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The Scientific-Technological Revolution: Soviet Views, Yesterday and Today

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The Scientific Technological Revolution Soviet Views, Yesterday and Today[1]

by
Jeffrey L Roberg with Roger E Kanet

Since the Second World War rapid industrial growth has swept the developed countries of the northern hemisphere In the Soviet Union analysts have attempted to explain this rapid industrialization within a theoretical framework referred to as theory of the Scientific Technological Revolution (STR) This article will deal with several issues directly related to the STR First how have Soviet leaders and analysts approached the fields of science and technology within the framework of the theory of STR? Directly related to this what were the objectives of the USSR concerning the use of STR and how have science and technology been employed to achieve these objectives? Second what explains the failure of the Soviet Union to implement successfully the objectives of the STR and to turn the achievements in Soviet basic science and technology into applied results during the 1970s? Also has the nature of the problems of implementing science and technology been adequately identified and what, if anything is currently being done to resolve these problems? Third and finally does the STR still exist as a theoretical construct? If it does do the objectives of the STR remain the same as they were during the 1960s and 1970s?

As implied by the above comments the following commentary will focus on two distinct periods in the Soviet discussion and analysis of the Scientific Technological Revolution First we will examine the emergence of the concept and its implication for Soviet science and technology policy in the period prior to 1985 It was during the 1970s a time of general euphoria concerning the changing international co relation of forces that the USSR emerged internationally as a superpower and continued to make progress on the domestic front which provided a foundation for that emergence As we shall see Soviet leaders and analysts have been far less sanguine concerning the attainment of international objectives and the status of science technology and the economy within the domestic realm

The Original Concept of the Scientific Technological Revolution

Before discussing the ways in which the Soviet Union has utilized the STR it is important to discuss the meaning of the term and the objectives that the scientific technological revolution has been expected to accomplish Soviet analysts have stated that the STR is a world wide phenomenon with favorable implications for the future of world society it will contribute to the ultimate downfall of capitalism while hastening the development of socialism Unfortunately Western analysts have found that Soviet literature contains not a single position concerning the nature and scope of the STR In general STR has been conceived of as the technological application of science as a direct productive force '[2] Specifically Erik Hoffmann and Robbin Laird have identified six components of the Scientific Technological Revolution

1) The merging of the scientific revolution with the technological revolution
2) the transformation of science into a direct productive force
3) the organic unification of the elements of the production process into a single automated system whose actions are subordinated to general principles of management and self management,
4) qualitative changes in the technological basis of production which signify changes in man machine relations
5) a new type of worker who has mastered scientific principles of production and

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2 Erik P Hoffmann Soviet Views of The Scientific Technological Revolution *World Politics* vol. 30 (1977 78) p 618

6) the shift from extensive to intensive development of the production process [3]

Soviet Marxism Leninism of the Brezhnev era described the STR as leading the Soviet Union to and through the stage of developed socialism Developed socialism was viewed as a period during which the basic social and political institutions of socialism are adapted to the challenges raised by the STR It is by mastering and taking full advantage of the Scientific Technological Revolution that the socialist state will be able to attain developed socialism In practice this ideological formulation meant that scientific change would lead to development However blocking the economic and socio political development of the state are intervening factors which for their own specific reasons either do not desire this development or are intentionally or unintentionally slowing its emergence In fact, the STR is not a new concept for the leadership of the Soviet Union Lenin understood the importance of the STR and the concepts of revolution in science and technological revolution appeared in his writings [4] Writing in 1931 Nikolai I Bukharin also spoke about a technical revolution [5] Theoretical discussions of the links between science and the transition from socialism to Communism occurred during both the first and third five year plans introduced under Josef Stalin This theorizing was interrupted by Stalin s cult of personality during and after World War II

N A Bulganin became the first high level Soviet leader to use the phrase Scientific Technology Revolution in a speech at the July 1955 Plenum of the Communist Party Central Committee Speaking about the energy of the atom Bulganin stated that we stand at the threshold of new *scientific and technological revolution* the significance of which far surpasses the industrial revolutions associated with the appearance of steam and electricity [6]

At the 24th Party Congress in 1971 the Party leadership announced that the task facing the Soviet Union was *to organically fuse the achievements of the STR with the advantages of the socialist economic system* [7] It was also observed that the STR had social and economic consequences as a result of the displacement of labor by changing the role of humans in the system of productive forces In 1973 for example Vladimir G Marakhov wrote that the STR was a double edged weapon

> It is not only that powerful means of destruction have been created on the basis of the achievements of the STR but also that even the peaceful development of scientific and technical progress and of the STR in particular brings with it both positive and in corresponding social and economic conditions negative results The latter are linked with the accelerating process of exhaustion of stocks of some useful minerals pollution of the environment high rates of industrial processing of oxygen the utilization of fresh water etc [8]

Another danger of the STR was the possible creation of a technocratic consciousness among technical and economic elites which possibly would result in downplaying the class nature of the political and economic processes and emphasizing technological development for its own sake But the emergence of a dominant focus on technology was not seen as inevitable it was viewed as a potential threat the STR does not develop in a social vacuum and in turn exerts a powerful influence on the development of existing social relations [9] It was

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3 Erik P Hoffmann and Robbin F Laird *The Scientific Technological Revolution and Soviet Foreign Policy* (New York Pergamon Press (1982) pp 9 10

4 See Julian M Cooper "The Scientific and Technical Revolution in Soviet Theory in *Technology and Communist Culture The Socio Cultural Impact of Technology under Socialism* edited by Frederic J Fleron Jr (New York Praeger Publishers 1977) p 149

5 Cited in N I Bukharin *Socialist Reconstruction and the Struggle for Technique* (Moscow Cooperative Publishing Society of Foreign Workers in the USSR 1932) p 10 cited in Cooper "The Scientific and Technical Revolution p 151

6 N A Bulganin s Report to the July 1955 Plenum of the Central Committee of the CPSU *Pravda* 17 July 1955 p 2 (emphasis added)

7 *Materially XXIV S ezda KPSS* (Moscow Politizdat 1971) p 51 cited in Cooper The Scientific and Technical Revolution p 146 (emphasis in the original)

8 Vladimir G Marakhov "Osushchnosti nauchno tekhnicheskoi revoliutsii Obmen mneniiami *Filosofskie nauki* no 5 (1973) p 90

9 See Hoffmann "Soviet Views of The Scientific Revolution p 624 The citation comes from B M Kedrov and S R Frolov *Nauchno tekhnicheskaia revoliutsiia i solsial nyi progress* (Moscow Politizdat, 1973) p 37

asserted however that these problems could be overcome by strengthening social controls over the STR while using science to provide new long term solutions

The main Soviet hope was that science and technology could be utilized to improve factory productive capacities and to raise the levels of Soviet economic and industrial growth According to John Thomas and U M Kruse Vaucienne Science was elevated to the status of a productive force in the new Party Programme at the 22nd Party Congress with the implication that it would play a more fundamental role as part of the material basis and not merely as an aspect of the superstructure "[10]

Speaking in 1976 Chief Soviet ideologue Mikhail Suslov that the STR opened unseen possibilities in the use of science to master and protect the forces of nature and to solve social problems while simultaneously acting as the material preparation for Communist civilization "[11]

Implementation of the STR

Various attempts were made to implement the objectives of the STR Unfortunately for the Soviet leadership these attempts sometimes had effects opposite to those desired The first effort to achieve the objectives of the STR included the reorganization of the Academy of Sciences in 1961 when the Academy lost over 40 percent of its scientific establishments While the Academy had 240 research establishments in 1960 it retained only approximately 160 two years later The institutes that were taken from the Academy were those of applied research institutes this permitted the institutes of the Academy to focus on basic scientific development rather than on implementation [12] In the view of Loren Graham the institutes themselves played a positive role in the decision to remove the applied institutes John Thomas on the other hand believes that this decision was imposed on the Academy [13] Following the Communist Party of the Soviet Union (CPSU) Plenum of 1962 the Central Committee and the Council of Ministers issued a decree to reorganize the Academy with the purpose of developing the social and physical sciences as a means of improving technological and industrial progress and to identify new uses for existing technology that would strengthen the national economy [14]

The failure of the reorganizations of 1961 and 1962 to exert a major positive impact on the Soviet economy resulted in a second attempt to achieve the objectives of the STR within the context of Prime Minister Aleksei Kosygin s economic reforms initiated in September 1965 These reforms granted a limited devolution of economic authority while simultaneously preserving a large measure of directive planning Kosygin s reforms were meant to increase the operating powers of individual enterprises and institutes by granting them more independence in their everyday operations Controls on enterprises were reduced in 1965 two years later controls governing many of the applied research development establishments also were reduced It was hoped that these two reforms both related to the restructuring of incentives would allow institutes and enterprises to cooperate more effectively with one another in promoting scientific and technological advances But Bruce Parrott has noted that, enterprise directors were either unable or unwilling to protect their rights against ministerial incursions [15] As a result, decision making autonomy did not emerge and cooperative arrangements among Research and Development (R&D) establishments did not expand appreciably

A second important problem also surfaced for the granting of greater autonomy to the production and research enterprises actually produced an unexpected decline in the rate of technological progress As Parrott has noted, the 1965 reform inadvertently strengthened the impact of the existing financial disincentives [which existed within the Soviet economy] by reducing the central administrative pressure which had previously sustained the process of innovation " As the reform became more widespread, the number of prototypes of new machines and instruments created each year fell off sharply as did the number of prototypes introduced into the

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10 John R Thomas and U M Kruse Vaucienne "Soviet Science and Technology An Introduction *Survey* vol 23 no 1 (102) (1977 78) p 13

11 Cited in Thomas and Kruse Vaucienne "Soviet Science and Technology p 12

12. See Loren B Graham The Role of the Academy of Sciences *Survey* vol 23 no 1 (1977 78) p 120 See also John Turkevich "How Science Policy is Formed *Survey* vol 23 no 1 (1977 78) p 92

13 Graham The Role of the Academy of Sciences and Thomas and Kruse Vaucienne "Soviet Science and Technology

14 Bruce Parrott "Technological Progress and Soviet Politics *Survey* vol 23 no 2 (1977 78) p 51

15 *Ibid*

production cycle Between 1965 and 1968 the percentage of new machines and equipment included in the output of nine major machine building branches of the economy dropped from 13 8 to 8 2 percent [16]

The failure of the Kosygin reforms led the Soviet leadership to create both complex research institutes and Scientific Production Associations" (NPOs) through the decree issued on 24 September 1968 These associations represented an attempt to create optimum ties between research institutes and production institutes " in the words of Eugene Zaleski [17] The task of a complex institute was to improve the technology of a specific sector of a ministry s production while the NPOs combined different research institutes and production units and were generally directed by a research institute " By February 1976 more than 100 NPOs had been created as a means to encourage technological innovation throughout the Soviet economy Zaleski notes that innovation was also encouraged by the removal of administrative barriers not only among the various research institutes but also at different stages of the R&D process "[18] NPOs were more engaged in the innovation process than were the complex institutes Yet it is unclear to what extent the creation of the complexes and associations actually had the desired effect of increasing technological innovation within the Soviet economy

A third approach to the creation of optimum ties" between research and production institutes was the establishment of production associations which resulted in the subordination of most research organizations to industrial production units By the end of 1976 there were more than 3 000 such production associations in existence providing approximately 40 percent of total industrial production [19]

The last major reform introduced during the 1970s that related to efforts to improve technological innovation and to gain greater benefits from the scientific economic revolution was the attempt to introduce economic accountability (*khozraschet*) at the branch level based on a decree issued on 2 March 1973 The decree provided for the abolition of main administrations of ministries and their replacement either by production associations or by industrial associations Though the industrial associations functioned on the basis of *khozraschet* their production associations NPOs and enterprises retained separate legal identity and accountability [20]

In connection with the reforms mentioned above various systems of incentives were implemented in the effort to achieve the objectives of the STR Based on a decree issued in 1968 by the Central Committee of the CPSU and the Council of Ministers the source for funding incentives was changed The old methods of rewards had been based upon the number of projects completed by an enterprise The new method of determining economic incentives was based on the amount of the rewards on the return that R&D results yielded to both the consumer and the economy The 1968 the decree created three incentive funds The first gave bonuses to workers based on both the annual results achieved by their institutes and their own individual achievements A second fund provided for housing construction and repair as well as the financing of cultural organizations and services provided to workers The third fund resulting from the 1968 decree provided for additional investments in equipment, instruments and materials aimed at encouraging technical achievements and improvements in the quality of research [21]

In addition to the incentive funds established in 1968 a second incentive system was tried it tied the salaries of scientists to the results of their research activities rather than to their prior level of training that they might possess A G Orlov discussed this attempt at salary reform in his analysis of the new forms of material incentives introduced at various enterprises throughout the USSR for example those at the Karpov Institute of Physical Chemistry [22] According to Orlov the productivity of the institute rose rather dramatically after the introduction of the new salary system In 1969 the first year in which the policy was in force inventions

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16 *Ibid*

17 Eugene Zaleski "R&D Planning and Financing *Survey* vol 23 no 2 (1977 78) p 51

18 *Ibid*

19 *Ibid* p 20

20 *Ibid*

21 *Ibid* p 25

22. See A G Orlov "New Forms of Material Incentives for the Work of Scientists and Scholars *Sovetskoe gosudarstvo i pravo* no 1 (1974) translated in *Soviet Review* vol 15 16 (1974 76) pp 3 19

increased 2 2 times over the level of the previous year and the number of papers submitted for publication increased by 25 percent [23] However any attempt to posit a causal relationship between the introduction of a new salary incentive system and the productivity of the institute is likely to be flawed First of all Orlov does not discuss the degree to which the number of inventions " or research papers represent true additions to scientific or technological knowledge Moreover the inventions that came to fruition during 1969 may have been available a year earlier In sum the experience of the Karpov Institute and the impact of the new salary incentive system on technological innovation is not entirely clear

The Failure of the STR

Despite the various efforts made by the Soviet leadership to attain the objectives of the STR by initiating policy reforms the USSR failed to reach its objectives throughout the 1970s The reasons for this failure fall into three basic categories political constraints organizational impediments and economic factors Political constraints consisted first of all of the continuation by the CPSU of a policy that limited contacts between Soviet scientists and their foreign counterparts as well as placing restrictions on travel by most Soviet scientists A second political constraint stemmed from the lack of information available to Soviet scientists concerning new developments occurring in their fields of research This factor led to the impossibility of or the massive delay in receiving information about materials published outside the USSR The system of distributing scientific information in the USSR came under strong criticism from Soviet scientists Although noted first in 1969 the following criticism applies as well to the recent past the core of the problem is the bad organization of our country s scientific information service—the delay in the movement of new ideas through the communication channels are unacceptably long It can reach and even exceed five years The major obstacle [responsible for the delay] is the absence of direct and regular contact with scholars abroad. [24]

Another impediment to accomplishing the objectives of the STR resulted from organizational problems stemming from the lack of unified scientific command For every annual and five year plan the State Committee for Science and Technology (SCST) devises the top priority programs pursued by the Academy of Sciences as well as by the many research institutes and ministries Each of these actors possessed its own budget, personnel and facilities Organizational problems that occurred in the implementation of research programs included the lack of an umbrella organization to carry a project from the initial research stage to production under a single leadership The need for centralized leadership within the Soviet economic environment becomes clear when one recognizes that the entire R&D cycle is fragmented among diverse research institutes and production enterprises Indicative of this problem are the barriers between scientific institutes and industry Industrial ministries do not readily take up the innovative ideas of scientists nor do they carry out their own basic research and development. Rather historically they have contented themselves with duplicating research work done elsewhere or with maintaining outdated machinery and production processes The Scientific Production Associations established in the 1960s to solve this problem of coordination did not succeed in part because of administrative barriers that divided the enterprises from one another and the research institutes from the production units One reason for the relative success in technological innovation in the military security area has been the existence of centralized command able to force coordination among R&D and production units in the military sphere

Other organizational problems have stemmed from the jurisdictional boundary disputes among three key actors in the Soviet economy—the Academy of Sciences the SCST and the production ministries The Academy of Sciences has been in conflict with the SCST because of the widespread view among Academy leaders that the State Committee had infringed upon the Academy s exclusive right to make decisions concerning science as well as to oversee contacts with foreign scientists [25] At the same time the Academy also has been in conflict with the production ministries because of the former s loss of a substantial number of institutes and personnel which were transferred to the ministries during the early 1960s in the attempt to increase the

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23 *Ibid* p 8

24 V V Nalimor and Z M Mul chenko *Naukometria* (Moscow Nauka 1969) p 163 cited in Yakov M Rabkin "The Study of Science " *Survey* vol 23 no 1 (1977 78) p 137

25 See Thomas and Kruse Vaucienne "Soviet Science and Technology p 4

effectiveness of applied scientific research Thus the Academy of Sciences which favors basic science is often in conflict with the ministries which emphasize applied scientific research

Another jurisdictional dispute has engaged the SCST and the ministries The State Committee is in charge of the implementation of scientific and technological innovations in the plants and institutes of the various ministries However the ministries have resisted the introduction of new technology since they are held accountable for the fulfillment of production quotas even during periods when new technology and new production equipment is being installed [26]

The last jurisdictional dispute has been one between the all union and the republic level Academies of Sciences Their disputes revolve around the quality of personnel the size of budgets and the level of interaction with foreign scientists that the all union Academy of Sciences receives in comparison with that received by the republic level academies In addition some of the strains have been aggravated by tensions between different nationalities within the USSR

Another aspect of the organizational problems that have arisen to restrict the effectiveness of efforts to reform the process of technological innovation within the USSR concerns the formation of production associations Although these associations were supposed to be adopted industry wide by 1980 by 1977 there were already numerous complaints of footdragging in the creation and running of associations "[27] In fact the associations were never emplaced as originally planned A final set of organizational problems derived directly from the system of central planning As Thomas and Kruse Vaucienne note central planning results in low risk taking on the part of enterprise managers the lack of individual responsibility in the case of failure and the identification of scapegoats to be blamed in the case of serious errors [28] All of these behaviors are evident in the Soviet case

A third and final source of obstacles to successful implementation of the STR objectives was economic One major economic problem has been the absence of incentives for scientists and research institutes to be innovative Although as noted above serious efforts were made to introduce incentives they proved to be inadequate to motivate the majority of the members of the scientific research community A second important economic problem touched on above in the discussion of organizational impediments stems from the use of a production quota system in establishing the reward system in industrial production This system in effect, penalizes unsuccessful innovation and raises fears among enterprise managers that the implementation of new technology may result in a failure to fulfill quotas and thus a reduction in income for both management and workers

Policy Innovations in the Gorbachev Era

We turn now to an examination of the policies pursued by Mikhail Gorbachev since his elevation to the position of General Secretary of the CPSU in spring 1985 The questions that emerge concern Soviet science and technology policy since 1985 and the objectives of policies associated with STR In his discussion of current Soviet science policy analyst Peter Kneen has noted that. It is the added responsibility assigned to science together with the attempt to revitalize its institutions which distinguish the current leadership s science policy from that of its predecessors "[29] On the surface this objective seems no different from the objectives pursued previously in the attempt to bring technological progress to the Soviet Union But officials claim that the goal of revitalizing science in the USSR now differs because the Soviet Union can no longer rely on an increasing pool of workers to bring about higher industrial production levels Yet as Kneen notes the current desire for the intensification of scientific research can be traced back to the 8th Five Year Plan [30] At the 27th Congress of the CPSU in 1986 Gorbachev also spelled out what he believed to be the practical responsibilities of Soviet scientists He noted that the Soviet leadership s commitment to strengthening support for science was

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26 *Ibid* p 5

27 See Keith Bush "Soviet Economic Growth Past Present and Projected *Survey* vol. 23 no 2 (1977 78) p 11

28 Thomas and Kruse Vaucienne "Soviet Science and Technology p 19

29 Peter Kneen Soviet Science Policy under Gorbachev *Soviet Studies* vol 41 no 1 (1989) p 67

30 *Ibid* See also Cooper "The Scientific and Technical Revolution in Soviet Theory p 146

made on the assumption that it would be paid back handsomely in discoveries and inventions that will revolutionize production "[31]

Writing in 1986 Soviet analyst Gennadii Dobrov stated that the criteria for the selection of goals for the Unified State Policy for Science and Technology (EGNTP) are the same as they were 70 years ago The policy was created in order to utilize the forces of science for their greatest contribution to society and represent a set of coordinated directives established to accomplish three goals

1 the selection of such goals for scientific and technological activity as will serve the interests of the nation as a whole

2 the proper formation and smooth development of work force and

3 improvement of the organizational and economic links between science and industry and widespread dissemination of scientific and technological achievements throughout the country [32]

Dobrov continues that, although the development of fundamental research would receive high priority applied research would be emphasized Applied Soviet science would be expected to develop new technologies to be introduced into the production process [33]

The problem currently facing the Soviet Union is one of utilizing the enormous scientific and technological potential now at the disposal of the country Through the mid 1980s each year approximately five percent of the national income was allocated to scientific development. Approximately five million Soviet scientists specialists and other workers engaged in the attempt to speed up scientific and technological development [34] This situation led Gorbachev to remark in 1985 that

> We can and should achieve a much greater return from scientific research We must re-examine the tasks of science in the light of current requirements which are that science must be brought firmly into line with the needs of social production and production oriented towards science All the links connecting science technology and production must be analyzed and consolidated on this basis [35]

How are all of the objectives noted above to be implemented? On 14 July 1984 Academician Abel Aganbegian who soon thereafter became a key advisor to Gorbachev suggested in an article in *Pravda* that the creation of up-to-date truly comprehensive research and production associations will solve the problem of the development and introduction of advanced technological and economic systems Furthermore he noted the creation of more progressive types of machinery with higher efficiency will be more economical than repairing old outdated equipment.[36]

Before March 1987 no major reforms to science policy had occurred Rather variants of old measures were tried In 1984 a published decree had sanctioned the creation of temporary scientific collectives [37] Although the introduction of such collectives had been begun by the Academy of Sciences three years earlier only 50 scientific collectives were in existence by 1984 all within the structure of the Academy During the mid 1980s an attempt was made to create new scientific production associations in order to take full advantage of the scientific development potential of industry By the end of 1987 there were in existence more than 500 national production associations and 22 interbranch scientific technical complexes However in the words of Aleksei Levin they were burdened with all the old sins departmentalism extreme centralization and administrative command management."[38]

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31 M S Gorbachev in *Pravda* 25 February 1986 p 4

32. Gennady M Dobrov "The Strategy for National Science Policy in the USSR *International Social Science Journal* vol 38 no 2 (1986) p 289

33 *Ibid* p 294

34 *Ibid* p 296

35 M S Gorbachev "Korennoi vopros ekonomicheskoi politiki partii *Kommunist* no 9 (1985) p 296

36. A Aganbegian "Roots of Technical Progress Spread our Wings *Pravda* 14 July 1984 p 2 translated in *The Current Digest of the Soviet Press* (hereafter CDSP) vol 36 no 28 (8 August 1984) p 3

37 See Aleksei E Levin "Soviet Science Policy in the *Perestroika Period* An Overview *Report on the USSR* vol 1 (26 May 1989) p 10

38 *Ibid*

We have already identified a number of organizational problems such as administrative and jurisdictional barriers between science and industry that have impeded efforts to improve Soviet science and technology Many of these barriers continue to stand as noted in a 1984 article in *Pravda* in which the author observed that the production of the Kama Truck Plant is tormented to a much greater degree by its own lack of interdepartmental coordination disruptions in deliveries and defective planning —and first of all by uncompleted construction "[39] It has been estimated by Soviet analysts that barriers of this sort have caused delays in the introduction of scientific developments by eight to ten years [40]

Leading Soviet scientists have tended to blame the industrial ministries for not taking up the scientists ideas and rather purchasing industrial equipment abroad Former president of the USSR Academy of Sciences A P Aleksandrov stated in April 1986 that the Academy had created 300 completed development projects which to date had not been introduced into industry [41] Political leaders have also blamed the ministries for not assimilating the new technologies developed within the Soviet Union into their production lines For these reasons Boris Paton president of the Ukrainian Academy of Sciences has called for the creation of a unified organizational economic mechanism similar to the interbranch scientific technical centers developed in Ukraine in order to bypass these administrative barriers [42] Both Gorbachev and former Prime Minister Ryzhkov have expressed enthusiasm for the type of organizations pioneered by Paton in Ukraine for they bring research and production facilities together and thereby bypass the ministerial hierarchies that tend to obstruct the assimilation of technical innovation [43]

It is within this context that the leadership of the Soviet Union has again attempted to link the scientific research establishments within industrial enterprises Currently this link is being forged through the new interbranch scientific technical complexes (MNTK) As the scientific production associations (or NPO) before them MNTK are formed around a lead institute However unlike the NPOs the MNTK can be formed around a branch or an Academy institute they are also different because they combine research developmental and production facilities from different branches of the economy thus necessitating the co-operation of a large number of ministries and other state agencies "[44] The MNTK operate on the basis of both annual and five year plans that coordinate the work done with other MNTK They also possess another considerable advantage for their directors exercise considerable formal authority and can submit requirements to the USSR State Committee for Material and Technical Supply (Gossnab) for material and technical resources on the basis of both long term and immediate needs "[45] Yet despite these advantages the MNTK still suffer from numerous problems of coordination even in some high priority areas

Other organizational innovations that both strengthen the link between science and industry and weaken administrative barriers include engineering centers temporary laboratories and factory laboratories The most interesting of these innovations are the factory laboratories set up by the Academy of Sciences [46] One attempt currently being made to increase the Academy s technical ties is the establishment of a number of construction bureaus that will be administered by the Academy in order to increase the production of scientific equipment.[47]

Through various reforms since 1985 President Gorbachev has attempted to ensure the carrying out of his scientific objectives by committing the necessary funds However he has noted that resources for the development of science and technology should be concentrated so that they are utilized in the most efficient

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39 S Bogatko and N Morozov Ways to Improve the Kama Automotive Plant, *Pravda* 9 July 1984 p 3 and 10 July 1984 p 2 translated in *CDSP* vol 36 no 28 (8 August 1984) p 10

40 See B Konovalov "Introduction is a Key Task Storehouses of Intellect and Knowledge" *Izvestiia* 30 January 1985 p 2 translated in *CDSP* vol 37 no 5 (27 February 1985) p 14

41 A P Aleksandrov "Speech by Comrade A P Aleksandrov President of the USSR Academy of Sciences *Pravda* 27 February 1986 p 5 translated in *CDSO* vol 38 no 9 (2 April 1986) p 9

42. Cited in Kneen "Soviet Science Policy under Gorbachev p 72

43 See M S Gorbachev in *Pravda* 26 February 1986 p 4 N I Ryzhkov in *Pravda* 4 March 1986 p 2

44 Kneen "Soviet Science under Gorbachev p 72

45 *Ibid* p 73

46 *Ibid* pp 73 74 See also Konavalov Introduction is a Key Task pp 15 16

47 See Kneen "Soviet Science Policy under Gorbachev p 70

possible way Furthermore Gorbachev has asked that associations and enterprises be shifted to *khozraschet* In July 1987 SCST was made responsible for implementing the *khozraschet system* [48] One reason for these efforts was related to a point made by Loren Graham who has noted that the Soviet Union which from 1981 to 1985 spent 131 billion rubles on science simply is not getting sufficient return on its enormous investment "[49]

Efforts have also been made to accomplish the objectives of the STR through changes in the incentive structure for scientists and engineers Over the decades of the 1960s and 1970s the pay of engineers declined in relation to that of other workers As Soviet economist Abel Aganbegian stated in 1985 engineers often made a salary about the same as or even less then that of factory workers [50] Today it appears that the monetary incentive reforms for engineers and science personnel as well as the system of remuneration within the Academy of Sciences are like those originally introduced in the Karpov Institute back in 1968 The result is an increase in pay of between 30 and 50 percent for engineers and other skilled scientific researchers [51]

The objectives of STR are also being implemented through preliminary reforms in both the organization of the Academy of Sciences and the production ministries Beginning in 1987 reforms were undertaken within the Academy to reduce organizational centralization while increasing the amount of democratization In the ministries reforms have switched the scientific enterprises and industries over to the *khozraschet* accounting system [52]

The optimism that characterized views about the STR during the 1970s underwent a subtle transformation as the Soviet Union entered the 1980s Throughout the 1980s the Soviet leadership seemingly became less concerned with the ideological aspects of the STR and more interested in its practical aspects This does not mean that analysts completely stopped referring to and writing about the ideological aspects of science and technology For example Yurii Marchuk the chairman of the SCST stated science is becoming a direct productive force in the society exerting a direct effect on all its components hardware and technology production and social relations and man himself [53] Dobrov has also that the modern scientific and technical revolution essentially entails the progressive transformation of a growing number of branches of science into a direct productive and social force "[54] However rather than focusing on the ideological components of the scientific technological revolution Soviet analysts now concentrate on the issue of technical or technological progress and the factors that encourage and facilitate technological innovations

The analysis of the STR undertaken in this article cannot possibly encompass all the various reforms that have been attempted But this analysis does provide evidence that the concept of STR has continued to play a role in Soviet thinking and policy since Mikhail Gorbachev s rise to political power in 1985 Gorbachev himself has acknowledged that machine-building plays the dominant, key role in carrying out the scientific and technological revolution " However such references occur less often It appears that the STR as a term is now synonymous with the phrase accelerating scientific and technological progress [55] The major difference between the current STR and the ideologically based STR of the1960s and 1970s is the current commitment to fill the scientific and technological gap between the USSR and its industrial competitors by setting ideological factors aside and focusing on upgrading Soviet science and technology

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48 M S Gorbachev "The Fundamental Question of the Party s Economic Policy Report by Comrade M S Gorbachev *Pravda* 12 June 1985 pp 1 2 translated in *CDSP* vol 27 no 23 (3 July 1985) p 6

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