs than in the branch as a whole.[42] In the associations from 40 to 50 percent (and climbing to 80 to 90 percent) of the completed R&D is actually implemented while in autonomous scientific and technological organizations only 15 percent is successfully utilized. Labor and material costs are reduced because of less duplication, greater specialization, better organization of design work, fewer documentation errors, greater standardization of parts, and more extensive automation of work processes. In addition, NPOs are credited with harmonizing the actions, goals, and interests of different performers and with creating a favorable climate for innovation. They enjoy greater possibilities of applying network planning methods and computer techniques to the innovation cycle, of using matrix organization

and project management concepts to improve the decision process and to build more dynamic and flexible innovative structures. Above all, they are said to generate favorable conditions for the conduct of uniform policies and integrated leadership throughout the associations.[43]

As Berliner notes, however, much of the evidence on NPOs deals with the performance of individual or groups of associations. Aggregate data in systematic form are still lacking.[44] It is hard to get a good "qualitative fix" on these organizations as a whole. Nonetheless, there is sufficient fragmentary information and critical analysis to suggest a more mixed record of performance and diverse development. Not all associations have been resounding successes. Even those NPOs that have been held up as stellar examples, like "Pozitron" and "Plastpolimer," have important problem areas. Despite individual accomplishments and some remarkable gains, serious deficiencies and gaps persist in both the theory and practice of science-production associations. The ostensible advantages of these new complexes are not always or, to use the Soviet phraseology, "automatically" realized.

One area of criticism and controversy concerns the optimal structure and composition of NPOs. Basically at issue here are conflicting views about the essential purpose and function of these associations. There is general consensus that in promoting the rapid creation and smooth transfer of technology the associations are to encompass the entire research-production cycle. Disagreement exists, however, over what should be the precise role and form of participation on the NPO in the initial and concluding phases of the cycle.

As regards the latter question, there are two main schools of thought. One holds that the task of the association should be limited essentially to the development and testing of prototypes. According to this view, which finds partial support in the official statute on the NPO, the business of series and mass pro-

duction of new technology belongs not to the NPO but to the production associations and enterprises. If these two tasks are not delimited organizationally between science-production and production associations but are done within the NPO, then confusion and a distortion of functions takes place. The inclusion of enterprises engaged in series production leads to an expansion of manufacturing operations to the detriment of R&D activity. The main function of the NPO—prototype development—becomes subordinate to the task of fulfilling current production programs.

Indeed the claims and fears of those adopting this view are confirmed by experience. In several NPOs the share of scientific research and experimental design work comprises only 5 to 15 percent of the volume of industrial production activity. Some NPOs, like "Istochnik" in Leningrad and "Akkumuliator" in Podolsk, both of which fall into this category, were renamed production associations in 1976. In "Elektrokeramika" the proportion of series production has risen to more than 90 percent of the total work plan of the association. Because of this R&D results are accumulating and cannot find an outlet either at the association or at other enterprises of the branch. The share of new products originating in the NPO and assimilated into series production has also declined in recent years at "Elektroapparat" and "Kondensator." More than half of the workload of series production facilities at some NPOs deals with assignments that have nothing to do with the activities of their own R&D units and sometimes even fall outside the specialized profiles of the associations. NPOs having major enterprises of series and mass production have shown a strong tendency to become interested mainly in improving production indicators and not in accelerating innovation. To weaken the desire to maintain production runs of the same items and to encourage greater product mix and renewal, a new rule has recently been introduced. If an NPO issues a particular product more than three years, deductions to its incentive funds are then reduced by fifty percent.[45]

On the other hand, many specialists insist equally strongly that series or batch production is an integral part of the NPO. The role of series production facilities is not to increase industrial output but to serve as an arena within which the NPO can test and perfect its innovations under actual production conditions. If NPOs lack series production capability, this forces them to transfer the assimilation of new products and processes to other organizations that prolongs the process and reduces the quality of innovation. A proponent of this view is Dr. Kim Isaevich Taksir of the Academy's Institute of Economics and one of the foremost authorities on NPOs. It is precisely the capacity to produce unique or small batches of new technological items, he claims, that distinguishes the NPO from a complex research institute.[46] V. I. Shteingauz and V. N. Arkhangelsky share a similar opinion. Without this function, the latter points out, the NPO is excluded from the most important stage connected with the implementation of R&D results and cannot perform its role of connecting link between science and industry. Other Soviet writers also maintain that when the NPO concentrates mainly on "preproduction" work, it cannot really qualify as a "science-production" association.[47]

Differences of view--though less sharply defined--also exist with respect to the place of the NPO at the research end of the innovation process. For that matter, there is no agreement in the Soviet Union about the place and role of basic research generally in the "research-production cycle."[48] Until recently, major NPOs like "Pozitron" themselves performed fundamental research at the level of nearly 10 percent of their total scientific research effort. It became necessary to abandon this practice by the mid-1970s, however. While a few NPOs still engage in some exploratory research, the majority rely upon institutes of the Academy to conduct fundamental research for them on the basis of contracts.[49] Befitting their role and development as "branch" institutions, NPOs focus predominantly on applied R&D.[50]

At the same time, the scope and volume of scientific research and development vary considerably among NPOs. In some associations the share of R&D may be less than 10 percent of the total cost of production activity while in others it may account for as much as 50 percent. Table 1 reveals this range of diversity for a few selected associations.[51] Some specialists believe

Table 1

THE SHARE OF R&D AND OF INDUSTRIAL PRODUCTION IN NPOs
(Expressed in terms of total cost)

NPO	R&D	Industrial Production
Plastpolimer	24.0	76.0
Pishchepromavtomatika	23.2	76.8
Elektroapparat	10.0	90.0
Elektrokeramika	6.0	94.0
Bummash	20.3	79.7
Pozitron	33.0	67.0

Source: K. I. Taksir, Nauchno-proizvodstvennye obedineniia, p. 110.

that a fixed percentage should be established for the ratio of "science" to "production" activity as a mandatory condition for the functioning of NPOs. Though he disagrees with this view, Taksir notes that when a complex is headed by a small research institute which conducts an insignificant volume of R&D (less than 10-12 percent), then the NPO is generally unable to direct effectively the research-production cycle. Arkhangelsky also stresses that experience has shown that the capacity of the R&D center must be nearly 20 percent of the production capacity for an NPO to perform successfully its various functions.[52]

This aspect acquires special importance, because the NPO is intended to serve as the scientific-technical center for the branch or subbranch in the area of its specialization. In fact, this is seen as a distinguishing feature of the NPO which differentiates it from a production association and other research and production complexes which may also contain R&D subdivisions. In the NPO these units are expected to conduct general-purpose or branch-wide R&D, developing innovation for the industrial branch as a whole. In production associations, however, scientific organizations are usually of local significance

and confine their research-development-innovation work primarily to the production needs of the associations. The "head" organization is also different in these two kinds of integrated structures. While this role belongs to an industrial enterprise in the production association, it is performed generally by a powerful research institute in the science-production association.

As branch S&T centers, NPOs are assigned several tasks. Their responsibilities include, for example, long-range planning of the main directions of research; developing forecasts and programs to solve the most important scientific and technical problems in the branch, especially those related to improving production efficiency and product quality; and making recommendations about the use of R&D results in both the branch and the economy as a whole. NPOs are expected to coordinate scientific research, experimental design, and engineering work done by other organizations and production associations in their spheres of specialization, regardless of the departmental affiliation of these units. In addition, they perform other branchwide services, such as supplying scientific and technical information, doing economic analysis and engineering feasibility studies, conducting work on patents and licensing, setting branchwide technical standards, forecasting the demand for new products and processes, and providing management training and advice on production organization with respect to new technology. The associations are also expected to develop and provide special services for introducing new technology, its assembly, start-up, and adjustment to other enterprises and organizations.[53] In exercising these functions, the NPO clearly assumes (or shares) certain of the responsibilities formerly held by the ministry technical administration and other staff units.

To be sure, several NPOs do perform these tasks and act as the principal organizers of technical progress in their branches. "Soiuznauchplitprom," for example, plays this role in the wood processing industry. One hundred and five

enterprises of the USSR Ministry of Timber and Wood Processing Industry and 67 enterprises of other ministries produce items developed by the NPO. "Mikrobioprom" is the S&T headquarters for the microbiological industry. More than 70 enterprises work on projects originating at the association. "Plastpolimer" is the leading center for plastics and has overall responsibility for high pressure polyethelenes, polystyrenes, fluoro-plastics, and polyvinylacetates. Between 1969 and 1973 the NPO introduced 117 technological innovations into Soviet industry. More than 300 sugar plants in the USSR produce products which utilize developments of the NPO "Sakhar." In the cryogenic engineering industry nearly 90 percent of all machinery and equipment produced is based on designs developed at the industry's NPO "Kriogenmash." In radio electronics "Pozitron" is the S&T center. "Ritm" occupies this position in shipbuilding. During the Ninth Plan (1971-1975) 40 percent of all improvements in labor productivity at shipbuilding enterprises were to be based upon the application of engineering ideas developed at the NPO.[54]

It is also clear that not all NPOs serve as the scientific and technical headquarters for their branches. Some associations serve only a few enterprises and contain very small R&D units. Others that do exercise branch-wide functions do not provide all the special services mentioned above. Some NPOs are unable to perform broad S&T responsibilities, because they lack a research institute all together or, if one is present, it is not the leading link in the association.[55]

These basic differences in perception and practice, moreover, find expression in the structure of science-production associations. Notsurprisingly, a variety of institutional forms has evolved. While as many as six or seven separate kinds of NPOs are described by some specialists, they generally fall into three main types: (1) a technical or scientific-technical association, which engages in general prototype development and innovation; (2) a science-production

association per se, which conducts R&D, prototyping, testing, first series production, and assimilation of new products and equipment; and (3) a production-technical association, which is occupied primarily with the assimilation, assembly, installation, and debugging of new processes and products.[56] As Taksir points out, however, what are called scientific-technical associations are essentially complex scientific research institutes while production-technical associations are really specialized organizations for the introduction of new technology. Neither type envelops the entire research-production cycle.[57]

Generally speaking, NPOs are mergers in various combinations of branch scientific research institutes, design bureaus, project-design and development engineering organizations, experimental plants, industrial enterprises for series production, assembly, start-up, and installation facilities, centers for management training, divisions for various scientific-technical services, etc. It is not necessary for an NPO to contain all of these units, however. Table 2 gives information about the structural make-up of 15 leading NPOs. All these associations include both a scientific research institute and a series production unit. Thirteen have an experimental production capability. Other evidence suggests, however, a less uniform picture for NPOs as a whole. In a study of 40 NPOs, V. I. Kushlin notes that 10 percent had no series production unit while 8 percent lacked a scientific research subdivision. Eighteen or 45 percent of the NPOs had no experimental production or testing facility.[58]

Particularly absent, it seems, are facilities such as start-up and adaptation organizations and training centers which can promote more rapidly and effectively the implementation of R&D results. A few NPOs, like "Pishchepromavtomatika" (food processing), "Soiuznauchplitprom," and "Impuls" (mini-computers), have established special services that help introduce new products and processes directly at customer enterprises and train their personnel in the use and repair of technology. Other associations have created at series plants of their branches

Table 2

THE STRUCTURAL COMPOSITION OF SELECTED SCIENCE-PRODUCTION ASSOCIATIONS

Name of the NPO	Subdivisions included in the Association							
	Scientific Research Institute	Design Bureau	Design-Technological Bureau	Project Organization	Experimental Production Plant	Series Production Facility	Assembly, Startup and Installation Organization	A Training and Methods Center
Agropribor	+	-	+	+	+	+	-	-
Soiuznauchplitprom	+	-	+	+	+	+	+	-
Sakhar	+	+	-	-	+	+	-	-
Sistema	+	-	+	+	+	+	-	-
Istochnik	+	-	-	+	+	+	-	-
Mikrobioprom	+	-	-	+	+	+	-	-
Soiuzsteklomash	+	-	+	+	+	+	-	-
Znamia Truda*	-	+	-	-	+	+	-	-
Plastpolimer	+	+	-	+	+	+	-	-
Bummash	+	-	-	-	+	+	-	-
Pozitron	+	+	+	-	+	+	-	-
Pishchepromavtomatika	+	+	-	+	+	+	+	+
Ritm	+	-	-	-	-	+	-	-
Soiuzavtomatstrom	+	-	-	-	-	+	+	-
Turan	+	-	-	-	+	+	-	-

*The head organization of the NPO is the Central Design Bureau for Construction Engineering which is essentially a scientific research institute

Source: Taksir, Nauchno-proizvodstvennye obedineniia, p. 34.

special departments (affiliate services of the NPO) which include design engineers and technologists who assist the plants in retooling and manufacturing new products.[59] In general, though, this set of important functions is not yet being performed by the majority of NPOs.

Underlying these issues of the optimal structure, composition, and functions of science-production associations is the problem of what in American business terminology is called "product differentiation." Given the array of new structural designs and associational forms that have evolved since the late 1960s, the NPO has had difficulty in gaining and maintaining a distinct identity. Lacking a precise definition of the NPO, some ministries have been rather arbitrary in classifying and creating the new complexes. What are labeled NPOs are, in fact, production associations or complex scientific institutions. Some NPOs have experienced difficulty in preserving their fundamentally dual character. Overdevelopment of their scientific functions turns the NPO into a traditional research institute, only larger. Hypertrophy of production operations, on the other hand, transforms the complex into a production association. The problems of maintaining a "dialectical unity" of functions have led some experts to press for some kind of fixed ratio or at least minimum levels regulating these activities.[60]

The problem of product differentiation is made all the more difficult because in some instances it is practically impossible to distinguish between an NPO and a production association which contains its own large R&D complex. For example, the "Uralmash" Production Association includes a scientific research and engineering design institute of heavy machine building which has more than 6,000 workers and does business by contract with more than 60 R&D establishments in the country. During the Ninth Plan the association developed more than 100 prototypes of new machines and equipment. Other POs which conduct major scientific research and development include "AvtoZIL," "Svetlana," and "Elektrosila."

The distinction becomes especially fine when a production association creates new products in small series or single lots and is one of the major producers of this type of product, like in the case of "Elektrosila."

On another level, the relations of science-production associations with higher ministerial authorities are not uniform and regularized. In some branches there is no permanent body to lead NPOs. Where such organs exist they sometimes fail to take into account the distinct features of individual associations and regard them as all alike. Some ministries and agencies approach NPOs as ordinary research institutes or industrial enterprises. The lines of subordination also vary. A few NPOs such as "Soiuznauchplitprom" and "Mikrobioprom" report directly to the ministry (frequently to a deputy minister). The majority, however, operate on a three-link system (NPO—glavk/industrial association—ministry). They report either to one of the glavki or main administrations in their respective ministry or to an all-union industrial association. "Plastpolimer" provides an example of the latter pattern, which will probably become more common as the ministries reorganize and the glavki are liquidated or transformed into industrial associations. The majority of NPOs function as the first link of management. Yet a number of them conduct from 30 to 100 percent of all R&D done in the branch. In addition some NPOs are essentially all-union associations. These differences are not reflected in their legal status, however. This causes some specialists to argue that certain NPOs should have additional powers and prerogatives in comparison with other NPOs.[61]

Internal organizational development has also been marked by problems and diversity. The key issue here has been the degree of legal authority to be exercised by the central management or head organization as against that retained by the constituent units. "The criteria for establishing a happy median between loose or formal merger and overcentralization of decision-making are apparently difficult to arrive at," observes Louvan Nolting.[62] The aim of creating these new complexes, it will be recalled, is to break down structural barriers, to

bring the multiple participants in innovation into closer association and even under common administration.

Meanwhile, two negative tendencies found expression in the institutional evolution of NPOs up to 1976. On the one hand, integration stopped far short of the model of a unified and organic system. Amounting to little more than a mechanical conglomerate of autonomous units, the NPO was transformed into "an administrative superstructure, a superficial link on the path from the ministry and glavk to science and production."[63] Even among the earliest and most tauted NPOs institutional consolidation was slow and incomplete. An investigation of nine major NPOs by the Institute of Economics in 1974 found that a council of directors had not yet been formed in three of the complexes. One still lacked a scientific-technical council for the association.[64]

On the other hand, centralization was sometimes carried to an extreme. Constituent units of an NPO were denied any autonomy, even in operational management and control. This situation proved especially debilitating when the association contained subdivisions that were highly diverse and geographically dispersed. As a result the NPO became unmanageable. The decision process became frozen as each unit was forced to go to the highest levels and much time was lost in getting agreements and approvals. In short, association members became caught in the familiar bureaucratic chain from which they were supposedly to be liberated.[65]

Of these two tendencies, the first was the most dominant. The retention of autonomy by component parts almost everywhere impeded, if not prevented, the development of an integrated planning and management structure for the association as a whole. Indeed, this was the conclusion that several NPOs, including "Ritm" and "Pishchepromavtomatika," drew after two or three years of operation.[66] The pressure subsequently mounted on Moscow authorities to impose greater centralization. Significantly, the official statute on the NPO, which was finally approved

by the USSR Council of Ministers on December 30, 1975, stipulates that all units joining an NPO are denied any legal autonomy. At the same time, the ministries and union republic officials have been given some discretion in applying this ruling and making exceptions.[67] Intra-associational relations are likely to continue to reflect substantial diversity in practice, if not in form. How successful the 1975 statute will be in overcoming formal merger without leading at the same time to excessive centralization still remains to be seen. A year after passage of the statute two Soviet science analysts admitted, "While some services are centralized, a system has still not been found of organizing the mutual relations of structural units and the machinery of management for the complex as a whole."[68] Indeed, until 1976 NPOs were not even registered as an independent institutional category at the USSR Central Statistical Administration. All accounting was done strictly in terms of their individual structural components.[69]

On the whole, centralization of planning and management functions within science-production associations remains both uneven and incomplete. Professor Dzhavadov goes so far as to assert, "Practice shows that NPOs are created on the basis of existing research institutes, design bureaus, and enterprises without any radical changes in the structure of management."[70] A few associations like "Plastpolimer" have built new and separate management bodies to run the complex. However, the majority organize administration around the managerial staff of the head unit. As a rule this structure is too small and inadequate for servicing the association. Additional personnel from other subdivisions of the NPO must be brought in to beef up existing departments or to form new administrative sections at the head organization. Since no unified staff list has been developed for the management of NPOs, each person is paid according to the salary scale and bonus system of his particular subdivision. Wages and incentive systems are not

the same in research institutes and production units. As a result association executives doing identical work are frequently paid in different ways, and they are motivated to fulfill different indicators and in varying degrees.[71] Not-surprisingly, these factors have impeded the recruitment and development of a strong and competent management team for the NPOs. To help remedy the situation the official statute on science-production associations gives to the general director of an NPO greater powers to apply more flexible wage structures and to effect organizational change. The ministries have also been permitted to raise the salaries of managerial officials by 10 to 15 percent at the largest NPOs.[72]

Planning and financing are two areas in particular where NPOs have major problems. As regards the first, long-range planning is still undeveloped in the associations. Though a few like "Plastpolimer" have drawn up plans for five years and scientific forecasts for 25 to 30 years in areas of their specialization, they are clearly the exception. It is said to be possible now to have in the NPOs truly major projects extending over the long term rather than minor themes as prevailed in R&D units in the past.[73] So far, however, medium range planning has been minimal. During the Ninth Plan, in fact, NPOs received five year plans only for production, not for R&D which continued to be conducted mostly on an annual basis.[74] Nor have NPOs been successful in integrating research-development-innovation-production plans for the complexes as a whole. Ministries and higher planning bodies have persisted in issuing plans to separate NPO units rather than to the association leadership. Work plans are approved "in pieces," at different times and by different deputy ministers or administrative divisions in the branch, and they are brought to the association without being coordinated.[75] More than 18 months after adoption of the 1975 statute on the NPO, V. Pokrovsky observed that science-production associations were still taking only "the first steps" in drawing up integrated plans.[76]

Divided authority and fragmented administration also prevail in financial matters. As a rule, NPOs have no centralized funds and reserves. Financing is done through multiple channels, and resources are allocated separately to each subdivision. Characteristic of Soviet budgeting generally, financing is oriented to maintaining institutions (research institutes, design bureaus, and enterprises) and not to supporting programs and projects. At least until recently the central management or head organization of NPOs lacked authority to redistribute assets, investments, and funds of the constituent units.[77] Development of a unified incentive structure has also been a special problem. Up to now each subdivision formed and spent its own fund for material incentives and the NPO did not have any right to these funds. As a result top management could not utilize these resources or part of them as an economic instrument. Furthermore, the magnitude of bonus payments for developing new technology vary substantially among subdivisions, reflecting their different orientations and interests. The absence of unified funds and more uniform bonuses has prevented NPOs from using monetary incentives to get association members to pull in the same direction.[78] To enable the NPOs to overcome these problems and to apply economic stimulation as a means of promoting throughout the complexes planning and management by objectives, Kremlin authorities adopted new regulations in the fall of 1976. These decisions set down new guidelines for the formation and utilization of common bonus funds in NPOs.[79] Nonetheless, an editorial in Pravda on January 12, 1978,devoted to a ten-year assessment of this institution, observed, "There is [still] no precise financial and economic system that, taking into account the distinctive characteristics of the association, could provide a solid support for the organic merging of science and production, and promote the efficient development of new technology."

Underlying these problems of the continuing fragmentation of planning, financing, and management of NPOs are serious and unresolved methodological questions

about how to evaluate these structural entities coupling science with production. Basically, new integrated performance criteria have not been devised. This explains partly, in fact, why ministries and higher planning and financial agencies persist in issuing plans and funds to separate NPO subdivisions. Many performance indicators still relate to the activities of R&D and production units in their previously independent status. Existing indicators do not differentiate between R&D subdivisions that belong to NPOs and those that do not. According to current methods of accounting and statistical reporting, it is not possible to aggregate the results of activity of organizations that relate to material production and to the world of non-production.[80]

To be sure, some efforts are being made in this direction. Some norms have been devised for determining the average length of the research-production cycle and are used in measuring performance of NPOs. According to Tabachnikas and Skliar, however, these norms are established rather arbitrarily, largely "by eye." No fixed and uniform methodology exists yet for this purpose. In other associations indicators are used to determine the degree to which the research-production process has been reduced over time. Taksir points out, however, that this kind of norm is of dubious value because reduction of the innovation cycle obviously has a limit.[81] What methodological progress has been made in devising integrated evaluative indicators and norms for NPOs is still largely confined to experiments. Not everyone realizes yet that the NPO is not simply the sum of its parts but represents a qualitatively new type of organization.

Looking back on the first decade of its life, therefore, we can say that this new institutional form has still not found its proper face and place in the Soviet scheme of things. Very few NPOs have approached—much less accomplished—the goal of creating an organizationally, technologically, and economically integrated system for promoting innovation. In most, "science" and "production"

continue to lead separate lives. The administrative and psychological barriers between them have not been effectively broken down. Organization-building has been marked by much confusion and diversity, not to mention bureaucratic opposition and lethargy. In the absence of clear guidelines from the center, branch ministries created NPOs as they saw fit, often obliterating the boundaries between different kinds of research and production complexes. Sometimes NPOs were put together without any systematic research and analysis of design and development problems. Little consideration was given to their place in the context of future directions and needs of the branch as a whole.[82] Initially, the lack of a formal statute permitted needed room for flexibility and experimentation. It also reduced the danger of putting these new structures into an organizational straitjacket and monolithic mold. More and more, however, the absence of a document establishing the legal status of the NPO and defining its basic functions and principles of organization had prevented the solution of a number of complex problems. The associations were recognized as being frozen in their units, forms, and relations.

A new stage of development came in 1976. After confirmation of the NPO statute, Kremlin authorities stepped up efforts to impose greater clarity, order, and direction in the affairs of the associations. A drive was launched to make the Tenth Five Year Plan a period of "development not only in breadth but also in depth" for research and production complexes of all kinds, and not just NPOs. As regards the latter specifically, their number was to grow to between 200 and 250 by 1980.[83]

Nonetheless, the effect of these actions and announcements remains to be seen. This is amply demonstrated by an article in Pravda in March 1978 on the NPO "Sistema" of the Ministry of Tractor and Farm Machinery. Despite the fact that the NPO was formed eight years ago, its assistant general director admits,

"There are certain shortcomings and rough edges, since Sistema is still trying to find itself." Indeed, to date the association, we are told, has produced almost no articles related to automated control systems, the area of its alleged specialization. Detailing a "list of all kinds of foul-ups and absurdities" in the NPO's activity, the Pravda reporters attribute most of these problems to a proforma approach taken when the association was created. "Ministry officials gave no thought to the necessary correspondence between the form and content of the new research and production association." The reporters add,

> It was assumed that in time everything would work itself out and fall into place. But, as we see, this has not happened. Now, eight years later, no one in the ministry wants to admit the mistake, since such an admission would make it necessary to name the specific parties responsible for such an unsuccessful experiment. As a result, a search is underway for all sorts of half-measures to get the hastily formed association moving.

In concluding their piece of investigative reporting, the authors note that Sistema's unlucky story is by no means exceptional. "Nowadays calling a research institute merely an institute or a plant merely an enterprise somehow seems clumsy, an admission of one's backwardness," they say.[84] In the era of the scientific and technical revolution and amidst the new systems rhetoric flowing from the Kremlin, organizational nameplates must be changed to keep pace with the times.

At the same time, expectations for the NPOs seem to have cooled in recent months. Much of the initial optimism that surrounded them has dissipated. The accumulation of a variety of unresolved problems in the course of their development has diminished the institutional glow and image of the NPO as a possible panacea for the innovation problem. As one Soviet observer noted in the summer of 1976, "One can hardly find now defenders for the view that every branch institute should be turned into an NPO. The opinion is growing slowly but steadily that the number of NPOs in industry cannot be big, perhaps three or four in one ministry." "And if this is so," he continued, "then it is necessary to recognize

directly that the NPO is a partial solution to the problem of [strengthening] the ties between science and production."[85] V. G. Shteingauz also concludes, "The NPO must be regarded as a successful but far from the only form of integrating research with production."[86] The NPO is still expected to play an important—and even increasing—role in accelerating innovation and technical progress, but there is growing realization that other kinds of integrating structures will have to be developed and that each can contribute to innovation in different ways.

Carrying R&D Results over into Application: The Institutionalization of Entrepreneurship

Along this line Soviet interest has mounted in recent years in establishing a network of specialized innovation organizations whose task is explicitly the implementation and spread of new technology and production techniques.[87] Since this function is not the main job of either scientific or production organizations, a new type of institution is needed for this purpose that is neither a research institute nor an industrial enterprise, some specialists argue. They see innovation—the exploitation and application of new ideas and designs—as a distinct activity that is fundamentally different from both research and production. Hence, they maintain that new technology transfer vehicles are required to perform vital but neglected innovation functions. Such specialized organizations are depicted as new connecting links between science and industry which serve as important "middlemen" facilitating and mediating the research-to-production process.[88]

Attention to these new structural forms has grown in part because the science-production associations have proven to be more successful at creating new technology than at applying it. While a few NPOs conduct extensive innovation activities, they are clearly the exception rather than the rule. The majority of associations lack the services and staff needed to perform these functions on any meaningful scale. NPOs have other limitations as well that prevent them

from acting as a significant force for the mass introduction and diffusion of R&D results. The creation of NPOs strengthens the production ties of only a few research institutes. It does nothing for other branch R&D units that do not belong to the NPOs. They remain as isolated and insulated as before. Moreover, even the most specialized enterprise cannot be satisfied with the services of only one scientific organization to solve all the problems of its technological development. Since NPOs generally produce new items at best in small lots of a 100 or so, their volume of output is clearly insufficient for the needs of the branch as a whole. In addition, the NPOs are obliged to implement their own R&D. Their experimental production capacity is usually too small to handle research and engineering results produced by outside organizations. In short, the NPOs are closed and relatively confined complexes, walled off from many R&D organizations and production establishments in their branches. What is needed are organizations specializing exclusively in translating R&D results into practical use. They must be distinguished by their universality and capability of introducing ideas generated by many sources; they must be places where any R&D unit or industrial plant can turn for assistance.[89]

Actually, the idea of innovation firms is not new. Taksir describes five kinds of organizations that have evolved since the late 1960s and are oriented specifically to the utilization of new technology.[90] One type includes institutions like "Energotekhprom" within the USSR Ministry of Power and Electrification that are fully geared to develop and transfer R&D results into application. Established in 1965, this experimental production and engineering facility provides a broad array of innovation services in the amount of more than 14 million rubles a year. Besides installing and debugging new products and processes, "Energotekhprom" trains personnel at client enterprises. The firm also helps research institutes formulate their work agendas to incorporate specific requests from industry.

A second type of adaptation organization is of a more mixed profile. Along with introducing new technology, it also engages in repair and construction work. Examples include several associations that have been set up by the USSR Ministry of Non-Ferrous Metallurgy. Enterprises in this branch are generally not able to conduct technological modernization and improvements on their own. Some of these innovation associations have a specific technical specialty; "Uralenergotsvetmet," for example, installs evaporative cooling equipment in metallurgical plants, pneumatic transport systems for loose and pulverized materials, and special pneumatic dust collecting devices. Economic savings from the innovations by this one association alone are estimated to have been about 30 million rubles for the period 1971 to 1975.

"Soiuztekhosnastika" represents the third variety of introduction organization. This association deals mainly in the installation of different interbranch engineering devices. One of its chief tasks is the creation and broad dissemination of a uniform system of standardized multipurpose assembly and readjustable equipment.

A fourth group of innovation organizations is made up of the Centers for Scientific Organization of Labor at various research institutes. Conducting all their work through economic contracts, these centers resemble, to a certain extent, management consulting firms in the West. They serve essentially as organizational intermediaries between R&D establishments and the world of production. Their business involves not only the introduction and diffusion of new technology but also the propagation of knowledge and advanced production experience. The Center for Scientific Organization of Labor and Production Management under the All-Union Institute of Economics and Labor Organization in the oil and gas industry falls into this classification.

From a Western perspective, the fifth category of introduction organization identified by Taksir is perhaps the most interesting. This group is comprised

of what can best be described as profit maximizing engineering or management consultant firms. They are created and sustained through largely private initiative of technological entrepreneurs seeking to exploit scientific advances. Offering a broad profile of services, these organizations exist essentially outside the formal economic system and beyond official planning and control. Paradoxically, this is both their greatest strength and their greatest weakness. In accord with the initial decentralizing spirit of the 1965 economic reforms, more than a dozen of these new technical firms sprung up across the Soviet Union. They included, for example, "Fakel" (The Torch) in Novosibirsk, "Novator" (Innovator) and "Khikmet" (Wisdom) in Baku, "Neva" in Leningrad, "Iskra" (The Spark) in Tomsk, "Poisk" (Search) in Severodonetsk, and "Temp" (Tempo) in Moscow. By the early 1970s, however, most of them were forced to close their doors. Others continue to lead a semi-legal life. In general, these structures have not been stable and surviving additions to the Soviet science and technology establishment. This is not because they have been inefficient but, on the contrary, because their success and viability have not been acceptable in ideological and political terms.

Indicative of the nature and fate of these entrepreneurial ventures is the "tale of the Torch."[91] "Fakel" was set up by a few young scientists-entrepreneurs in 1966. It had no budget, no material supplies, no paid staff, and no office space. After compiling a list of prospective consultants and their specialties, the founders simply set up headquarters in a dormitory of the University of Novosibirsk and began soliciting contracts. Consultants would be chosen to work on problems in their spare time. Various organizations were paid for the use of their equipment and facilities during non-working hours. The Torch received 3.5 million rubles from 263 contracts for the period up to June 1970. Allegedly, the innovations introduced by it resulted in a savings of 35 million rubles. These included the development of "an optimal plan for forest exploitation" in Novosibirsk Province,

a system of computer analysis of seismic materials for a local geological expedition, and an experimental model of a Torch-built swamp vehicle for oil exploration in the Western regions of Siberia. Other projects were in such diverse fields as gold extraction, the use of manure, development of coloring substances, and of control devices for the Novosibirsk Power Station. Despite support from the Presidium of the Siberian Division of the Academy of Sciences, not to mention the local Komsomol authorities under whose wing "Fakel" formally operated, however, this efficient but unconventional organization came under strong attack and eventually closed down in May 1971.[92]

One of the few firms of this kind to have survived--in modified form--is "Novator." Formed in 1967, it was reorganized by the leaders of the Azerbaidzhan Republic in 1971 and placed under the jurisdiction of the republic Trade Union Council. It has since been put under dual subordination to the republic Ministry of Local Economy and the State Committee on Inventions and Discoveries. Basically, the firm seeks and screens relatively simple "orphaned inventions" from institutes throughout the USSR that cannot exploit them. By 1976 "Novator" was doing an annual business of over a million rubles. Since its creation the firm has developed and disseminated more than 120 innovations. Some of these have been awarded state medals, and others have been displayed at the Leipzig international trade fair.[93]

Scientists in particular attempt recurrently to revitalize and legitimize these entrepreneurial firms. Recently in the Academy's main economic journal Taksir and M. Krasnokutsky argued that these institutions were viable and desirable. They urged that these products of private initiative be turned into state organizations with a firm legal basis.[94] The central issue is the institutionalization, if not bureaucratization, of entrepreneurship. The problem is how to preserve these innovating forms without destroying their spontaneity, independence, and <u>elan vital</u>--the very foundation of their success. Some Soviet specialists recognize that entrepreneurship is frequently associated with specific and special personality traits.

Like R. M. Shteinbok, they reason then, "If there are people, there can be organizations as well."[95] The fundamental and problematical elements involved in institutionalizing the innovative spirit are not fully appreciated or addressed.

In general, all five kinds of innovation organizations are severely limited in their capacity for introducing new technology. There are very few of them. Their legal status remains ill-defined. No formal statute establishes their goals and functions, rights and responsibilities, organizational and administrative relations. Their activity is not properly planned, monitored, or stimulated.[96]

Since the Twenty-Fifth Party Congress there has been renewed interest in expanding and developing this net of specialized innovation associations. A national conference devoted to the problems of accelerating innovation in the economy, held in Voronezh in December 1976, endorsed the idea of creating special diffusion organizations. A proposal was made to establish under the State Committee for Science and Technology a national center that would be responsible for organizing the practical utilization of R&D results. Such a Center should exercise methodological leadership over specialized diffusion agencies as well as oversee the innovation services at production and science-production associations. Such centers, it was pointed out, do exist in other socialist countries, notably Hungary and Poland.[97] Meanwhile, also under consideration is a proposal to establish under the USSR State Committee on Inventions and Discoveries and the All-Union Exhibition of Achievements of the National Economy an interbranch association in charge of developing, testing, and making the first application of important inventions.[98] In short, the debate about and search for new forms of speeding technological modernization continues.

Soviet opinion remains hotly divided, however. Some commentators feel that structures specializing exclusively in innovation have a "right to exist." Given the constraints on existing production and research units, many recognize that new instrumentalities can be useful. Others stress that innovation is the proper function

of production units. What is needed is a more favorable climate for innovation at plants. Indeed, the formation of special introduction facilities carries the possible danger that they, like R&D units in the past and even still today, will become organizationally separate from the production sector. As a result, a set of superficial links may be created. Innovation functions themselves may become distorted and exaggerated, and lead to the introduction of unprofitable and unnecessary technological change. The vital interface problems that plague the research-to-production process today would not only persist but be compounded by still another set of administrative barriers.

Special innovation firms, therefore, should also be seen to be only a partial solution to the problem of modernization. As one Soviet observer notes, "Until the economy itself begins to work fully for the introduction of new technology, no organizational structures by themselves will guarantee success."[99] While there is growing awareness that new approaches and perhaps even radical organizational changes are needed to provide the stimuli, the incentives, and the opportunities for innovation, there is no clear consensus about the shape these solutions should take. Though the important role of individual entrepreneurs is glimpsed, the art of fostering technological entrepreneurship is not well understood or developed. The care, feeding, and coupling of such creative people have not received prominant attention or analysis.

Innovation and the New Architecture of Linkage: Complexities and Constraints

In the beginning of this essay, we noted that technological innovation has long been a problem area in Russia and the Soviet Union. Since at least the mid-1960s a variety of steps have been taken to speed up the rate and to spread the incidence of technology transfer into the economy. Despite these efforts and some gains, however, the barriers to innovation have persisted. In Siberia the gap has grown between the number of ideas proposed for application by the Siberian Division of the Academy and the number being introduced. If in the early 1960s

nearly 25 percent of finished R&D recommended by the Division did not find practical application, then a decade later this figure had climbed to 40 percent.[100] A similar situation has developed in the Ukraine as well. Though the lead time between the ending of R&D and its introduction decreased between 1970 and 1975 in the USSR ministries of heavy machine building and of the electrical engineering industry, this gap actually increased for other all-union and union-republic ministries in the Ukraine.[101] Advances in science and technology have outpaced the ability of industry and of institutions to deal with them.

These developments have caused Kremlin authorities to take a consuming interest in integrating more effectively research with production. In approaching these coupling problems, they have given considerable attention to structure, to improving the architecture of linkage. Through new institutional forms and structural arrangements it is hoped that organization can be made a force that fosters rather than impedes innovation. Given the heavy emphasis on organizational issues and approaches, the key to innovation seems, at times, to be simply "management by structure."

As regards prospects for improvement, however, there are important complexities and constraints at work in the system that necessarily limit the effectiveness of structural solutions. These can perhaps be grouped into three broad areas. First, restructuring itself is a formidable task. Established organizational structures and processes have an inexorable momentum of their own, a built in continuity difficult to break. Gvishiani writes, in fact, that Soviet science has a surplus of stability and even of conservatism. At the same time, he admits, "It is extremely hard to recast the structure of a scientific establishment that has taken decades to shape."[102]

Second, structure is an ambiguous variable that is not easily disentangled from other elements with which it interacts. Modifications in organization are

usually accompanied by improvements in planning, the use of new incentive systems, the application of computers, and changes in personnel as well. It is difficult, if not impossible, to determine the consequences and benefits of structural change alone. This is particularly true at present because the Soviet architecture of linkage is in transition. It is still evolving. Old structures and links are clearly ineffective and cumbersome. At the same time, new institutional forms and relationships have not yet acquired what in American political science terminology is called "enabling effectiveness." They are still largely experimental structures, coexisting with the old. Until they gain status, borne of the experience of their adequacy, these structural designs will continue to inhibit as much as they enable innovative action.

Finally, it is important to stress the importance of nonorganizational factors and broader environmental features that affect structural developments. The problems underlying innovation in the USSR—and elsewhere—are fundamentally human problems. People and relationships, not structure, are the key. Proper attitudinal changes must keep pace with structural reforms. The creation of large integrated research and production complexes requires a corresponding psychological remolding of collectives which are used to working in isolated groups. Structure is merely a means for accomplishing purposes and overcoming obstacles. Inspiration, will, and teamwork are the real motive forces that cause innovation to happen.

On balance, the new architecture of linkage appears to be more supportive of innovation than the old mechanisms of technology transfer. Many basic problems, nonetheless, remain unresolved and incapable of solution by structural means alone. Though the 1970s have brought conceptual changes and greater awareness of the multiplicity of factors involved in moving ideas from the laboratory into use, Soviet understanding of the innovation process is still incomplete. Above all, practice continues to lag behind perception.

FOOTNOTES

1. XXIV s"ezd KPSS: Stenograficheskii otchet (Moscow: Politizdat, 1971), I, pp. 80-81.

2. XXV s"ezd KPSS: Stenograficheskii otchet (Moscow: Politizdat, 1976), I, 72.

3. V. A. Trapeznikov, "Upravlenie naukoi kak organizatsionnoi sistemoi," in D. M. Gvishiani, ed., Osnovnye printsipy i obshchie problemy upravleniia naukoi (Moscow: Nauka, 1973), p. 28.

4. Joseph Berliner, The Innovation Decision in Soviet Industry (Cambridge, Massachusetts: MIT Press, 1976), p. 102.

5. Andrei Sakharov, Roy Medvedev, and V. F. Turchin, "Letter of Appeal of Soviet Scientists to Party and Government Leaders of the USSR," March 19, 1970, reprinted in Survey, no. 76 (Summer 1970), pp. 161-170.

6. XXIV s"ezd KPSS, I, 82 and XXV s"ezd KPSS, II, 237.

7. L. I. Brezhnev, Ob osnovnykh voprosakh ekonomicheskoi politiki KPSS na sovremennom etape: Rechi i doklady (Moscow: Politizdat, 1975), I, 418; XXIV s"ezd KPSS, I, 80; XXV s"ezd KPSS, II, 24.

8. XXV s"ezd KPSS, I, 73.

9. Pravda, June 13, 1970.

10. N. S. Kalita and G. I. Mantsurov, Sotsialisticheskie proizvodstvennye obedineniia (Moscow, 1972), pp. 3-4; Boris Milner, "Organization of the Management of Production," Social Sciences (Moscow), VII, 3 (1976): 48.

11. XXIV s"ezd KPSS, I, 90, 179-180; P. Danilovtsev and Yu. Kanygin, Ot laboratorii do zavoda (Novosibirsk, 1971), p. 40.

12. See Louvan E. Nolting, Sources of Financing the Stages of the Research, Development, and Innovation Cycle in the USSR (Washington, D.C.: US Department of Commerce, 1973), p. 3; V. N. Arkhangelskii, Organizatsionno-ekonomicheskie problemy upravleniia nauchnymi issledovaniiami (Moscow, 1977), p. 33; V. I. Kushlin, Uskorenie vnedreniia nauchnykh dostizhenii v proizvodstvo (Moscow, 1976), p. 3

13. See Yu. M. Kanygin, Nauchno-tekhnicheskii potentsial (Problemy nakupleniia i ispolzovaniia) (Novosibirsk, 1974), pp. 157-159, 179-180.

14. E. I. Gavrilov, Ekonomika i effektivnost nauchno-tekhnicheskogo progressa (Minsk, 1975), pp. 283-284; Yu. Kanygin, Nauchno-proizvodstvennyi tsikl: Voprosy teorii i organizatsii (Novosibirsk, 1971) and Nauchno-tekhnicheskii potentsial, pp. 179-182.

15. Tom Burns, "Models, Images, and Myths," in William H. Gruber and Donald G. Margues, eds., Factors in the Transfer of Technology (Cambridge, Massachusetts: MIT Press, 1969), pp. 11-23.

16. One of the best discussions of Soviet views of innovation is by Kanygin. See his Nauchno-tekhnicheskii potentsial, pp. 151-213 and Nauchno-proizvodstvennyi tsikl: Voprosy teorii i organizatsii.

17. Berliner, The Innovation Decision, p. 107.

18. Kanygin, Nauchno-tekhnicheskii potentsial, p. 225.

19. L. S. Bliakhman, "Nauka kak otrasl proizvodstvennoi deiatelnosti," in L. S. Bliakhman, ed., Voprosy ekonomiki i planirovaniia nauchnykh issledovanii (Leningrad, 1968), p. 15.

20. K. I. Taksir, Integratsiia nauki i proizvodstva pri sotsializme (Moscow, 1975), p. 14 and Kushlin, Uskorenie vnedreniia nauchnykh dostizhenii v proizvodstvo, p. 122.

21. V. G. Shteingauz, Ekonomicheskie problemy realizatsii nauchno-tekhnicheskikh razrabotok (Moscow, 1976), p. 118.

22. A. Zalkind, "An Academy for the 'Nonacademic' Sciences," Literaturnaia gazeta, no 12 (March 24, 1976), p. 11.

23. See V. I. Berlozertsev, "Soedinenie nauchno-tekhnicheskoi revoliutsii s preimushchestvami sotsializma," in Problemy soedineniia dostizhenii nauchno-tekhnicheskoi revoliutsii s preimushchestvami sotsializma (Voronezh, 1974), pp. 11-12.

24. omit

25. See G. Kh. Popov, Effektivnoe upravlenie (perspektivy razvitiia) (Moscow, 1976), pp. 12-13; G. A. Dzhavadov, V. N. Varvarov, and A. V. Sobrovin, "Organizatsiia ratsionalizatsii upravleniia nauchno-tekhnicheskim progressom v otrasli," in G. Kh. Popov, ed., Problemy organizatsii sovershenstvovaniia upravleniia sotsialisticheskim proizvodstvom (Seminar g. Kalinin 1-10 fevralia 1974g) (Moscow, 1975), p. 253.

26. E. Kosov, "Ekonomicheskie problemy upravleniia nauchno-tekhnicheskim progressom," Ekonomicheskie nauki, 7 (1971): 52.

27. Kanygin, Nauchno-tekhnicheskii potentsial, p. 183.

28. D. M. Gvishiani, "The Scientific and Technological Revolution and Scientific Problems," Social Sciences, I (7) (1972): 52. Emphasis added.

29. D. Gvishiani, Organization and Management: A Sociological Analysis of Western Theories (Moscow: Progress Publishers, 1972), p. 146. He adds, "This approach makes it possible to see the whole managed system as a complete set of interrelated elements, united by a common aim, to reveal the integral properties of the system, its internal and external links." (p. 142).

30. L. S. Bliakhman and A. F. Ivanov, "Nauchno-proizvodstvennoe obedinenie kak forma sistemnoi organizatsii tsikla issledovanie-proizvodstvo," Izvestiia Akademii nauk SSSR, seriia ekonomicheskaia, 6 (1971): 39; K. I. Taksir, Nauchno-proizvodstvennye obedineniia (Moscow, 1977), p. 16. Hereafter referred to as NPO.

31. Yu. Mikhnevich, Ekonomicheskie problemy upravleniia nauchno-tekhnicheskim progressom (Leningrad, 1974), p. 5; Kanygin, Nauchno-tekhnicheskii potentsial, p. 183.

32. L. Bliakhman, "Associations Link Science and Industry," Pravda, December 1, 1971.

33. Mikhnevich, Ekonomicheskie problemy, p. 148.

34. Berliner, The Innovation Decision, p. 526.

35. A. Bachurin, "The Industrial Association and Technical Progress," Ekonomicheskaia gazeta, 43 (1970): 5-6.

36. Louvan E. Nolting, The Financing of Research, Development, and Innovation in the USSR, by Type of Performer (Washington, D.C.: US Department of Commerce, 1976), p. 10.

37. See Nolting, The 1968 Reform of Scientific Research, Development and Innovation in the USSR (W shington, D.C.: US Department of Commerce, 1976).

38. V. Sominskii and L. Bliakhman, eds., Ekonomicheskie problemy povysheniia effektivnosti nauchnykh razrabotok (Leningrad, 1972), p. 178; Pravda, March 14, 1977.

39. K. I. Taksir, NPO, pp. 42-53, 57-58; Yu. Subotskii, Novyi etap razvitiia obedinenii v promyshlennosti (Moscow, 1973), p. 26; L. N. Andrukhovich, Upravlenie kachestvom (Novoe v zhizni, nauke, tekhnike—seriia nauka upravleniia), 10 (1976): 47

40. Taksir, NPO, p. 57; G. A. Dzhavadov, Upravlenie nauchno-tekhnicheskim progressom (Moscow, 1976), p. 23.

41. Taksir, NPO, p. 132.

42. Ibid., p. 145; V. Pokrovskii, "Perestraivaias' na marshe," Sotsialisticheskaia industriia, July 13, 1977, p. 2.

43. Taksir, NPO, pp. 125-154; Subotskii, Novyi etap razvitiia obedinenii, p. 18; Shteingauz, Ekonomicheskie problemy, pp. 120-122 and her "Novye organizatsionnye formy sviazi nauki s proizvodstvom," Ekonomika i organizatsiia promyshlennogo proizvodstva (EKO), 3 (1973): 46-47; G. A. Dzhavadov, "NPO—forma integratsii nauki, tekhniki, proizvodstva," Sovetskoe gosudarstvo i pravo, 1 (1975): 37, 43-44; N. E. Drogichenskii, Sovershenstvovanie mekhanizma khoziaistvovaniia v usloviiakh razvitogo sotsializma (Moscow, 1975), pp. 168-171; and Andrukhovich, Upravlenie kachestvom, pp. 48-50.

44. Berliner, The Innovation Decision, p. 135.

45. See Dzhavadov, "Nauchno-proizvodstvennye obedineniia—forma integratsii nauki, tekhniki, proizvodstva," p. 37; Yu. V. Subotskii, Razvitie obedinenii v promyshlennosti: Voprosy teorii i metodologii (Moscow, 1977), pp. 66-67; V. Kochikian and V. Kushlin, "Osnovy khoziaistvennogo rascheta v nauchno-proizvodstvennykh obedineniiakh," Planovoe khoziaistvo, 7 (1977): 25-26; Taksir, NPO, p. 39;

Pokrovskii, "Perestraivaias na marshe," p. 2.

46. Taksir, NPO, pp. 35, 39-40.

47. Shteingauz, Ekonomicheskie problemy realizatsii nauchno-tekhnicheskikh razrabotok, p. 124; V. N. Arkhangelskii, Planirovanie i finansirovanie nauchnykh issledovanii (Moscow, 1976), pp. 158-160.

48. Yu. Kanygin and S. Kostanian, "Nauchno-proizvodstvennyi tsikl," Voprosy ekonomiki, 12 (1976): 61.

49. Mikhnevich, Ekonomicheskie problemy upravleniia nauchno-tekhnicheskim progressom, p. 57.

50. B. E. Paton, President of the Ukrainian Academy of Sciences has raised the idea of creating a new academy-based research complex called an academy scientific-technical association (akademicheskoe nauchno-tekhnicheskoe obedinenie) which could encompass the spectrum from fundamental research to the production of experimental prototypes. This proposal was supported at a meeting of the USSR Academy in late 1976 by A. P. Aleksandrov, President of the Academy. See Vestnik Akademii nauk SSSR, 2 (1977): 51, 57.

51. This information is cited by Taksir in his book published in 1977, but it may be substantially out of date. These same percentages were used by Bliakhman and Ivanov in their 1971 article, "Nauchno-proizvodstvennoe obedinenie kak forma sistemnoi organizatsii tsikla 'issledovanie-proizvodstvo," p. 44.

52. Taksir, NPO, p. 111 and Arkhangelskii, Planirovanie i finansirovanie nauchnykh issledovanii, p. 162.

53. These tasks are listed in the statute on the NPO. See "Polozhenie o nauchno-proizvodstvennom obedinenii," Sobranie postanovlenii pravitelstva SSSR, 2 (1976): 24-25. See also Subotskii, Razvitie obedinenii, p. 67 and Dzhavadov, "NPO—forma integratsii nauki, tekhniki, proizvodstva," pp. 38-39.

54. Taksir, NPO, pp. 43-79.

55. Ibid., pp. 38-39, 74-79; Kushlin, Uskorenie vnedreniia, p. 111.

56. For a description of the various kinds of NPOs, see Nolting, The 1968 Reform, p. 17 and Taksir, NPO, pp. 29-34.

57. Ibid., p. 32.

58. Kushlin, Uskorenie vnedreniia, p. 111; Pokrovskii, "Perestraivaias na marshe," p. 2.

59. Taksir, NPO, pp. 48-49, 139-140.

60. Ibid., pp. 32, 37 and Problemy sovershenstvovaniia upravleniia sotsialisticheskoi ekonomikoi (Moscow, 1976), pp. 135-136.

61. Taksir, NPO, pp. 36, 55-56, 78, 157-158 and Shteingauz, Ekonomicheskie problemy realizatsii nauchno-tekhnicheskikh razrabotok, p. 124.

62. Nolting, The 1968 Reform, p. 16.

63. Sominskii and Bliakhman, Ekonomicheskie problemy povysheniia effektivnosti nauchnykh razrabotok, pp. 188-189; and Dzhavadov, "NPO—forma integratsii nauki, tekhniki, proizvodstva," p. 40.

64. Taksir, NPO, pp. 54-55.

65. Sominskii and Bliakhman, op. cit., p. 189 and Gavrilov, Ekonomika i effektivnost nauchno-tekhnicheskogo progressa, p. 296.

66. B. Tabachnikas and M. Skliar, "Khoziaistvennyi raschet nauchno-proizvodstvennykh obedinenii," Voprosy ekonomiki, 12 (1976): 73 and Gavrilov, op. cit., pp. 295-296.

67. "Polozhenie o NPO," p. 23.

68. Tabachnikas and Skliar, op. cit., p. 73.

69. Kushlin, Uskorenie vnedreniia, p. 112. In its decision approving the NPO statute the USSR Council of Ministers stipulated that the USSR Ministry of Finance and the Central Statistical Administration had to draw up within six months time bookkeeping and statistical reporting forms for NPOs.

70. Dzhavadov, "NPO—forma integratsii nauki, tekhniki, proizvodstva," p. 41.

71. Arkhangelskii, Planirovanie i finansirovanie nauchnykh issledovanii, pp. 168-169; Taksir, NPO, p. 56.

72. "Polozhenie o NPO," pp. 53-55; "Postanovlenie Soveta Ministrov SSSR ob utverzhdenii Polozheniia o nauchno-proizvodstvennom obedinenii," ibid., pp. 19-20; A. Vershinina, "Nauchno-proizvodstvennye obedineniia i stimulirovanie tekhnicheskogo progressa," Sotsialisticheskii trud, 7 (1976): 32-36.

73. omit

74. Tabachnikas and Skliar, op. cit., p. 73.

75. Taksir, NPO, p. 77; Nolting, The 1968 Reform, p. 16.

76. "Perestraivaias na marshe," p. 2.

77. K. I. Dubrovskii and Yu. Yu. Ekaterinoslavskii, Upravlenie nauchno-tekhnicheskim razvitiem proizvodstvennykh obedinenii: Informatsionnyi aspekt (Moscow, 1976), pp. 18-20; Dzhavadov, "NPO--forma integratsii nauki, tekhniki, proizvodstva," pp. 42-43; Nolting, The 1968 Reform, p. 16.

78. Arkhangelskii, Planirovanie i finansirovanie, p. 162; Taksir, NPO, pp. 111-113.

79. For the text of the regulation, see "Polozhenie o poriadke obrazovaniia i ispolzovaniia fondov ekonomicheskogo stimulirovaniia nauchno-proizvodstvennykh obedinenii," Ekonomicheskaia gazeta, 36 (September 1976): 15-16. For the procedures for awarding bonuses, see ibid., 48 (November 1976) and 49 (December 1976): 14

80. See Nolting, The 1968 Reform, p. 16; Gavrilov, Ekonomika i effektivnost, pp. 297-305; B. Tabachnikas and M. Skliar, "Otsenka raboty i printsipy obrazovaniia fonda materialnogo pooshchrenniia nauchno-proizvodstvennykh obedinenii," Planovoe khoziaistvo, 2 (1974): 123-124.

81. Tabachnikas and Skliar, "Khoziaistvennyi raschet nauchno-proizvodstvennykh obedinenii," p. 77 and Taksir, NPO, pp. 101-102.

82. Gavrilov, Ekonomika i effektivnost, pp. 294-295 and Mikhnevich, Ekonomicheskie problemy, pp. 71, 85.

83. Subotskii, Razvitie obedinenii v promyshlennosti, p. 5 and Taksir, NPO, p. 158.

84. G. Ivanov and G. Yakovlev, "Under a New Name-Plate," Pravda, March 26, 1978.

85. R. M. Shteinbok, "Komu vnedriat novuiu tekhniku," EKO, 6 (1976): 78-79.

86. Shteingauz, Ekonomicheskie problemy, p. 125.

87. Such organizations have been given a variety of names: "innovation" or "introducing" firms (vnedrencheskie firmy), specialized associations for the introduction of new technology (spetsializirovannye obedineniia po vnedreniiu novoi tekhniki), and associations for scientific-technical services (obedineniia po nauchno-tekhnicheskomu obsluzhivaniiu).

88. See Taksir, Sushchnost i formy soedineniia nauki s proizvodstvom pri sotsializme (Moscow, 1974), pp. 92-104; V. Pavliuchenko, "Ot stola konstruktura do zavodskogo konveiera," Pravda, June 13, 1971 and his Ekonomicheskie problemy upravleniia nauchno-tekhnicheskim progressom (Moscow, 1973), pp. 202-213; Shteinbok, op. cit., pp. 76-85.

89. Shteinbok, op. cit., pp. 70-80 and L. Davydov and R. Shteinbok, "Formy organizatsii vnedreniia novoi tekhniki," Voprosy ekonomiki, 9 (1977): 134.

90. See Taksir, NPO, pp. 24-25.

91. See the excellent article by John Lowenhardt, "The Tale of the Torch: Scientists-Entrepreneurs in the Soviet Union," Survey, XX, 4 (93) (Autumn 1974): 113-121.

92. Ibid., pp. 117-118.

93. K. Taksir and M. Krasnokutskii, "Formy organizatsii vnedreniia novoi tekhniki," Voprosy ekonomiki, 1 (1977): 50;V.Pokrovskii, "Novaia tekhnika: Dorogi i porogi," Ekonomicheskaia gazeta, 10 (March 10, 1976): 10.

94. Taksir and Krasnokutskii, op. cit., p. 50.

95. Shteinbok, "Komu vnedriat novuiu tekhniku,"p. 80.

96. Taksir, Integratsiia nauki i proizvodstva pri sotsializme, pp. 47-48.

97. See Voprosy ekonomiki, 2 (1977): 151-153; Ekonomicheskaia gazeta, 52 (December 1976): 14; Taksir and Krasnokutskii, op. cit., pp. 52-53.

98. Pokrovskii, "Novaia tekhnika: Dorogi i porogi," p. 10.

99. EKO, 5 (1977): 160. These differences of view are expressed in the debate in this issue of EKO (pp. 143-146) under the subject, "Komu vnedriat novuiu tekhniku?" This was the same time that Shteinbok used in his article in EKO the year before. The discussion in the May 1977 issue contains reactions and reflections to Shteinbok's article and call for specialized innovation organizations.

100. Kanygin, Nauchno-tekhnicheskii potentsial, p. 243.

101. V. P. Aleksandrova, Problemy planirovaniia i effektivnosti razvitiia nauki i tekhniki v Ukrainskii SSR (Kiev, 1976), pp. 53-54.

102. Gvishiani, "The Scientific and Technological Revolution and Scientific Problems," pp. 55-56.