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Project planning in Soviet R&D *

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Science in the USSR has not escaped the general commitment of the authorities to centralized planning. But they have long been dissatisfied with the degree of *de facto* decentralization and isolation from production of the traditional science planning process, as well as the lack of flexibility of an institution-based system. This article examines the recent response to these problems – comprehensive goal-oriented programme methods of science planning and management, apparently derived from both Soviet and US defence R&D management. The problems of the approach are revealed, primarily in terms of the excessive bureaucratization of science involved and the continuing isolation of R&D from production. The article concludes by speculating on the significance of the 'entrepreneurial revolution' in Western R&D for the Soviet system.

1. Introduction

Centralized planning is a fundamental principle of Soviet economic management, with the centralized planning of scientific research considered an important part of it. Scientific research was included in the preliminary work on drawing up the First Five Year Plan in the late 1920s. However the relatively low priority given science by the industrial planners and the reluctance to cooperate of many scientists meant that science was not in fact included in the national plan. Nevertheless the Academy of Science and the branch institutes as individual institutions quickly found themselves subject to detailed central plans, whether on a yearly or a five-yearly basis. [26, Ch 7; 36] Since that time the planning grip has been applied ever more tightly.

From the beginning science planning has had three characteristic features: formally a high degree of centralization accompanied by a considerable degree of *de facto* decentralization; planning based on institutions rather than projects or research problems; and a general lack of integration into production plans.

Centralization. The centralization of the planning process has always been a matter of concern to many scientists. The fact that most research they do must be set out in a plan that in advance determines the nature of the work, the completion date, the amount it will cost and the source of the funds, and that the plan will be compiled and the confirmed by high-level government agencies – a ministry, the Academy, the State Committee for Science and Technology (GKNT), or Gosplan (the State Planning Committee) – creates concern that their academic freedom and creativity will be stifled.

The concern of the party authorities is the opposite. They complain that the planning system is in fact not sufficiently centralized, and that scientists are able to determine what goes into the plan to an excessive degree. Because of the lack of expert staff in the planning departments of higher agencies, science plans are all too often simple compilations of the 'pet projects' of individual researchers. The consequences of this 'planning from below' are: the difficulty that leading authorities have in establishing priorities among different research projects; the unresponsiveness of the system to attempted changes in priorities; and a tendency for projects to be of a minor character, with little thought being devoted to their final practical use or the financial parameters that might determine that use. This means that all too often they are not used at all.

Institution-based planning. The Soviet planning system has traditionally been based on institutions. Plans are drawn up for a ministry, the Academy, an institute or a laboratory, rather than for a particular research project or problem. This reinforces the problems caused by the *de facto*

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decentralization of the planning process. A new field of research will be investigated only by an existing laboratory or institute changing its field of work, not always easy to achieve, or by the setting up of a new institute. The proliferation of highly specialized institutes and laboratories indicates that the latter course is often chosen. Nevertheless, setting up a new organization is difficult. The result is an inflexibility and unresponsiveness to new scientific demands. Further, an institution-based planning process is seen as contributing to over-specialization and a lack of cross-fertilization between the scientific disciplines.

Lack of integration with production plans. Following the failure to build scientific research into the First Five Year Plan research plans have been kept quite separate from production plans. It was only in 1966 that the main Five Year Plan had a science and technology section included for the first time, and yet this section was still entirely separate from and not coordinated with the production sections of the plan. (There has been a science and technology section in annual plans since 1949). This separation is seen as being at the bottom of Soviet R&D's greatest problem, *vnedrenie* (the process of the results of R&D being adopted and put into regular use or production by production enterprises). It reflects the lack of interest of each side, research and production, in what the other is doing; it greatly increases the probability that research work will be undertaken for which no use will ever be found, or that the user will be unable to use the finished work because of incorrect specifications or scheduling problems; and it simply drags out enormously *vnedrenie* lead times by increasing bureaucratic delays.

The Soviet authorities saw these features of the traditional planning system as producing serious problems for Soviet R&D – difficulty in determining and enforcing priority areas of research; inflexibility and unresponsiveness to important new areas of research; a lack of cross-disciplinary and inter-branch communication; and poor and wasteful *vnedrenie* of research results in production.

The maturing of the Soviet economy, the reduction in investment and labour resources, and the diminishing rates of return from technology imports made the costs of these shortcomings increasingly hard to bear. The Khrushchev regime is credited with the first realization that the Soviet economy now had to rely on domestic technological development rather than as before entirely on Stalinist methods of industrialization and imported technology. That change in Soviet policy is usually dated from Bulganin's speech at the July 1955 Central Committee plenum. But in this paper we will be more concerned with changes following Brezhnev's 'conversion' to science as the saviour of the Soviet economy, usually dated from his adoption of the scientific-technical revolution at the 24th Party Congress in 1971.

Under the influence of the systems theory which has become so fashionable in the Soviet academic world since the 1960s [6], a dual solution was developed for the problems of science planning. The first aspect of the solution was *kompleksnost'* (comprehensiveness), the idea that plans should cover all stages of a particular research problem from the basic research through to series production. By removing the separation of research and production plans, many of the problems of *vnedrenie* would be removed, particularly as at the same time steps would be taken to integrate scientific and production organizations into single associations.

The second aspect of the solution was *tsel'nost'* (goal-orientation), the idea that plans would be drawn up for projects rather than organizations. If a project was to be 'comprehensive' it would inevitably be worked on by a number of institutions, often in different branches of the economy, and even institutions such as the Academy and universities outside the branch R&D network. The work done by all these different institutions would be fitted into a single goal-oriented project. This would make 'planning from below' a much more difficult proposition and give the higher planning authorities considerably greater power in determining priorities and allocating resources. This project approach will usually require some restructuring of science institutions and management procedures. If science planning is project based, the management and implementation of research plans must also be based on project groups rather than the more usual single discipline and highly specialized institutes, departments and laboratories.

The task of this paper is to describe the implementation and problems of the new approach in Soviet science planning. Its two aspects have not

always been treated together, but when they are they are most simply and briefly referred to as *programmno-tselevy metody* (*PTsM*, programme-goal methods. The word 'programme' expresses the essence of *kompleksnost'*, while *tselevye* is the adjective from *tsel'nost'*.) I will usually refer simply to *PTsM*.

2. New approaches

I will begin by briefly speculating on the possible origins of the new Soviet approach.[1] Soviet commentators claim a long domestic tradition of *PTsM*, going right back to the GOELRO programme of electrification of the 1920s, and even Lenin's 1918 'Outline of a plan of scientific-technical work'. Each compete as the 'first scientific programme in history' [22, p 21; 74]. The 'Outline' is nothing more than a scrap of paper of less than 200 words, primarily recommending self-sufficiency in energy and resources for the new Soviet state [68, pp. 100–101]. GOELRO was a more substantial undertaking, and yet it too seems to be treated as no more than one of those things that must be given a token reference, mainly because Lenin was involved in it. It is rare that Soviet research management theorists describe the lessons of GOELRO in detail. Those features that are mentioned are the GOELRO commission under the All-Union Council for the National Economy (VSNKh), that is, a body with special responsibility for all stages of the electrification project, and its integrated, single-source funding (the commission had a credit of 20 million roubles to be disposed of as it wished) [52 p. 237].

A few Soviet writers mention in the same list of precursors, with equal lack of detail, the military tasks that faced the USSR after the Second World War, specifically the development of nuclear weapons and delivery systems, as well as the space programme [45]. It seems probable that the experience gained from these programmes has had a considerable effect on Soviet research management theory and practice. Many of the participants still occupy senior positions in the Soviet scientific community, while the histories of some of those programmes are reasonably well-documented, even in the open press. The history of the development of the Soviet atom bomb, for example, reads not unlike that of the Manhattan Project. While the role of the USSR's Oppenheimer, Igor Kurchatov, might be exaggerated at the expense of Malyshev, Vannikov and Zaveniagin, the Soviet equivalents of General Groves, one gets the impression of a very clear goal with all necessary resources being devoted to its achievement; the encouragement of work on competing approaches, but all under the strict overall control of a single person; the closest possible cooperation between science and production, with indeed stern subordination of the former to the latter; a good understanding of the need to work towards the final goal stage by stage while integrating an enormous number of discrete processes; and a project structure, in this case based on a special organization just for this project, the famous Laboratory No. 2, but with other established institutions contributing according to the requirements set by Kurchatov [13,15].

These lessons have presumably had an important long-term effect on the way Soviet defence research is managed. It is generallly considered to have always had a strict goal orientation, concentration of resources and close researcher-producer-user links that ensure that it, while not necessarily cost-efficiently, does at least produce a usable and wanted product. Western commentators claim that Soviet defence research makes use of not just its own experiences, but also makes considerable use of Western defence research experience. [6] This includes the general principles to be learnt from accounts of the Manhattan Project [14, vol. 4, pp. 395–396], the nuclear submarine and Polaris developments, the work of NASA, as well as specific and detailed management systems such as PERT, PATTERN, Delphi methods, matrix structures, etc.

It appears, although the evidence is circumstantial, that American research methods adopted by the Soviet defence research sector were, as in the US, picked up by the civilian sector. Few Soviet sources on civilian research acknowledge that the military acted as go-between in this transfer, but that is presumably the result of censorship rather than a reflection of the true situation. Meagre as they are, such clues as the fact that pioneers of the civilian application of *PTsM* such as G. Pospelov have a defence research background [2, p. 478], that the first published translations of the US

[1] I ignore here the probably important interaction between the Soviet Union and other CMEA countries in the development of project planning. I will leave it to someone with a greater knowledge of CMEA and East Europe than I have to cover this point.

literature were done by the *Sovetskoe radio* publishing house, the only Soviet publishing house to list its address as a post-office box (generally considered a sign of a high-security organization), and the interesting detective work of Robert Campbell, suggest that civilian *PTsM* owe a lot to defence research procedures. In particular, Campbell speculates on the military origins of *setevoe planirovanie i upravlenie* (network planning and management), a Soviet version of PERT, which some Soviet writers claim was the prototype of *PTsM* [6, pp. 602–608] [18, p. 138].

Whatever the route taken, US models did reach Soviet theorists on civilian research management, and a reasonably extensive literature now exists [35, Ch 7] [62, Ch 3]. Some of these Western methods, particularly matrix structures and probably Delphi methods, are used in Soviet science planning within the framework of *PTsM*.

The first calls for a new approach were heard in the early 1960s, primarily from scientists. See, for example, the calls for problem-oriented project planning from Topchiev, former chief scientific secretary of the Academy of Sciences, in 1961, and Paton, director of the Paton Institute of Electrical Welding, in 1962. This could have been part of an effort on the part of senior Academy scientists to regain for the Academy an important coordinating role after the setbacks of the 1961 reorganization [12, p. 14], [41] [64, p. 13]. Soviet management and economics specialists were already at this stage taking a keen and public interest in Western methods [56]. But no changes were made until after the fall of Khrushchev. In 1965 the State Committee for Science and Technology (GKNT) was set up, with extensive powers in the coordination and planning of scientific research, and in 1966 for the first time a section of the new Eight Five Year Plan was set aside for scientific and technical developments. The section listed 240 particularly important R&D problems [14, vol. 3, p. 98].

But the first serious step in the direction of *PTsM* was the September 1968 Central Committee and Council of Ministers decree which dealt in some detail with how projects for inclusion in the Five Year Plan should be chosen. From then on a whole series of changes were introduced in typically incremental style, but with the effect of gradually strengthening and broadening the application of *PTsM* to science planning. The changes were designed to get control of the planning process by having the most important projects centrally determined some time in advance, and having them integrated in state economic plans; to cover the entire 'research-production' cycle; and to extend these principles through all levels of the R&D system, on both a vertical and regional basis.

The determination of projects and their inclusion in the planning process . A number of decrees, starting in September 1968, set up an elaborate system of scientific forecasting and long-term planning. The 1968 decree directed GKNT, the Academy of Sciences and Gosplan to work out forecasts (*prognozy*) of scientific and technical developments for the next ten or more years. On the basis of these forecasts GKNT and the Academy would work out the major R&D problems to be listed in the science and technology section of the Five Year Plan [38, para 2].

Long-term planning was broadened to include the whole economy, not just science and technology, in 1972. Following Kosygin's call for the development of a long-term plan for economic development at the 24th Party Congress in 1971, in August 1972 a Central Committee and Council of Ministers decree 'On developing long-term perspective and five year (1976–80) plans for the development of the economy' was duly issued. It called for a plan covering the period 1976 to 1990. It appears that no such plan appeared before 1976 and eventually a period from 1980 to 1990 was adopted [2, pp. 480–481]. This followed the appearance of the July 1979 decree 'On improving planning and strengthening the influence of the economic mechanism on raising the effectiveness of production and the quality of work.' Of interest to us is that an important input into the long-term plan is the 'Complex programme of scientific and technical progress for the next twenty years.' It was originally intended to cover the period from 1976 to 1990, but was only completed in 1979, with the period extended to 2000. Recent references have appeared to a programme to 2005 and even 2010, indicating that as intended the programme is being updated in five year periods.

The programme includes two sections, for scientific and technical problems, work on which is headed by GKNT's S.M. Tikhomirov and conducted by 16 special commissions, and for socio-economic problems, directed by the Academy's N.P. Fedorenko working with 11 commissions. A

special joint scientific council of GKNT and the Academy, headed by Academy vice-president V.A. Kotel'nikov, oversees the whole project. About 2000 scientists and specialists have been involved [44, pp. 113–114], [57, pp. 41–48].

The programme itself has not been published but scattered reports suggest that it is based on desirable and hopefully feasible changes in the economy and society, although it presumably also lists the new technologies and products which are to bring about those changes [57, p. 36]. The following goals are examples of those apparently contained in the Programme:

- Accelerate the rate of growth in labour productivity throughout the economy;
- Significantly reduce the consumption of metal in industry (between 1981 and 1990 the metal content of machinery can be reduced by approximately one-third, and in construction work by 15–20 percent);
- Raise in the next ten years productivity in land use and livestock production by 20–30 percent, which should allow, in conditions of reduced production losses, the resolution of the agricultural problem even with some reduction in agricultural land and a stabilization of herd size [21, p. 46].

Once the Complex Programme, divided into five-year periods, is drawn up – it should be ready in up-to-date form two years before the beginning of each new Five Year Plan – Gosplan uses it, plus other long-term goals set by the party, to determine the basic direction the economy is to take over the next ten years. The ten-year long-term plan for economic development is then drawn up.

On the basis of the long-term plan the regular Five Year Plan is put together. It includes a Five Year Plan for Scientific and Technical Development, which in turn contains two sections – a section for basic scientific and technical problems, for which GKNT is responsible, and a section for *vnedrenie* under the control of Gosplan. The Eleventh Five Year Plan was foreseen as containing 160 programmes, of which 38 would be concerned with the broad application of already existing technology (these are called 'goal-oriented complex scientific-technical programmes'), while 122 would be concerned with developing new technologies (these are called 'programmes for major scientific-technical problems') [57, p. 30], [76, p. 96]. It appears that in fact 170 programmes were eventually included. These programmes are apparently quite detailed. They might be expressed in terms of achieving a particular economic goal or of developing particular technologies or products. As an example of the former we can take the 'grain programme' of the Eleventh Five Year Plan. Its goal was to raise the gross harvest of cereal, pulse and maize grains by not less than 25 percent and raise the productivity of labour 20 to 30 percent. The programme set out the areas in which work was to be done to achieve these indicators. It set out stages and periods for fulfilment and named lead and other institutions. Over 250 scientific organizations from nine ministries and agencies were involved [70, pp. 48–49] As an example of the latter type of programme, aimed at specific technologies and products, we can mention the programme for the development of 'blocks of machinery for automated large-scale chemical production'. It contains five basic tasks (*zadaniia*), divided into 16 jobs (*raboty*), 61 stages and 120 substages. One task is 'to establish the equipment for production lines for the production of ammonia with a unit capacity of 1200–1500 tonnes per day.' [33, p. 115].

Another important plan, but one which is not included in the state Five Year Plan, is the five year plan for natural and social science research, drawn up and supervised by the Academy of Sciences. It is concerned with fundamental research for which no practical application is foreseen in the plan period [1, pp. 158–164].

'Research-production' cycle. It is intended that the programmes that make up the Five Year Plan for Scientific and Technical Development cover all stages of the 'research-production' cycle. The first programme, introduced in 1976, included funding and equipment allocations and generally took projects up to prototype stage. From 1981, the beginning of the Eleventh Five Year Plan, programmes were expected to take a project through to the organization of series production and large-scale *vnedrenie*.

Interbranch cooperation. It is inevitable that such programmes involve many organizations, often from different branches of the economy. For example, the ammonia programme mentioned above involves 17 ministries and agencies, about 75 research and design organizations and over 60 industrial enterprises [33, p. 115]. Up to 1976, before

scientific problems were listed as programmes in the scientific and technical Five Year Plan, the necessary cooperation was supposed to have been obtained through coordination plans. These plans were drawn up after the publication of the Five Year Plan, on the basis of direct contacts between the organizations involved. They were to bring about a proper division of tasks and integrated scheduling. The plans were confirmed by GKNT, which also nominated a lead organization, usually a ministry, which would take on the operational management of the work and which was also expected to find the necessary funding.

The coordination plans came to be seen as in-sufficiently goal-oriented, in that implementation of a project listed in the Five Year Plan depended on the interpretation given it by the cooperating organizations. There was also the problem that they could be arranged only after the Five Year Plan and the individual plans of the organizations involved had been determined. Also they apparently did not include complete funding and supply details. Thus a call was made at the 25th Party Congress in 1976 for the introduction of national goal-oriented research programmes with priority access to funding, personnel and resources. The relevant changes were made to the new Tenth Five Year Plan. The programmes listed the part to be played by all participating organizations, while as with the coordination plans, a lead organization would be designated to exercise operational control. (Coordination plans continue to exist, apparently either covering specific projects involving a simple bilateral relationship, with the Academy often on one side, or as part of research programmes. In 1982 the head of the scientific-technical administration of the Ministry of Chemical Industry referred to 365 joint projects contained in coordination plans with the Academy, for the Eleventh Five Year Plan, of which 239 were part of goal-oriented programmes [40, para 7][51, pp. 37–39]).

PTsM at lower levels. If the new programmes being determined at higher levels were to be efficiency implemented, it was considered that a centralization was needed of science management within the branch ministries. Changes in this area had begun quite early, with in 1969 the Ministry of Electrotechnical Industry on an experimental basis giving greater control of the science planning process to the central apparatus and head institutes, and attempting to consciously develop integrated 'complex' plans [1, pp. 175–176]. Then in 1972 a major new experimental form of science management was introduced into a number of ministries, particularly the Ministry of Chemical Industry and the Ministry of Instruments, Means of Automation and Control Mechanisms. The experiment introduced the work-order (*zakaz-nariad*) system, meaning that resources for R&D work were no longer allocated by the ministry to individual institutes, but rather to particular projects. All the details and stages of each project, including its economic justification, are included in the work-order. Usually a head institute is put in charge of operational management of the project. At the same time funding of R&D work within the ministry was centralized, with a 'unified fund for the development of science and technology' being established in each ministry, usually financed from the ministry's planned profits or planned volume of sales. Once the state Five Year Plan included programmes in its science section, those for which a particular ministry was head organization could be transferred to the ministry plan as a work-order with little difficulty. Work that had to be done outside the lead ministry would be done on a contract basis, financed from funds allocated in the work-order [9] [39].

By the beginning of 1978 a further ten industrial ministries had been transferred to the new system, with another five being transferred in that year. By 1981 all industrial ministries had at least formally been transferred, although in practice the situation seems to be somewhat different [55].These changes meant not only that it would be easier to include the all-Union programmes listed in the Five Year Plan in the plans of the ministries, but that bilateral and intra-branch research would also be done according to *PTsM*. Programmes are now set up between branches, including between the Academy and ministries [42] or within single republics, branches and even institutes [47]. This required not only changes in planning and funding arrangements, but also organizational changes. The existence of programmes cutting across institutional boundaries, with the selection of head institutes and project managers, meant that the old institutional hierarchies had to be modified. The need to combine the traditional linear-functional hierarchies with a project approach produced a great interest among academic students of mana-

gement in US matrix structures. Some Soviet institutions indeed claim to have introduced matrix systems. [2, pp. 464–465] [4, pp. 72–74, 167] [34, Ch. 4] while throughout the Soviet R&D system debate continues about the proper powers to be given to lead institutions and project managers.

Regionalism. The final aspect of *PTsM* is its use at the regional level. The 1970s saw a great new emphasis on territorial management of the economic system. Following the fall of Khrushchev and his chaotic *sovnarkhoz* system there had been a strong reaction back in favour of a powerful branch system. But by the 1970s patience with the 'sectional' (*vedomstvennye*) tendencies of the ministries was wearing thin, and moves were made to increase territorial power, which means to a large extent regional party power, as a counterweight to the ministries. This was happening at the same time as Siberia and the Far East were being developed, something which needed a regional approach.

A new system of territorial planning was introduced in 1973 and 'territorial-production complexes' were set up, particularly in Siberia and the Far East. The new trends were discussed at the 25th Party Congress in 1976, which was followed by the setting up of regional science centres with very heavy local party involvement [12, pp. 52–54]; the working out under the supervision of local party leaders of regional 'plans for socio-economic development'; and the establishment in the union republics of republican councils for scientific and technical progress, responsible for supervising republican research programmes.

The July 1979 joint decree gave further impetus to these developments with a call for greater territorial planning. It was followed by a great burst of publicity for the Ukrainian regional science centres and the setting up of new ones, increasing calls for the establishment of new regional economic coordinating bodies, and greater use of regional and republican programmes. Since the death of Brezhnev the emphasis has continued, although without major administrative charges.

All the indications are that *PTsM* have been adopted formally on a large scale. Large numbers of programmes exist at all levels of the system and covering a wide range of industries and technologies. Official administrative procedures have been published, while party leaders make their commitment clear. About 25 percent of research funding in both the Tenth and Eleventh Five Year Plans was said to have been allocated to research programmes at the all-Union level [50, p. 182]. It is claimed that 39 billion roubles were spent on such programmes in the Eleventh Five Year Plan, which were to produce about 25 percent of new products, machinery, techniques and fuel savings [44, p. 118]. About three times this amount has been allocated in the Twelfth Five Year Plan [32]. We have no data on the extent of use of *PTsM* at branch, regional and institute levels. One guesses that another 25% of research funds might go on research programmes below the all-Union level. (In 1971–75 in Czechoslovakia goal-oriented research took 60 percent of all science funding and in Poland 70 percent [17, p. 260].)

Despite these signs of a strong commitment to *PTsM*, what we do not have are detailed descriptions of the new processes actually at work. This might be a matter of official secrecy, although outside the defence sector one can see no reason for such secrecy; it might be because the final results of programmes have not yet begun to work through; it might be because in practice nothing has been done or has been done purely formalistically.

If *PTsM* were being applied seriously one would expect to find greater centralized control, exercised primarily by Gosplan and GKNT, of the R&D process and of technological change in general, and therefore a greater emphasis on major new technological breakthroughs rather than an 'incremental' approach. One would also expect to find an easing of the perennial Soviet problem of excessive and inefficient capital investment. Finally we would expect to find more interbranch cooperation in R&D and a reduction in the overspecialization and autarchic tendencies of the ministries. Of course these are precisely the things that continue to attract the critical attention of Soviet leaders, Gorbachev's speech to the June 1985 Central Committee conference on scientific-technical progress being a good example.

How far then has the rather complex *PTsM* system succeeded in either being implemented or achieving its goals of establishing firm priorities for Soviet R&D, ensuring the efficient investment of resources for the achievement of these goals, and ensuring the necessary integration of different branches of the economy and all the different stages of the 'research-production' process?

I will approach the question by looking in turn at the two main features of *PTsM*, *kompleksnost'* (comprehensiveness) and *tsel'nost'* (goal-orientation).

As far as *kompleksnost'* is concerned, the first thing to strike one is how un-comprehensive and unintegrated the programmes are. If a particular project is to traverse the whole 'research-production' cycle it will find itself in three different major plans with different supervising agencies. The plan for fundamental research is the responsibility of the Academy of Sciences; the applied R&D stage is the responsibility of GKNT; while Gosplan draws up the *vnedrenie* programmes. Belorussian data show that the distinction between the different stages can be made in terms of the working institutions as well as the supervising agencies. Academy institutes and universities concern themselves with the first stage, while branch institutes concentrate on the latter two stages. Only 14 percent of programme projects worked on in Belorussia during the Tenth Five Year Plan were worked on jointly by more than a single institute, and only 11 percent involved interbranch cooperation [47, p. 72].

It might make sense to keep the fundamental research stage separate – there is little point in mapping out a whole development and production programme if the basic scientific problems have not been ironed out. However, such separation is likely to make more serious the problem of 'creeping sophistication', the habit scientists have of ignoring or putting off the final goal in order to pursue interesting but perhaps distracting and non-essential scientific enquiries.

The separation of the development and *vnedrenie* stages, and more importantly, their subjection to different agencies, would seem to be a more serious shortcoming. There is a strong suspicion that Gosplan tends to be more interested in output than innovation, and is likely to protect branch ministeries from excessively innovatory demands. There are indications that programmes, even those listed in the Five Year plan, do not always include the *vnedrenie* stage. In the Ukrainian Ninth Five Year Plan 21.4 percent of R&D listed was considered completed at the end of the research stage; 64.6 percent once experimental (*opytno-konstruktorskaia*) work had been finished; and 14 percent following production testing [3, pp. 105–106], [54, p. 158], [55]. It is not impossible that this is the result of Gosplan's refusal to include projects in the *vnedrenie* section of the Five Year Plan. Gosplan and GKNT do not have a record of good relations, and they would seem to represent very different interests within the Soviet system.

Even if a programme is included in the Five Year Plan through to the *vnedrenie* stage, there is considerable evidence that Gosplan and the ministries are able to give programme fulfilment decidedly second-priority status. This is made easy by the fact that eventually even the most important national programmes have to be broken up and included in the regular plans of ministries and institutes, where they have to compete with plans containing projects of purely branch and institute priority, and finally in the production plans of enterprises. A deputy chairman of GKNT recently criticized Gosplan for failing to include in ministries' yearly plans the programme tasks that had been included in their five year plans [75]. The ministries are also subjected to regular criticism for these faults [30, p. 67], [44, p. 80], [46], [57, p. 76].

The problem seems to be two-fold. Firstly, the lead ministry, which has responsibility for funding the entire project, is interested in the programme only to the extent that it furthers its own sectional interests. It has no interest in spreading the benefits of the research done to other ministries. It also has no interest in extending the programme into fields which will not directly benefit it. In such cases the programme will become little more than the personal R&D project of a single ministry, with funding allocations reflecting that fact. Alternatively, the lead ministry will have no particular interest in the programme at all, in which case funding will not be allocated to the programme or be diverted from it to non-programme tasks, while the necessary capital investment and supply plans are left unfulfilled. The lead ministry has no power to force other ministries to contribute to the funding, which increases its incentive not to fulfil programme-funding targets. Increasing the formal responsibility of the lead ministry without giving it extra power does not help. It only produces what one Soviet commentator calls 'a liberal attitude' to accounting procedures, that is, faking the figures [58, p. 123]. As summarized by Ronald Amann:

If the attempt [to apply defence methods to the

civilian sector] is half-hearted, it is almost certain that traditional malpractices will begin to re-establish themselves. This stricture applies with particular force to the introduction of programmed planning which without real resource priority and support from the centre is likely to remain a toothless administrative superstructure laid upon a base of departmental rivalries. [2, p. 36].

There are two popular approaches to solving this problem. Firstly, give more power to the lead ministry. Even Marchuk, chairman of GKNT, has demanded that a special section of state plans be set aside purely for research programmes, and that lead ministries be given all necessary resources and powers for the fulfilment of these programmes [30, pp. 67–68]. This is presumably a sign that he recognizes that GKNT itself is not in a position to take over the management of all programmes. Nevertheless, fears that giving lead ministries greater powers will only encourage them to use programmes and any priority funding they might attract for their own sectional interests have led to demands that greater programme management powers be given to GKNT [1, pp. 166, 213–215], [30, p. 71] [31] [46] [65, p. 99]. Most suggest that GKNT would exercise these greater powers through interbranch councils of outside experts, although some consider it necessary that GKNT have considerable 'in-house' research capacity of its own [67, pp. 58–68]. There has also been considerable support for a greater role for the Academy of Sciences in R&D management, with references to its greater 'objectivity' derived from its lack of branch subordination [12].

However, these changes have either not been implemented or implemented so irresolutely that the signs of non-integration of R&D programmes remain. The programmes tend to be limited to a specific part of the 'research-production' cycle and be divided into overly independent stages; sectional interests are still too strong to make possible a common commitment which might lead to *de facto* coordination and cooperation; which makes it almost inevitable that the proper balance of power and responsibility for lead organizations is impossible to find.

Turning now to *tsel'nost'*, there are signs that *PTsM* programmes are also lacking in this virtue. We are hampered in our evaluation by lack of access to the full detail of the programmes, but the goals and designations that we do know are alarmingly vague. The goals of the higher-level programmes appear to be improvements in usually vague economic indicators ('accelerate the rate of growth of labour productivity throughout the economy'). Only occasionally are they more specific ('reduce metal used in construction work 15 to 20 percent'). Lower level programmes have such blunt designations as 'Labour', 'Energy complex', 'Metal', etc. and such vague goals as 'build and introduce into production new catalysers to replace imported ones.' [21, p. 46]. One assumes that the programmes are therefore made up simply of collections of any or all research projects that could contribute to such goals. Soviet commentators admit that programmes often take such a form, and indeed suggest that some programmes are no more than the invention of institutions and individuals interested in the priority funding for their own 'pet' projects they might get as a result [55], [57, p. 90].

Another factor leading to lack of *tsel'nost'* is the continuing fragmentation of funding of programmes. As we saw above, lead ministries are expected to provide funding for interbranch programmes. If this expectation is enforced they are reluctant to give the programme a truly interbranch character. To overcome this, multiple sources of funding appear to be still the rule [50, p 253]. This leads to complaints of a dissipation of goal-orientation and further demands for the granting to GKNT of the exclusive right to fund major interbranch programmes [50, p. 282].

There is certainly nothing about the goals of the programmes as we know them that suggests anything of the urgency, clarity, excitement and single-mindedness of 'build a bomb within five years' or 'get a man to the moon by 1970'. Both Soviet and Western experience suggests that these are the kinds of goals that are needed for a major R&D programme if it is to meet with success.

Given these limitations it is perhaps not surprising that *PTsM* programmes show every sign of usually being little more than compilations of projects that would have been undertaken anyway, with funding coming in the usual way. While the *PTsM* process might improve communications and therefore lead to a voluntary increase in interbranch cooperation, there is nothing about *PTsM* as reported publicly that suggests that significant

changes have been made in R&D planning and management procedures. Certainly there are few signs that the Soviet Union is having any more success than it has in the past in resolutely pursuing radical new technologies at the expense of 'incrementalism' or in reducing the overspecialized autarchism of the branch structure and the wasteful investment practices it produces.

However it would seem too early to write off *PTsM*. The commitment still seems to be there, with the changes that Gorbachev suggests are to come all being compatible with *PTsM*, particularly increasing the powers of the central agencies at the expense of the ministries. If Gorbachev is able to change the balance of power within Soviet R&D and economic management – a very big if – *PTsM* could well come to have a more substantial effect on R&D planning than it seems to have had so far. This would seem to require at the very least the granting of true administrative powers to central agencies with some commitment to technological change, and providing *PTsM* projects with obligatory status over and above the tasks set out in regular branch production plans.

So far the talk has been of problems of implementation. However it is worth considering the more general question of whether there might be some problem of conception, firstly, that there are inherent problems of the Soviet R&D system which receive no attention; secondly, that there are aspects of the approach which are misguided.

User incentive. One of the biggest problems of the Soviet R&D system is the lack of involvement of the customer, the end-user, in the process. *PTsM* aimed to attack this problem by integrating the R&D process from beginning to end as much as possible. But, as we have seen, success has been limited. Programmes remain far from integrated, with the *vnedrenie* section often left out altogether.

But the problem goes deeper than simply poor implementation. Firstly, one has to ask whether the end-users are given sufficient opportunity to involve themselves in the setting of the goals of the *PTsM* process. As American commentators have pointed out in connection with their country's experiences, goal-oriented research is just as likely to be taken down blind alleys as freely chosen research, if it is still the scientists who determine the goals [23, p. 153]. They state, therefore, that end-users should be involved in project selection [29, p. 17]. From what we know of the Soviet system of forecasting and long-term planning on which the major *PTsM* programmes are based, the scientists there are very much in charge, with them seemingly dominating the Academy and GKNT councils and commissions which draw up the top-level programmes.

US commentators further stress that end-users must be intimately involved in the R&D process throughout if the innovation process is to succeed. In the case of large-scale, government-funded projects the project manager is very often the end-user, or at least very close to that end of the chain (the Navy's Bureau of Ships in the case of nuclear submarines, the Special Projects Office in the case of Polaris, and NASA in the space programme); in private industry new products are often developed in close collaboration with customers and sometimes even on their premises [43, Ch. 6]. Soviet reports of successful innovation show that those involved there also well understand the importance of the close involvement and interest of the end-user. But there the formal customer (*zakazchik*) for the biggest programmes is GKNT or Gosplan, that is, a bureaucratic agency [40, para 8–9], and the project manager is more likely to be one of the developers of the project that one of the users. Even in programmes which go through to the *vnedrenie* stage, the 'producer' organizations involved are likely to be the machine tool ministries that develop and make a new product or the equipment for a new process, rather than the user of the product or process (for example, the Ministry of Machine Tools (Minstankoprom) is more likely to be involved in developing NC machine tools then, say, the Ministry of Automobile Industry in whose factories the machine tools will be used). The problem is often, therefore, as much the gap between the producer and the user as between R&D and the producer. This long neglected aspect of the problem is clearly entering into the consciousness of Soviet writers, as we see from the appearance of a new slogan 'science-technology-production-use', with 'use' being a recent addition to the sequence [44, p. 132].

The problem is not only that Soviet planners do not see the importance of the user. Rather it is that the system has not been able to provide the producer or user with the desire for new technology. There is nothing in *PTsM* to attack this age-old Soviet problem. While recent decrees have made R&D programmes part of the obligatory state

plan, industrial ministries and their managers have long understood that there are parts of the plan which can, indeed must, be ignored, if the most important indicator, volume of output, is not to be jeopardized. *PTsM* have done nothing to remove the second class status from new technology and *vnedrenie* plans. Efforts to encourage a positive attitude to innovation through the manipulation of prices have also failed [5]. The ever greater reliance on research bodies, particularly the Academy of Sciences, to push forward new technology, is a practical recognition of these failures. But such policies seem inevitably destined for failure as long as the problem of lack of producer or user interest in innovation remains unsolved. Indeed, any efforts to reform the R&D system are unlikely to succeed while this problem remains.

Over-management. It is interesting that American versions of *PTsM* gained their greatest popularity in the US corporate world around the end of the 1960s, as a result of increasing financial stringency. Earlier, with lots of money around (and new markets more easily found and exploited), research management theory and practice stressed the value of independence for R&D personnel. "In the 1950s and early 1960s, firms frequently did not try to manage R&D in much detail. Subsequently, many firms began to emphasize control, formality in R&D project section, and short-term effects on profit. This shift in emphasis has tended to reduce the proportion of R&D expenditures going for basic and risky projects." [29, p. 16]. As a vice-president for R&D of one major firm said:

> At the high cost of R&D, we can no longer afford to plan and manage it in a random manner. It has to be very closely tied to strategic business planning. [71, p. 33].

Perhaps not coincidentally, *PTsM* became a major strategy in the Soviet Union only a little later, at a time when, firstly, technology was identified more strongly than ever as the USSR's hope for the future, and secondly, when funding for research was being squeezed by demands for military and agricultural investment. The American experience shows that the reflex is not peculiar to the Soviet Union, but surely it is a reflex particularly well developed there; if something is very important, it must be highly managed, particularly if resources are tight. *PTsM*, and indeed all recent developments in Soviet research management, seem to be a classic example of such a reflex. As Eugene Zaleski recognized, the purpose of the replacement of coordination plans with complex goal-oriented programmes, was simply to establish more control over the R&D planning process. [73, p. 19] The present problems of *PTsM* are attributed in Soviet sources to the lack of detailed documents setting out procedures and the strict division of responsibilities between the various organizations involved. [1, p. 22] [19, p. 149] [66, p. 31] But one of the common features of successful American versions of *PTsM* has been the lack of strict definition of responsibilities.

Soviet scientists regularly and publicly criticize the over-bureaucratization of science. Many of their arguments against over-centralized goal-oriented planning are convincing and are supported by an extensive Western literature. They complain, or strongly imply, that too often the actual implementation of planning is in the hands of incompetent planning officials with no understanding or knowledge of science; that an excessive concentration on management methods both stifles creativity and distracts attention from the final goal, this being particularly so in systems with many stages and strict hierarchies of responsibility through the stages; that long-term goal-oriented plans tend to be inflexible and difficult to cut off even when success will clearly never arrive; and that if a programme is overly self-contained that inflexibility is likely to be particularly great, and indeed the over-specialization that *PTsM* were designed to overcome will again become a problem.

It is interesting that in the last few years in the US there has been a strong movement against the overbureaucratization of science, particularly when applied to project management systems. A suspicion that a perceived slow-down in US innovation can be blamed on the overmanagement of science, the experience of the deregulation of a number of industries, and the shifting of the focus away from traditional highly concentrated industries to the new 'entrepreneurial' industries have produced a new emphasis on the values of small size, the encouragement of competition and duplication even within a single firm, a willingness to try endless new products untill a winner is found, a reliance on the personal skills of project managers

rather than systems, and a commitment to 'entrepreneurial culture' to provide integrative mechanism within highly flexible organizational structures [43], [53]. Those writing in this vein are at pains to stress that they are not claiming that large organizations cannot be innovative or that management and planning systems should be abandoned completely. Techniques such as PERT can be, and are still used to provide a broad view of a programme, but their detailed and bureaucratic supervisory functions should be ignored [7]. Large firms should try to behave as if they are small firms, or more accurately a conglomeration of competing small firms. The new entrepreneurs should use, but not allow themselves to be stifled by financial and marketing specialists. If they are in a large firm they can be supported by the more structured part of the firm. Strategic corporate planning still has an important role to play, but as the basis for building a 'corporate culture' rather than the first stage of an elaborate bureaucratic process. One wonders whether such a free and easy approach will survive the drying up of the easy profits that have come from dramatic technological breakthroughs in very new industries. However at the moment the approach is dominant and would seen to have a lot to recommend it.

Given that some Soviet scientists have apparently long been aware of the value of this type of approach [69], and that today's research management theorists clearly play considerable attention to American trends, one wonders whether we shall find a similar reaction against over-bureaucratized *PTsM* in the Soviet Union. While influential members of the scientific establishment are clearly less that happy with present Soviet research management [31], there are no signs of a serious opposition campaign such as was evident in the second half of the 1950s. The one slight sign of a move for greater flexibility and decentralization, beyond the regionalization mentioned above, is renewed interest in *Fakel*-type innovation firms. *Fakel* was the Novosibirsk prototype of a large number of organizations which sprang up more or less spontaneously throughout the Soviet Union from about 1966. They were loose-knit groups of specialists who in their spare time accepted contracts from institutes and enterprises for development work. Both the contracts and the work groups involved were highly flexible, and the rapid growth of the organizations indicated that they were meeting a real need. However, despite the support of senior scientists and regional party leaders, the organizations were closed down in 1970 on the grounds that they failed to meet the conditions required to be treated as socialist enterprises and therefore could have no legal status in the eyes of the Soviet planning and financial authorities [28]. Even since, there have been complaints about their disappearance, complaints that have become somewhat louder and more common in recent times. [60] One 1982 publication even refers positively to the success of similar organizations in the US as justification for their reestablishment in the USSR [4, pp. 74–75]. These calls come at the same time as economists concerned with economic management in general are increasingly criticizing the traditional 'command economy', the best-known example being Academician Zaslavskaia's leaked discussion paper. Other economists talk of privatizing some service and light industries and refer nostalgically to the economic decentralization of the New Economic Policy of the 1920s. [8], [59], [61].

There are no signs of an official response to such demands. The new engineering centres of the Ukrainian Academy of Sciences are described as having some of the features of *Fakel*-type firms [30], while recent decrees on research management show some vague signs of bureaucratic relaxation, such as encouraging temporary scientific-production associations and reintroducing one-off bonuses. However all this is overwhelmed by a primary concern with the bureaucratic refinement of *PTsM*, tighter high-level party control, a greater use of regional programmes (these are more susceptible to control by the party apparatus), and the manipulation of plan indicators, prices and bonus systems to encourage innovation [37]. The disappearance of *Fakel* and its brothers for classic bureaucratic reasons can hardly be considered surprising. Such private and unplanned initiative threatens not only the positions of powerful bureaucratic interests, but also the entire bureaucratic basis of the party's post-terror control of the population and economy. If even such limited developments as *Fakel* are unacceptable, one can only be very pessimistic about the possibility of an 'entrepreneurial revolution' in the USSR. There, big is still beautiful, duplication and competition are signs of waste and inefficiency, systems are still more reliable and controllable

than individuals, and the 'culture' tends to discourage both creativity and innovation [25].

3. Conclusion

It would be wrong to suggest that *PTsM* has been or must be a complete failure. The historical and foreign experience on which Soviet planners have based the new approach is valid, while recently some successes appear to have been gained, for example, if we can believe the reports, in overcoming Western technological embargoes [72, pp. 10–11]. However, the general conclusions of the most detailed studies of the level of Soviet technology, is that Soviet technological performance is inadequate [2]. Soviet commentators, including those most directly involved in the Soviet implementation of *PTsM*, also express scepticism [10, p. 145] [47, pp. 77–81]. It is interesting to note signs of problems in a number of the most important hitech industries. The performance of the Ministry of Radio Industry and the Ministry of Instrument Making in the computer field had apparently been so bad that the Academy has been asked to open a new Department of Computing and Information Sciences [11], the microbiology industry, the subject of a concentrated goal-oriented programme emanating from the very highest sources, is apparently in trouble [48], [49], Soviet fusion research appears to be bogged down [16], [63], while the Ministry of Energy has been subjected to savage criticism for serious delays in the nuclear power programme (although to be fair to the R & D people, the problems are mainly attributable to long political indecision and then catastrophic construction delays). It is even possible to find criticism of such pioneers of *PTsM* as the Ministry of Electrotechnical Industry for not being interested in the *vnedrenie* of new technology and not fulfilling its new technology plan, and of the Ministry of Chemical Industry for not being able to develop a unified policy of technological development for the chemical industry [2, pp. 205–206, 495], [20], [27].

The true successes of goal-oriented research have been cases where there have been very specific tasks which have been given the highest priority and for which a degree of enthusiasm has somehow been produced among the people involved. As a result of having the very highest priority the worst of bureaucratic control could be avoided. In any system at any time, therefore, the approach might be expected to be applicable to a very limited number of big problems. One wonders whether the approach, even if fully implemented, will contribute any more than the traditional approach to the broad-scale and essentially pedestrian tasks of innovation in the old-established industries, such as machine building, and whether the bureaucratic nature of *PTsM*, if widely applied will not in fact stifle development in the new 'sunrise' industries.

There is something about *PTsM* which is typical of the situation in which the Soviet Union presently finds itself. Its social and policy sciences are well enough developed to usefully analyse past, present and foreign experiences and to arrive at solutions that appear to offer hope of success. And yet any such solutions are inevitably within the framework of the old Marxist belief that socialist planning can guarantee 100 percent efficiency and that any competition is 'wasteful' and must be avoided. This economic doctrine, coupled with a desire for total political control, guarantees a commitment to overbureaucratized solutions.

That, of course, is assuming that *PTsM* are actually implemented. But perhaps the most interesting lesson to be learnt from the history of *PTsM* for students of the modern Soviet state is the failure of implementation. Despite clear historical and foreign models which have been worked into complex but comprehensible modern management procedures, implementation shows two typical problems of the Brezhnev and, as far as we can tell so far, post-Brezhnev era. Firstly, the leadership, with a pathological aversion to Khrushchev's 'hare-brained schemes' and a horror of upsetting established bureaucratic interests, approaches a fashionable concept with a degree of caution that borders on half-heartedness. Secondly, the established bureaucratic interests are able to treat these half-hearted measures with a disdain that borders on contempt, with both the spirit and the letter of the reforms being ignored.

The history of *PTsM* shows that the USSR is now a modern industrial state, making use of modern industrial and technological methods. But the inevitable narrowness and inflexibility in implementation of those methods ensure that it will still for many years to come struggle to catch up to its Western rivals.

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