INTEGRATION IN THE COUNCIL FOR MUTUAL ECONOMIC ASSISTANCE : SCIENCE AND TECHNOLOGY

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CERTIFICATE

This is to certify that the dissertation entitled **'Integration In The Council For Mutual Economic Assistance : Science and Technology'** is hereby submitted in partial fulfillment of the degree of Master of Philosophy of the Jawaharlal Nehru University to the Centre for Soviet and East European Studies.

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PREFACE

This work owes a lot to a number of people. Above all, I would like to express my deep gratitude to my guide Professor Jayashekhar, whose invaluable insights helped me enormously in achieving a proper understanding of the subject. Professor Jayashekhar's professionalism has been a great source of inspiration for me and has constantly encouraged me to give of my best.

I would also like to thank Salil Gupta for helping me with the collection of material. Sunil Naidu deserves my gratitude for assisting me with the editing. The work on this thesis would have been a far more onerous task if it had not been for the help, support and encouragement of Indrani.

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INTRODUCTION

The Council for Mutual Economic Assistance (CMEA) was established in January, 1949 in Moscow, by six East European socialist countries. The founder members were Bulgaria, Hungary, Poland, Rumania, Czechoslovakia and the U.S.S.R. Over the years other countries have become members, viz. German Democratic Republic (in 1950), Mongolia (in 1962), Cuba (in 1972) and Vietnam (in 1978).

Despite the fact that the CMEA countries as a whole achieved significant successes in terms of industrial production and growth in national income over the subsequent decades and established themselves as one of the world's leading economic blocs, towards the end of the 1970s, declining growth rates in these economies became apparent. This phenomenon was aggravated in the 1980s and brought to the fore the severe limitations of, what is widely termed in the CMEA as, the 'extensive' path of development. It manifested in the proliferation of new investments; setting up of new plants, factories etc, and not paying sufficient attention and importance to the modernization of existing plants and factories and reform of the economic management system.

The limitations of the 'extensive' path were further accentuated by the constraint in financial resources, the lower accretion to the labour market of new labour force and the continued depletion of the comparatively more easily accessible sources of fuel and raw-materials.

The deficiencies of the 'extensive' growth model were also aggravated by a number of other developments in the 1980s. The fall in oil prices led to a sharp decrease in the foreign exchange earnings for the Soviet Union which heightened the difficulty of going in for modern Western equipment and machinery. The foreign debt piled up by the CMEA countries, Poland in particular, and the increasingly high cost involved in servicing it brought about a further worsening in the resources position in general and the foreign exchange position in particular.

The economic development involving the setting up of ever new factories and enterprises and laying great stress on quantitative output indicators has given rise to tremendous wastage. There is a considerable degree of obsolescence in the massive capital assets accumulated over the years. The employment of obsolete equipment and machinery and outdated technological processes has in turn led to ever greater consumption of energy, fuel and raw materials. It has also led to overstaffing in factories and enterprises and given rise to problems regarding labour productivity and the capital output ratio.

The usage of old technologies and equipment has left its mark in the end-products, which while sometimes, and not always at that, being abundant in number, leave a lot to be desired in terms of quality, durability and consumer-acceptance in general.[1]

The CMEA countries therefore find themselves in a bind. The earlier three engines of economic growth viz. fresh capital investments, the influx of people into the labour market and the abundance of accessible organic fuels and raw materials have run out of steam and the continued dependence on the old methods and old technology would have led to a further depletion of these resources. As a result of these deficiencies the net average growth of national income in the CMEA bloc as a whole fell

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1) For a discussion of economic ills afflicting the Soviet Union for instance, see Colton T.J., "What Ails the Soviet System?" in The Soviet Union in the 1980s, Hoffman Erik. P.ed., Academy of Political Science (New York, 1984).

to 1.8% in 1981.[2)]

In order to overcome these unfavourable and stultifying effects on the national economies, the CMEA countries adopted the so-called 'intensive' form of development.

The intensive growth policy, includes reforms in the economic management system, structural changes and introduction of advanced technology.

The increasingly greater role played by science and technology in the achievement of social and economic goals was amply evident in the postwar resurgence of the Western economies. Policy makers in the CMEA countries were slow to appreciate this fact partly because of their early successes with the 'extensive' growth path and partly due to systemic rigidities.

At the policy level, it was only at the 24th Congress of the Communist Party of the Soviet Union in 1971 that Brezhnev spoke of the need.... "to combine organically the achievements of the scientific and technological revolution with the advantages

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2) <u>Mir Sotsializma V Tsifrakh i Faktakh 1985. Spravochnik</u>, Politizdat, (Moscow, 1986), p.16.

of the socialist economic system".[3] In other words, Brezhnev emphasized the need to utilize science and technology as a key factor of material production and to harness its potential to solve the pressing social and economic problems.

The appreciation of science and technology as crucial inputs into the economic process has led the Soviet Union to involve the other CMEA countries in this venture. This was a step dictated, to a considerable extent, by the Soviet desire to increase its scientific and technological capabilities by linking to itself the technological resources of other CMEA countries in specific areas. The European members of the CMEA, who were faced with the same economic problems as those of the Soviet Union, desired to follow a similar policy to strengthen their own technological capabilities.

Therefore, the policy of cooperation and integration in the field of science and technology among CMEA countries is a very crucial aspect of the entire process of development and growth of the

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3) <u>Materialy XXIV Syezda KPSS</u>, Politizdat, (Moscow 1971), p.57.

national economies of CMEA countries. The integration of science and technology is also now seen as a key step in the development of economic integration of CMEA countries.

Another aspect, which to a considerable extent explains the recent importance accorded to science and technology and the adoption of the Comprehensive Programme for Scientific and Technological Development up to the year 2000 (the CPSTP) is the tremendous progress made by the Western countries, in particular the U.S., in developing the state-of-the-art technologies like composite materials, biotechnology and genetic engineering, super computers and artificial intelligence and others. The known backwardness of the CMEA bloc in these technologies as well as the potential inherent in them for the development of the Strategic Defence Initiative has resulted in the adoption of the CPSTP whichseeks to concentrate in precisely these areas. The CPSTP seeks to pool the scientific resources of East European CMEA countries that are credited with higher level of technological development in some of these specific fields. For instance the German Democratic Republic in micro electronics and Czechoslovakia in biotechnology.

This study therefore, attempts to trace the growth of cooperation in science and technology among the CMEA countries and the evolution of the organisational structures formed for this purpose. It also attempts to analyse the problems confronting the CMEA countries in the realisation of the goals they have set themselves, particularly in connection with the implementation of the CPSTP. The study has concentrated on the European CMEA member countries as the level of involvement of Cuba, Mongolia and Vietname in the sphere of cooperation in science and technology is as yet not very substantial.

Paucity of material and factual data on development of scientific and technological cooperation in CMEA has been a major constraint in the preparation of this dissertation. The subject itself is new and the scant material that is available is in different languages. The inadequate development of library facilities on CMEA in India imposes formidable difficulties on anyone who wishes to investigate the subject. Therefore the present dissertation had to be prepared based largely on the material that is available in Russian and English. This has affected in a large measure the present study. A proper understanding of the subject and development of a balanced perspective on it is difficult without access to material from East European countries. Unfortunately there is no access to such material for a scholar working in Delhi. Even the material in Russian and in English is either too general or outdated. However, within these severe constraints an attempt has been made to examine the nature of cooperation in science and technology among the CMEA countries, the forces underlying such cooperation and the problems and prospects for this cooperation.

In Chapter I an effort has been made to trace, in brief, the evolution of scientific and technological ties among CMEA countries. The Plan coordination and the broad framework of cooperation in science and technology has also been discussed here.

Chapter II deals with the emergence and development of various organisational structures, through the medium of which this cooperation is sought to be carried out. Since it is difficult to understand the interaction of systems without understanding the systems themselves, the various organisational structures for the development of science, technology and the introduction of their results into the economy, of the individual countries themselves are described, with special emphasis on the Soviet Union.

Chapter III deals with the CPSTP, the various factors leading to its adoption, the expectations raised by it and the problems involved in its implementation. The five priority areas of cooperation are dealt with separately.

The concluding part of the dissertation assesses the prospects and viability of the process of cooperation and integration in science and technology, both in terms of achieving specific scientific and technological goals and the effort to translate them into economic reality.

It may be noted that this M.Phil dissertation is a part of an ongoing study and a number of questions thrown up here would be tackled in the subsequent Ph.D. thesis.

CHAPTER I

The Evolution of Scientific and Technological Cooperation among CMEA Member Countries.

The economic and political realities prevailing in the East European countries in the aftermath of the Second World War dictated the form and content of cooperation in the field of science and technology among them. Though the Soviet Union suffered by far the greatest depradations in the War, it must be noted that in relative terms the other East European countries had undergone devastation which was truly apocalyptic in nature. Moreover, with the successful evacuation by the Soviets of some of their major industries and scientific establishments to the East, the consolidation of the War economy during the last year or so of the War when the tide had turned in their favour and the considerable spin-offs generated for the civilian economy, the Soviets were placed in a far more favourable situation economically vis-a-vis their East European allies.[1)]

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1) Bykov A.N., Nauchno-Technicheskaya Politika Stran Sotsializma, Nauka, (Moscow, 1978).

In any case, the East European countries, with the exception of Czechoslovakia and the German Democratic Republic (GDR) were by and large agrarian economies with a comparatively low level of development of industry and a concomitantly low level of development of scientific and technological infrastructure. It must also be noted that the disruption caused in the civilian economies by the War and the advance of the Soviet army had resulted in a lot of the members of the scientific community fleeing to the West.

All this, together with the undeniable fact of the pursuit of strategic interests by the USSR, gave rise to ... an exchange which initially had a bilateral character and which in essence meant direct technical aid rendered by the Soviet Union to its allies in carrying out industrialization, in the establishment of the material-technical base of a socialist society."[2] This 'exchange', which

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2) Bogomolov O.T., Bykov A.N., eds., Strany SEV v Mezhdunarodnom Obmene Technologiyei, Mezhdunarodniya Otnosheniya, (Moscow, 1986), p.63.

corresponds to the first phase of formation and development of inter-state relations between the East European countries, was codified in a number of bilateral agreements reached between them in the 1940s and 50s. This state of affairs was projected into the multilateral arena and given a legal basis within the framework of CMEA, in the so-called "Sophia Principles of 1949."[3)]

It has been estimated that for the years 1948 - 1961, when this kind of technical aid was particularly dominant, the Soviet Union gave other socialist countries 31778 sets of technical documentation and received from them 8877 sets. The documentation predominantly concerned heavy industry and approximately 50% of it related to machine building.

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3) Osnovniye Dokumenty SEV v Dvukh Tomakh, CMEA Secretariat (Moscow, 1981). The receiving country had to bear only the costs of physical preparation of documents and their transportation.

However these figures include technical documents given to China.[4] If one were to take into consideration only the East European allies, then in the period 1948 - 1978, the U.S.S.R. handed over approximately 35000 sets of technical documentation to the CMEA countries and Yugoslavia, and received around 17000 sets from them in return.[5]

The benefits and advantages of this kind of an exchange were brought home by Gutiyeva, who estimates that the CMEA countries as a whole saved around 31 billion rubles in the course of the period 1948 - 1975.[6] It has also been estimated that for the years 1948 - 1978 mentioned earlier, an outlay of approximately 20 billion dollars would have been necessitated if the same documentation had been purchased on the world market.[(7)]

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4) Bykov A.N., Nauchno-Technicheskiye Svyazi Stran Sotsializma, Nauka, (Moscow, 1970), pp.68, 69.

5) Vneshnaya Torgovlya, No. 1, 1980, p.9.

6) Gutiyeva R.A., "Sotrudnichestvo Stran Chlenov SEV v Razvitii Nauki i Problemy Povisheniya Yevo Effectivnosti" in Sotsialisticheskaya Ekonomicheskaya Integratsia i Effectivnost Proizvodstva, Oleynik I.P., Kovaleva M.F., eds., Mysl, (Moscow, 1978).

7) Bykov A.N., Po Puti Sotsialisticheskoi Ekonomicheskoi Integratsii, Nauka, (Moscow, 1975), pp.60,61.

The corresponding expenses saved on the world market would by all accounts be a better measure of technical aid rendered by one party to the other. The use of a set of technical documentation cited as a unit and measure of scientific-technological exchange would otherwise presume a near-perfect equality amongst all sets in terms of technical worth as well as non-duplication among them.

At the same time however, together with this kind of 'non-commercial exchange' there co-existed transfer of licenses on a commercial basis. Already... "in the first years of existence of CMEA, the transfer of licenses of scientific and technological applications, which were carried out specifically for the needs and requirements of another socialist country on its orders, was established on commercial principles.[8)] The predominance of the latter form over the former and the increasing ascendancy of commercial principles in the scientific and technological cooperation between socialist countries was officially recognised in the recommendations adopted in the CMEA organs in 1967 and in subsequent bilateral agreements.

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8) Voronov K.G. & Dergachov V.I., Sovremennaya Organizatsia i Technika Torgovli Litsenziyami, Ministry of Foreign Trade, (Moscow, 1976). p. 36 - 38.

The basic principles of trade in licences between CMEA member-countries were put together by the CMEA Committee on Scientific-Technical Cooperation, approved by the Executive Committee of the Council on 26th October 1972 and published in "Organisational-Methodological, Economic and Legal Principles of Scientific and Technological Cooperation of CMEA member-countries and of the functioning of CMEA organs in this field."

This dualism, necessitated both by the fact that the severe limitations and strains of any kind of altruistic aid became apparent to the Soviets pretty soon and by the fact that towards the mid-sixties, the East European countries had advanced sufficiently, in the eyes of the Soviet Union, tobe able to pay for the scientific-technological aid, was further developed, and codified at the apex level in the "Comprehensive Programme for the Further Extension and Improvement of Cooperation and the Development of Socialist Economic Integration by the CMEA member countries" (CPDSEI) adopted in July 1971 and which is regarded as the main political and legal act of the Council's member-countries.[9)]

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9) CPDSEI, Progress, (Moscow, 1971).

In the field of scientific and technological cooperation, Article 3.2 of Section 2 of the Comprehensive Programme talks of ... the handing over of technical documents, samples, licenses, and other results of research and design work by agreement between the interested countries, both free of charge and for a financial compensation as arranged between the countries, in accordance with the scientific and technological level of the documents and their value...."

It is evident however that the 'handing over free of charge' at this stage related practically exclusively to Mongolia to which an entire subsequent article is devoted and to the imminent entry, in 1972, of Cuba.

The disquiet and dissatisfaction over the free transfer of scientific and technical know-how is quite apparent in the works of a number of Soviet authors. Voronov and Dergachov point out that ... it does not create a sufficient material stake in the acceleration of scientific and technical progress, in carrying out research at a high scientific level and does not economically stimulate wide application of new, more effective methods of cooperation on the basis of coordination and concentration of the combined efforts, resources and capabilities"[10)] of both the parties. Some authors pointed out that the easy accessibility to all kinds of technical documentation created piquant situations whereby the receiving countries themselves went in for the manufacture and export of similar products thus competing with the giver-country in external markets. Bogomolov admits that to a certain extent and this practice held back the transfer of latest results and know-how, especially when these results had been achieved at considerable efforts and cost, and which in turn affected adversely the viability of scientific and technical cooperation.[11)]

The evolution of commercial and legal aspects of the development of scientific and technical cooperation between CMEA member-countries was accompanied by the gradual perfectioning and improvement of

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10) Voronov K.G. & Dergachov V.I., <u>Sovremennaya</u> .... op.cit. p.38.

11) Bogomolov O.T., "Sotrudnichestvo Stran SEV na Vazhnom Rubezhe" in <u>Kommunist</u> No.18, 1966, p.21, 22; also Gvishiani D., "Nauchno-Technicheskoe Sotrudnichestvo na Sluzhbu Kommunizmu" in <u>Kommunist</u> No.11, 1968.

planning methods as a means of regulating this exchange, which allowed the coordination of this activity taking into consideration the national economic strategy of every member-country.

The initial steps in this direction were the bilateral and multilateral forms of coordination of scientific and technical achievements devised by the member-countries as an integral part of the coordination of their economic plans as a whole.

In effect, this kind of coordination really took off only after the CMEA countries started coordinating their economic plans beginning from the 1956-60 five-year Plan.[12] In May, 1956, at the 7th Session of CMEA, 8 permanent branch commissions were set up. Among their functions was - coordination of Research and Development (R&D) agreements, exchange of scientific and technical information, organisation

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12) For planning of R&D in CMEA countries and for plan coordination see Krasnoglazov B.P., Planirovanie Nauchno-Technicheskovo Progressa v Stranakh Chlenakh SEV, Ekonomika, (Moscow, 1982).; also Nolting Lonvan, "Integration of CMEA Science and Technology" in The Soviet Economy in the 1980s: Problems and Prospects, Joint Economic Committee, Congress of the United States, (Washington D.C., 1982) Part I.

of international conferences etc.. Indeed the first major multilateral undertaking of CMEA - the international research centre at Dubna, relates to this period viz. March, 1956.[(13)]

In 1962, at the 16th Session of the CMEA, the permanent commission for coordination of scientific and technological research was set up to serve as a clearing house and a general contact agency for national scientific organisations. During the period 1964-70[(14)] the CMEA member-countries first adopted

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13) The agreement for the establishment of the Unified Nuclear Research Establishment Institute at Dubna was signed on 26th March, 1956. Two research organisations of the U.S.S.R. Academy of Sciences, i.e. the Institute for Nuclear Problems and the Electro-physical Laboratory also became a part of the Dubna research complex. Also, three international projects were set up as a corollary to the Dubna Institute. They were a theoretical physics laboratory, a neutron physics laboratory and a cyclotron; see Multilateral Economic Cooperation of Socialist States, Progress, (Moscow, 1977), pp.442, 443

14) In 1965 a consolidated multilateral plan was formulated for coordination of R&D which included 50 major problem areas encompassing 200 different subjects; see Vlaskin G.A. & Khachaturian A.A., Nauchno-Technicheskie Issledovaniya i Razrabotki v Europeskikh Stranakh SEV, Nauka, (Moscow, 1986), p.133.

CMEA wide plans for dovetailing and coordinating the major multilateral and bilateral scientific projects and in February, 1964 the Executive Committee of the Council approved the first consolidated R&D plan for CMEA as a whole.

With the adoption of the Comprehensive Programme of 1971 the planning activity concerning R&D was set on a firmer footing. It was noted in the Programme "...that CMEA member-countries regard the coordination of their 5 year plans - as one of the major means of formation of stable and mutually beneficial economic and scientific-technical relations between them."(15) Indeed, Mikhlyaev goes to the extent of stating that the problem of the interconnection of the economic process and of scientific progress is a problem of 'major significance' for socialist planning.(16)

In short, by the early seventies, the modalities of coordinated planning of national R&D plans

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15) CPDSEI op.cit.

16) Mikhlyaev A.G., Perspektivnoe Planirovanie v Europeskikh Stranakh SEV, Nauka, (Moscow, 1985), p.16.

and their merger into a compatible whole had assumed a definite structure. The professed aim of the exercise was to - identify areas of research for cooperation, remove duplication in R&D efforts and pinpoint those fields where research could be profitably undertaken in countries other than the ones already considering embarking upon it.

The search for ideal forms of cooperation in R&D has led to the emergence of three basic frameworks, with of course a plethora of organisational structures and institutions to realise them on the ground. The three types of R&D projects are(17) -

(1) Coordinated R&D projects in which the work is subdivided and performed by the national head organisations. In this kind of a venture the responsibilities of the sides are not demarcated precisely and every side bears its own expenses. The coordinating head organisation arranges scientific conferences and takes note of the progress achieved.

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17) For an overview of the basic framework of cooperation in R&D, see Bykov A.N. & Lebin D.A., Sotsialisticheskaya Integratsia i Nauchno-Technicheskaya Revolutsia, Nauka, (Moscow, 1981); also Nolting Lonvan, "Integration..." op.cit.

The 'coordinated' form is considered to be the simplest and more conducive to the earlier stages of the general integration process. It was particularly widespread during the 1960s.

(2) Cooperative R&D projects which are coordinated by CMEA international organisations and by the coordination centres formed by CMEA member-states on specific scientific and technical problems, but carried out by the national head organisations. This form envisages an agreement between the participating sides clearly mapping out the various tasks, the expenses to be incurred and the modalities of usage of final results. In projects bearing potential of some technological innovation and commercial application the agreements also set out the terms of cooperation in production and marketing of new products.

(3) Joint Research, which is carried out in jointly managed facilities of the CMEA countries, in the international institutes, research centres and the R&D departments attached to the other international economic organis-

ations of the CMEA member-states.[18]

The latter forms of cooperation i.e. cooperative R&D and joint R&D, are assuming greater significance at the present stage of 'intensive' efforts at integration of the CMEA economies. Of course, together with these forms of R&D cooperation, coexists exchange of information on scientific and technological achievements which is carried out increasingly in the form of a trade in licenses. Indeed, Bogomolov justifies this purely commercial exchange by stating that "...worldwide experience demonstrates that the most progressive scientific achievements,

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18) Interestingly, there are consistent and logical parallels between the development of the integration process in the economic sphere, per se, and the development of forms of cooperation in R&D. Marer and Montias point out that there emerged principally 3 types of activity in the economic integration process - 1) Improved plan coordination 2) Cooperation in long term target programmes for basically priority areas like fuels, raw materials etc. 3) Joint investment projects which constitute the major new form of activity e.g. the Orenburg pipeline. See Marer Paul & Montias J.M., "CMEA Integration: Theory and Practice" in East European Economic Assessment, Joint Economic Committee, Congress of Unites States, (Washington D.C.,1981),Part II.

including new inventions, are diffused through licenses ....",[19] a conclusion which nullifies greatly the earlier posture of 'exchange on non-commercial and free basis'. A major factor which probably influences conclusions of this kind is the claim that the socialist countries have now amassed a huge number of basic scientific ideas as well as inventions. It has been reported, that in GDR itself around 5,00,000 inventions, innovations and suggestions for improvement of production processes are introduced into the economy annually. The figure for U.S.S.R. is purportedly in the region of 4 million.[20] It is also claimed that over a 1,00,000 innovations are registered as inventions annually throughout the CMEA.[21] All these claims raise questions about the content of novelty embodied in these inventions and their net effect on the economies.

Marchuk, the President of the USSR Academy of Sciences also claims that '...no other country

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19) Bogomolov O.T., Bykov A.N., eds., Strany SEV... op.cit. p.84.

20) Ekonomicheskaya Gazeta, No.44, 1984.

21) Planavoe Khozyaistvo, No.4, 1983.

has accumulated such a large store of fundamental scientific ideas...." as the Soviet Union.(22) It should be noted straight away, though, that Marchuk is referring here to basic research. At the same time he also declares that "...it is precisely the combination of science, technology and production that makes it possible to find the most effective technological solutions in the least amount of time. In an intensive economy all three elements are of equal value."(23)

Evidently the idea is to cooperate in the thrust areas, taking into account factors like a viable division of labour, economies of scale, the scope and structure of every national R&D and to fill in the gaps by way of sale and purchase of licenses among the CMEA countries themselves.

Two areas, where multilateral cooperation among CMEA countries has a long history are, nuclear energy and computers. The compulsions for going

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22) Marchuk G., Science Will Help Speed Production, Novosti, (Moscow, 1986)., p.30.

23) Ibid.,p.2.

in for cooperation in these two areas at an early stage were different. It should noted that the Soviets were very late in entering the computer field because of so-called 'ideological' obstacles, the fall-out of 'Lysenkoism' in cybernetics etc. in spite of there being strong votaries of cybernetics in the person of Academician Kolmogorov, Axel Berg and others. However the spectacular success of the U.S.A. in harnessing the 'information technology revolution', the needs of defense and the obvious benefits to the economy brought home the urgent need for developing a computer infrastructure. Since this involved an entire range of capabilities, from materials sciences, to machine tools for making chips to software development, the need for involving other CMEA countries becomes apparent.

In the case of nuclear energy it must be noted that the Soviets were the first to commission a nuclear power plant. The increasing difficulty and rising costs of exploiting the Siberian oil and gas fields, the opportunity cost involved in selling the same to East European countries and the siting of major industrial centres in European Russia and East Europe have all contributed to the development of the policy of going in for nuclear power plants in a big way, both in U.S.S.R. as well as other CMEA (European) countries.[24]

It must be noted that unlike the Nuclear Research Institute at Dubna, which is concerned with fundamental research and which is the manifestation of another traditional field of cooperation, these two areas dealt with the development and manufacture of end-products.

The development of cooperation in the field of nuclear power engineering is associated with the emergence of a new form of organisation in the early seventies-'The International Economic Association'.[25] Their range of joint economic activities was supposed to embrace the entire gamut - from R&D to production, service and foreign trade etc.

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24) Graham Loren, "Science and Computers in Soviet Society" in The Soviet Union in the 1980s, Hoffman Erik P., ed., Academy of Political Science, (New York, 1984); also Alexandrov A., Possessing Energy Resources Is Not Enough, Novosti, (Moscow, 1987).

25) The International Economic Associations (IEA) may provide the basis for creating socialist multinational cooperations according to Marer Paul and Montias J.M., CMEA...op.cit.

'Interatominstrument' was created in Warsaw in 1972 to engage in the field of nuclear technical equipment, including "...dosimetric, radiometric and nuclear physics apparatus, multichannel systems for nuclear research and atomic power engineering, nuclear medical apparatus, radiation detectors and other related instrumentation and equipment."(26)

Similarly 'Interatomenergo' was established in 1973 in Moscow for joint economic activities in the development and manufacture of nuclear power plants. Cooperation in this area revolves around the Soviet designed water-moderated, water-cooled nuclear reactors called VVER of 440 and 1000 megawatt capacity. Under the aegis of the umbrella organisation 'Interatomenergo' there has been considerable progress in specialisation and division of labour. Bulgaria specialises in the manufacture of biological shielding facilities for nuclear power stations, transportation and conveyer equipment, special purpose pumps and armature; the Hungarian 'Ganz-Mavag' works manufactures charging and discharging machines for refuelling

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26) "Statute of the Interatominstrument I.E.A. for nuclear equipment manufacture" in Multilateral...op.cit., p.571.

nuclear power reactors, special equipment for water-purging and for maintenance and repairs; the GDR produces transportation equipment including cranes, water purification systems and special armature; Poland specialises in the production of volume compensators, steam generators, heat exchangers, standby diesel generator sets and control instrumentation; Rumania manufactures main circulation pumps, safety system hydrovessels, 320 ton capacity cranes and other equipment; Czechoslovakia has set up production facility for over 80% of the entire technological equipment that goes into the making of a VVER-440 power unit; Yugoslavia has, since 1980, specialised in armature components and the USSR specialises in the production of reactors and around 50% of the basic equipment.(27)

The long-standing cooperation in the field of computers(28) has resulted in the development

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27) Soviet Export, No.5, 1985.

28) 'The Agreement on Cooperation in the Production and Application of Computer Technology' (The Inter Government Commissions) was signed by CMEA member countries, with the exception of Rumania, in 1969. See International Specialisation and Coproduction Carried Out By The CMEA Member Countries, CMEA Secretariat, (Moscow, 1983).

of the ES (Edinaya Sistema) Ryad series of computers and related peripherals, operating system software and application software packages.

The Agreement on Scientific Cooperation in the Fields of Organisational Control, Cybernetics and Operational Research was signed by the respective State Committees on Science and Technology or their equivalents, in Moscow in 1970.

Joint development of the Ryad family of computers has given rise to specialisation and division of labour in the manufacture of the various components that go into the making of these computers, as in the case of cooperation in the field of nuclear energy. Bulgaria specialises in computer peripherals including printers; GDR in computer processors and magnetic tapes; USSR and Czechoslovakia (the Polytechna organisation) jointly develop software; Poland in equipment for manufacture of integrated circuits; Rumania in semi-conducting materials; Hungary in testing equipment and the USSR in manufacture of large scale integrated circuits and very large scale integrated circuits.[29]

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29) <u>Soviet Export</u>, No.6, 1986.

At present under the ES programme the CMEA countries manufacture 210 different computers and devices including the software.(30) The general agreement provides for setting up a unified and standardised system of electronic items and components, technical equipment, semiconductor and pure materials as well as development of microprocessors. Of the 537 items of the range of integrated circuits and semiconductor components covered by the Unified System (ES), 261 have been included in the agreement for specialisation and joint development.(31)

There exist a number of bilateral agreements as well between the USSR on the one hand and some other European CMEA country for specialisation and development in the field of computer technology. The joint Soviet-Bulgarian organisation 'Interprogramma' set up in 1977 deals in software application packages.(32) The Intergovernmental Commission on Computer Technology between the USSR and Bulgaria plays a leading role in working out the modalities of cooperation.

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30) Soviet Export, No.3, 1986.
31) Soviet Export, No.5, 1985.
32) Vneshnaya Torgovlya, No.2, 1987.

The 'Robotron' Kombinat of the GDR cooperates with the Institute of Cybernetics of the Academy of Sciences of Ukraine and the Ministry of Communications of USSR for the joint development of new products like the Neva-1M communications computers. There is cooperation in the field of standards as well. On the other hand, under the aegis of the multilateral agreement on specialisation and cooperation in the development and manufacture of computers 'Robotron' produces the ES-1055 computer, plus peripherals, for which the floppy discs are supplied by the Soviet Union. 'Robotron' also specialises in printers.(33)

Trade in computers, peripherals and related devices among the socialist countries has risen tremendously over the last 15 years. Between 1970 and 1985 it is reported to have increased 40 times.(34) In the early years emphasis was laid on large main frame computers for application in institutions, in the central planning apparatus, defence industry etc. It must be noted that though the Ryad Series was instrumental in laying the basis of a computer

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33) Soviet Export, No.6, 1986.

34) Elorg, No.1, 1986.

industry infrastructure CMEA-wide, the achievements lag considerably behind world standards e.g. the ES-1066, one of the later models has an operating speed of 12.5 million operations per second and a memory of 16M.byte. Both the parameters are considerably inferior to those of contemporary Western models.

For over a decade and a half there has been ongoing cooperation in the field of space research and space communications, using artificial satellites, under the auspices of 'Intercosmos' and 'Intersputnik' programmes.(35)

The 'Intersputnik' organisation, which was created in 1971, was conceived as an open international organisation,(36) with the avowed aim of establishing an international system of communications based on a complex of communications satellites and earth stations. In its final stage of

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35) Vorotnikov V.V., ed., Mezhdunarodniye, Ekonomicheskiye i Nauchno-technicheskiye Organizatsii stran-chlenov SEV. Spravochnik, Mezhdunarodniye Otnosheniya, (Moscow, 1980), is a good reference work on I.E.A.s and International scientific and technological organisations of CMEA Member Countries.

36) The non-CMEA members included South Yemen, Laos, North Korea and others.

commissioning of the entire complex it was envisaged that the organisation would function on a commercial basis, renting out the communication channels.[37]

Under the framework of the 'Intercosmos' programme a number of cosmonauts of CMEA countries have gone on joint space flights with their Soviet counterparts. Though the bulk of the experiments carried out on board the space stations Salyut etc. were conceived by the Soviets, a number of experiments and apparatus designed by the East European scientists have also been included in the research part of the space itinerary. Carl Zeiss Jena, the well-known GDR firm specialising in optical equipment, has contributed unique custom designed cameras for use in space conditions and for various functional purposes of photography of the earth's surface.[38]

The framework of cooperation in science and technology has therefore evolved from the so-called 'free exchange' in scientific and technological results to the sale and purchase of licenses, which was once derided as a form of cooperation specific to the capitalist countries. On the other hand,

37) <u>Multilateral</u>...op.cit. p.431.

38) <u>Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV</u>, No.10, 1983.

it has given rise to the three forms of cooperation in R&D. In the latter sphere it was the most primitive form of cooperation - the coordinated R&D projects, which predominated and which to this day account for around 80-85% of the cooperation efforts in R&D.(39)

It is difficult to gauge exactly the contribution of the various partners in the R&D efforts involved in the traditional areas of cooperation viz. computers and nuclear power equipment. The external manifestation of specialised production of various components and machinery, which is the aspect usually stressed upon, does not give a correct picture of cooperation in R&D per se.

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39) Vlaskin G.A., Khachaturian A.A., Nauchno... op.cit. p.152.

CHAPTER II

The Organisational Structure Of Cooperation In Science and Technology

The problems of creating an effective organisational structure within the framework of CMEA for establishing scientific cooperation on a sound and firm footing have been an integral part of the problems faced by CMEA countries in developing the organisational structures of economic integration, per se.

Seemingly agreeing with the views of some Western scholars that it is not possible to organise economic integration efficiently unless supra-state organs of the European Economic Community (EEC) type are set up,[1] the Soviet Union reportedly proposed in 1962-64 that CMEA become a supra-national organ so that integration policies are imposed

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1) Ginsburg G., "The Implications of the 20-Year Comprehensive Programme of Economic Integration" in Proceedings of the American Society of International Law, November 1973, p.50.

from the top and become enforceable. This move, however, was resisted, particularly by Rumania and the Comprehensive Programme of 1971 emerged as a compromise document between the market mechanism leanings of Hungary and the concept of joint planning of regional economy's key sectors.(2) The Soviets have since dropped their suggestion of supra-national organs and tend to stress that integration of CMEA countries is completely voluntary and does not involve the creation of supra-national bodies.(3)

While rueing the absence of a 'single centre' or of a 'body' centrally directing, controlling

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2) Marer Paul and Montias J.M., "CMEA Integration: Theory and Practice" in East European Economic Assessment, Joint Economic Committee, Congress of United States, (Washington D.C., 1981), Part II.

3) For a theoretical survey of issues concerned see Senin M.V., Sotsialisticheskaya Integratsia, Nauka, (Moscow, 1969); Bezhak P. and Guzey M., Teoria Sotsialisticheskoi Integratsii, Progress, (Moscow, 1980), (translated into Russian from Polish, Sedova V.I., ed.).

and managing scientific and technological activity CMEA wide, Soviet scholars note that there are certain common specific circumstances surrounding the management of science and technology policy in individual CMEA member countries which create favourable grounds for pursuing integration policies in this sphere. Above all they note the following points[4] :-

(1) In a majority of CMEA states the responsibility for directing national, scientific and technological activity devolves upon a single, specialised body.

(2) The national centres for formulating scientific policy in the field of basic and fundamental research are the respective Academies of Science.

(3) The bodies responsible for the development of science and technology and for the realization of a unified policy in the field of applied research are primarily the ministries and government departments.

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4) Vlaskin G.A., Khachaturian A.A., Nauchno-Technicheskie Issledovaniya i Razrabotki v Europeskikh Stranakh SEV, Nauka, (Moscow, 1986), pp.126, 127.

(4) The respective government organisations dealing with education (or departments for science, technology and higher education) are in charge of scientific and technological activity carried out in the higher educational establishments. To a considerable extent the responsibility for preparing qualified scientific personnel is also entrusted with them.

By and large therefore there is considerable similarity in the structure of organisation of R&D, which is supposed to lay the ground for a broad based, planned and coordinated activity in this sphere, embracing all the levels of management of science and technology, from inter-government bodies to primary scientific collectives. Of course every country has introduced certain individual features e.g. in Hungary the science and technology policy is carried out by a Commission on Science Policy attached to the Council of Ministers and by the State Committee on Technological Development, whereas in GDR it is the Ministry of Science and Technology.[5]

The institutes carrying out actual research and development can also be grouped similarly in CMEA countries. As in the USSR the research network is divided by and large into - (1) The Research Institutes under the Academy of Sciences. (2) The Institutes attached to the branch ministries and departments and (3) The Higher Educational Establishments.[6]

It is worthwhile to have a short look at the organisation of R&D in the USSR as the predominant member of the Council by virtue of its scientific and production potential vis-a-vis other CMEA countries and see how the entire structure participates in R&D cooperation, whether bilateral or multilateral.

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5) For a description of the structure of science and technology in East Europe see Jones E.G., ed., Guide to Science and Technology in East Europe, Francis Hodgson, 1979.

6) For a description of the organisational structure of R&D in the Soviet Union see White Sarah ed., Science In The USSR, Francis Hodgson, 1979.

The Academy of Sciences of USSR is the supreme scientific establishment of the Soviet Union. It is under the direct authority of the Council of Ministers. Together with the State Committee for Science and Technology, which is the apex government body supervising the conduct of scientific policy, the Academy formulates plans for scientific research. The proposals of various ministries, departments and Republican Councils are also taken into consideration. The Academy has been traditionally involved in carrying out basic research. In the 1950s however it was directed to establish closer ties with the industrial enterprises and certain technological institutes were attached to it. In another reversal of policy in 1961, symptomatic of the ad-hoc policies pursued in the sphere of R&D it was decided that toomuch of the Academy's activities were centred on applied research and not enough on basic research. Therefore the industrially oriented institutes were shunted off to the appropriate government departments. Finally, in 1963 the Academy was relieved of all direct involvement in applied research and development.(7) The Academy system's isolation

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7) Ibid. p.14.

from applied research and particularly from the phase of introduction of new technology into production, was now complete.

Securely secluded in its ivory tower of basic research, in the 1970s the Academy system, which includes the Republican Academies and the Academy of Medical Sciences and the Academy of Agricultural Sciences contributed between 60-80% of all fundamental research work.[8]

In branch scientific institutions which are by and large responsible for applied research, the employment of scientific personnel is higher in the traditional spheres of machine building, metal working and chemicals and petrochemicals. There is a discernible shift in the 1980s however, toward electronics and electrical engineering.

The Soviet economy can be viewed as a pyramid like structure, with the apex being occupied by the top-priority defense sector, which is compartmentalised and segregated

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8) Nolting Lonvan & Feshbach Murray, "R&D Employment in USSR - Definitions, Statistics, Comparisons" in The Soviet Economy at Time of Change, Joint Economic Committee, Congress of U.S., (Washington D.C., 1979), Vol. I.

and reportedly even manufactures machine-tools for its usage.(9) The branch scientific institutions which are affiliated to the ministries forming part of the military-industrial complex are likewise segregated and accorded top priority. Even in other branch scientific institutions, which are involved in developing some aspect of applied research of some importance to the military, this state of affairs leads to compartmentalisation within the institute itself.

Though the Higher Educational Establishment forms a third arm of the science and technology structure, unlike in the Western countries, it plays an insignificant role in the development of either basic or applied research. The lack of a tradition of research and lack of any proper liaison with the industry or feed-back from it has resulted in enormous wastage of manpower and resources in the institutions of higher education. In 1976 out of a total of 380,000 scientific personnel with advanced degrees (Ph.D. or D.Sc.),

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9) For a description of the Soviet Economy and the level of technological innovation in it, see Amann R., Cooper J., eds., Technical Progress and Soviet Economic Development, Basil Blackwell, (Oxford, 1986).

nearly 179,000 were employed in the so-called VUZY(the institutions of higher education).(10)

The total picture that works out by and large therefore, is that the Academy system involves itself in basic research, the branch scientific institutes deal with applied research and the higher educational institutes occupy an indeterminate and ineffective niche generally, in the R&D structure. Moreover there is isolation to a considerable extent from one another and, to complicate matters compartmentalisation within the three arms themselves depending on the setting of priorities.

On the whole approximately 4% of the total employment is in the branch of the national economy termed 'Nauka i Nauchnoe Obsluzhivanie' i.e. 'Science and Science Services', which works out to around 5 million. Out of this, reportedly 20% is the

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10) Nolting Lonvan and Feshbach Murray, "R&D ...op.cit.

figure for scientific workers.(11)

Various adjustments and changes are being sought to be made in this basically three pillared structure of the research establishment. It has been acknowledged over the years that the research effort has not been responsive to the needs of an industrialised economy. An ever increasing number of Soviet scholars have declared that the "...basic reasons for the ineffectiveness of the management of R&D policy, formulated during the extensive phase of development of science.... is the absence of organisational-economic unity of the science-production cycle, the divergence and nonconformity of aims and methods of achieving them in the different stages of the cycle."(12)

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11) Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV, No.8, 1985, p.3.

12) Obrastsov N., Solovyov A., "Organizatsionno-Ekonomicheskie Factori Povisheniya Effectivnosti Nauki" in Voprosy Ekonomiki, No.6, 1987, p.67.

The same thing has been succinctly expressed by Henry G. Rowen, "...the Soviet economic performance has long been impaired by the separation of research, development and production into different organisations. Each organisation operates according to different planning targets. Scientific Research Institutes do basic research and are paid for successful completion of research projects, whatever their practical benefit to the economy. Design bureaus develop the blue prints for new equipment and are largely rewarded for the successful testing of the prototype. Rewards are only loosely linked to the successful incorporation of the new product into serial production."(13) Rowen, in fact, goes so far as to say that hostility to technological change at the producer level is characteristic of the Soviet economy.

In short, it is in the stage of implementation of an invention, a new product or process in the production sphere that the major problems arise. That the problems have assumed menacing

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13) Rowen Henry, "The Soviet Economy" in <u>The Soviet Union in the 1980s</u>, Hoffman Erik, P. ed., Academy of Political Science, (New York, 1984), p.41.

proportions is testified by the fact that in the official policy pronouncement 'The Major Directions of Economic and Social Development of USSR for 1986-90 and upto 2000 A.D.', it was stated that "...the principal task is to strengthen the linkage of science and production, create such organisational forms of integration of science, technology and production which would ensure a speedy traversal of scientific ideas, from the stage of inception to their wide application in practice."(14)

The acute realisation of these difficulties has led Soviet scientific spokesmen to proclaim "...that we are flexible and ready to make changes in this area"(15) i.e. in the organisational structure of science. It is easy to perceive that most of the steps the Soviets have taken in the last decade or so in the sphere of R&D policy have been dictated by this pressing need to make the technology-production linkages more effective in the overall science-technology-production process.

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14) Materialy XXVII Syezda KPSS, Politizdat, (Moscow, 1986), p.281.

15) Koptyug Valentin A., Siberia Is The Most Dynamically Developing Region of the Country, Novosti, (Moscow, 1987),p.11.

In an effort to mitigate the stultifying effect of the vertical heirarchies of the three major arms of the scientific research set-up, a number of functional or branch-specific organisations, bodies and councils were set up which cut horizontally right across the board encompassing parts of the basic research institutes, the technologically oriented institutes of the ministries and departments, design bureaus and enterprises.

At the coordinating and supervisory level there are a number of 'Science Councils for Major Complex and Inter-branch Scientific and Technical Problems,' attached to the State Committee for Science and Technology, as well as 'Science Councils for Major Complex Problems in the Natural and Social Sciences under the USSR Academy of Science'. The Councils are composed of leading scientists, manufacturers, designers and technologists.(16)

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16) For a survey of methods adopted to deal with the management of R&D in the recent years see Anchishkin A.I., Shiryaev Y.S., Nauchno-Technicheskaya Revolutsia i Sotsialisticheskaya Sistema Khozyaistvo, Ekonomik, (Moscow, 1983).

A number of institutes of the USSR Academy of Sciences have set up 'Problem oriented technological centres', whose function it is to translate the major scientific and technological achievements of their institutes into a production prototype and also render assistance in adapting the production process to the new requirements. A number of temporary scientific collectives have also been set up to solve inter-branch problems. It is also envisaged to increase the number of temporary, problem-specific laboratories which have been organised to fabricate new product prototypes and work out new technological processes based on the research of institutes and design bureaus.(17)

In an effort to overcome the isolation of basic research from applied and of the latter from the production process, in 1973 many Soviet enterprises and R&D centres were consolidated into science-production associations (research -production associations). According to Berliner, "...the problem that motivated the founding of the science-production associations was clear

17) Obrastsov N., Solovyov A., "Organizatsionno..."op.cit. pp 64,65.

enough. It was concern over the unsatisfactory rate of technological progress. This in fact is the first of the reforms under review in which the problem of technological progress was at the heart of the reform though it played a role in the others."(18)

The Research and Production Associations (RPAs) include research establishments, design and development organisations, pilot and batch production plants, and personnel training centres. Associations such as 'Kriogenmash' or the Leningrad 'Svetlana' are capable of putting into operation integrated production systems.(19) The formation of new RPAs is gathering momentum. Only in 1985-86, 154 new RPAs were formed, which embraced within their fold a total of 350 scientific research institutes and design bureaus. At present there are over 390 RPAs incorporating 700 institutes

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18) Berliner J.S., "Planning and Management" in The Soviet Economy : Toward the Year 2000, Bergson Abram and Levine Herbert S. eds., Allen and Unwin, (Massachusetts, 1983), pp 12,13.

19) Aganbegyan A.G., Make the Economy Responsive to Innovations, Novosti, (Moscow, 1986), p.18.

and design bureaus and 130 new RPAs incorporating 400 research institutes are in the pipeline upto year 1990.[20]

The proliferation of RPAs has evidently not resulted in solving the problem of technological progress to any great degree which accounts for the emergence of a yet newer form of organisation. In December 1985 the first Inter-Sectoral Scientific and Technological Complexes were set up with a view to tackle new and particularly complex problems in which either a wide range of disciplines are involved or which in the words of Marchuk "...do not fit into the existing framework of ministries and departments."[21]

In effect, Marchuk admits that the RPAs which were supposed to be instrumental in surmounting some of the barriers of isolation between science and production have not been able to overcome the departmental compartmentalization, parti-

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20) <u>Voprosy Ekonomiki</u>, No.6, 1987, p.65.

21) Marchuk G., <u>Science Will Help Speed Production</u>, Novosti, (Moscow, 1986), p.8.

cularly with respect to technologies involving a gamut of research disciplines and industrial sectors.

As Academician Frolov notes, most of the new processes and priority areas in modern day science and technology are multi-sectoral in nature and the most impressive breakthroughs have been made mainly at the junction between various fields of science.(22)

The first 20 Inter-Sectoral Scientific and Technological Complexes (ISTCs) have been set up under the Academy system, the Academy of Medical Sciences and certain engineering oriented Ministries. Some of them are 'Rotor' for rotary conveyer lines, 'Katalizator' for new catalysts and Industrial Lasers ISTC. Since this is a new form of organisation it is widely acknowledged that a number of managerial and economic problems arise in their creation, which have yet to be solved.(23)

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22) Frolov K., We Count On Machine Building, Novosti, (Moscow, 1986), p.13.

23) Obrastsov N., Solovyov A., "Organizatsionno..."op.cit., p.64.

If the formation of Research and Production Associations was necessitated by the need to hasten the process of technological progress,[24] the establishment of ISTCs is an ambitious and qualitative leap ahead, in so far as they are called upon to implement promising new ideas in basic research and develop fundamentally new areas. Many of the ISTCs are engaged in the frontline areas of modern day science and technology like lasers, automation, powder metallurgy, robotics etc. What is deemed particularly important is that the various constituents of an ISTCs, i.e. the research establishments, design organisations, pilot plants and industrial enterprises shall function in the pursuit of a single plan elaborated by a leading head organisation (a prominent research establishment) approved by the State Committee of the USSR on Science and Technology and endorsed by the USSR Academy of Sciences and the USSR State Planning Committee. This procedure would hopefully pool the efforts and resources of various establishments

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24) It may be noted that with the formation of large RPAs Soviet enterprises now have in-house R&D, so to speak, akin to the R&D centres of large Western companies.

and organisations, remove departmental isolation and compartmentalisation and strengthen the ties between science and production.(25)

The optimism expressed by Soviet scientists and official spokesmen about the future prospects of ISTCs is largely based on the success of a few of them, the most prominent being the ISTC based on the Paton Electric Welding Institute of the Ukrainian Academy of Sciences. This special task R&D complex incorporates seven engineering centres and has a design bureau, a pilot plant and a factory for the manufacture of welding equipment. Its personnel take part in 12 comprehensive programmes covering the development of welding methods, electroslag welding technology and welding, soldering, spraying and coating equipment.(26)

The frequency, with which the Paton experiment is cited and held forth as a shining example

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25) Frolov K., We...op.cit., p.12; For a study of efforts undertaken to strengthen linkage of science with production see Bykov A.N., Lebin D.A., Mekhanizm Integratsii Nauki s Proizvodstvom, Nauka, (Moscow, 1984).

26) Soviet Export, No.5, 1986.

of the potential inherent in this new form of organisation, would suggest that so far the success stories have been strictly limited.(27) It should however be noted that ISTCs are a recent phenomenon, many of them barely a year old.

The effort to involve research institutes in application programmes, either in the framework of the RPAs or in the structure of an ISTC is continuing apace. A considerable number of research institutes have been weaned away from their secluded ivory towers of isolated research efforts. Some of them are - The Solid State Physics Institute, Institute of Problems in Mechanics, Machine Science Institute, High Temperature Processes Institute, Institute of Metallurgical Problems, Hydrodynamics Institute, Institute of Casting Problems, Rostov Institute of Mechanical Engineering Technology and the institutes under the Republican Academies - The Superhard Materials Institute, Materials and Casting Methods Institute, The Physical Techno-

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27) Aganbegyan, Marchuk and Frolov all mention the Paton ISTC in 'Expert Opinion' APN series. Journals like <u>Voprosy Ekonomiki</u> and others also mention the Paton ISTC frequently.

logical Institute and the Institute of Machine Reliability and Durability Studies.(28)

As noted by Loren Graham, the Soviet Union today possesses the largest scientific establishment in the world. In the fields of Natural Sciences and Engineering it has a third more Ph.Ds. or equivalent than the United States. Graham also states that "...for decades the USSR has devoted a larger share of its Gross National Product (GNP) to R&D than the United States."(29)

Indeed, the rise in the outlay on R&D is increasing at a greater rate than the growth rate of national GNP in the USSR as well as other East European CMEA countries. The rate of growth of the absolute expenditure in R&D of certain European CMEA member states over the period 1970 to 1985 is as follows - Bulgaria 3.3 times, Hungary 3.3 times, USSR 2.4 times and Czechoslovakia 1.7

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28) Soviet Export, No.5, 1986.

29) Graham Loren, "Science and Computers in Soviet Society" in The Soviet Union in the 1980s, Hoffman Erik P., ed., Academy of Political Science, (New York, 1984), p.124.

times. As a result of this the proportion of expenditure on R&D as a percentage of national GNPs has gone up over the same period - for Bulgaria from 2.1 to 2.8%, for Hungary from 2.8 to 3.3%, for GDR from 3.9 to 4.6%, for USSR from 4 to 4.9% and for Czechoslovakia from 3.7 to 4.1%.(30)

Over the period under consideration, the total employment in the sphere of scientific, technological and design research work in individual CMEA countries has risen between 110 and 180%. On the whole, in 1985 there were 5.2 million employed CMEA-wide, in this field. Out of this total employment of 5.2 million around 1.7 million were scientific workers the rest being support personnel. Over 500,000 of these scientific workers had advanced scientific degrees (Ph.D or D.Sc.).(31)

If the other CMEA countries share with the Soviet Union a similar organisational structure of scientific research, they also have, in common with the USSR, the very same problems of implementation

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30) Collected from Materialy Statisticheskikh Organov SEV, CMEA Secretariat, (Moscow, 1986).

31) Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV, No.8, 1985, p.3 ; Argumenty i Fakty, No.5, 1985, p.2

of scientific discoveries, inventions and new products and processes in serial production; the problem of diffusion and dissemination of new technology throughout the civilian economy. As mentioned by Vlaskin and Khachaturyan "...in the seventies and early eighties, in a majority of these countries a number of measures were taken to improve the management system of creation and introduction of new technology. The most intensive efforts were made to perfect organisationally that stage, which is involved in the realisation of new technology in production."(32)

In many CMEA countries new conglomerations have emerged in an effort to integrate the entire process of development of new products etc. from the formulation and design stage to the production stage. In Bulgaria, e.g., Engineering-Implementation (Introduction) Organisations have been set up which are similar to the Research and Production Associations of the USSR.(33) In Hungary, re-organisation of scientific research institutes

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32) Vlaskin G.A., Khachaturian A.A., Nauchno.. ..op.cit., p.25.

33) Nauchno Technicheskaya Revolutsiya i Nauchno Technichesky Progress, (Sofia, 1982), (translated from Bulgarian into Russian), p.140.

has been under way over the last few years to make their structure more flexible. A concomitant measure has been to introduce a new type of organisation called Enterprise for Technical Development. Around 15 scientific research institutes were incorporated into such enterprises.(34) In GDR the process of development of new forms of organisations has led to the formation of integrated works, which group together a number of enterprises which produce similar, related products or employ similar technology. In effect the attempt is primarily to diversify horizontally. The integrated works are in many cases the sole manufacturers of the end-products in an entire sub-industry. These integrated works have established special working groups with the objective of introducing improvement in the technological processes.(35) The Czechoslovaks have come up with a specific form of amalgamation - the Gestsia,

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34) Tarsadalomtudomanyi Szemle, No.5, 1981 (from Hungarian) quoted in Vlaskin G.A., Khachaturian A.A. Nauchno....op.cit., p.51.

35) Vneshnaya Torgovlya, No.3, 1987, p.13; For details on integrated works in GDR see Shabalin A.Y., Tsedilin L.I., Kombinaty v Sisteme Upravleniya Narodnim Khozyaistvom GDR, Nauka, (Moscow, 1984).

which is a grouping together on a legal footing, of organisations and enterprises for the purpose of tackling on a cooperative basis problems of a technical nature. A leading research institute is usually the head organisation in this venture.(36)

Apparently, the experience of these organisations regarding introduction of technology into production could not have been a very favourable one, because besides these research and production organisations certain CMEA countries have seen the rise of another form of organisation - the so-called Specialised Implementation Organisations which occupy a unique niche in the entire process of introduction of new technology into production. Their services are supposed to include engineering consultancy, rendering assistance to individual inventors of different enterprises, to scientific organisations not possessing design bureaus and to enterprises lacking in R&D potential or financial resources. Their main objective is to hand over the results of research, inventions etc. in a form which is immediately adaptable to the exigencies of mass-production.

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36) Vlaskin G.A., Khachaturian A.A., Nauchno.. ..op.cit., p.58.

The Centre for Accelerated Implementation (Introduction) 'Progress' was set up by the Bulgarians in 1977. It is attached to the State Committee for Science and Technical Progress. Among its major tasks is the introduction of technological innovations which, for some objective or subjective reasons (the economic risk involved, lack of resources etc.) have not been included in the branch wise plans for R&D.(37)

The Hungarian Implementation Organisation 'Novex' is a joint stock foreign trade enterprise. Its major aim is to assist in the development of licensing and patents activity in Hungary and help in the quick assimilation of scientific and technical achievements of Hungarian and foreign specialists.

The Enterprise for Introduction and Diffusion of Technological Progress 'Posteor' was set up in Poland in 1973, with a view to introduce and disseminate various new products, processes and technological innovations in the industrial enterprises.(38)

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37) Problemy Teorii i Praktiki Upravleniya, No.4, 1984.

38) Problemy Teorii i Praktiki Upravleniya, No.3, 1985, pp. 40 - 43.

These specialised implementation organisations therefore try to fulfil a most vital task in the development of science and technology in the CMEA countries. They attempt to satisfy a long-felt need to strengthen and improve the weakest aspect of R&D in the socialist countries, i.e. the stage of implementation of R&D results in the economy.

It is perhaps a reflection of the state of affairs regarding the difficulties involved in the introduction of technology into production that the need is felt to conceive and establish organisations of this kind. In the existing scheme of things, it must be noted, any new organisation set up to mitigate red-tapism inevitably has to add another aspect of the same to the structure. It is a moot point therefore whether establishment of such organisations on a prolific scale would be a self-defeating purpose or not. As things stand at present the analysis of the multifarious activities of these specialised implementation organisations shows that they expend a major part of their efforts on setting up a data-base on the new scientific and technological innovations, discoveries and inventions which would give a significant economic effect if introduced into the economy.[39]

The various elements of the organisational structure of R&D in the CMEA countries, described above, play a role in varying degrees, in the process of cooperation in science and technology.

The viable functioning of the entire system of economic integration within the framework of CMEA is ensured by the international bodies and institutions as a whole, which organise the interaction between the individual national systems. At the apex of this effort is the Session of the Council for Mutual Economic Assistance which formulates basic, strategic policy. The supervision and monitoring of policy is done by the Executive Committee and the Secretariat looks after the day-to-day functions.[40]

At the bilateral level the same gamut of problems is addressed by the Inter Government

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39) Voprosy Ekonomiki, No.5, 1984, pp.110-111.

40) CMEA: Purposes, Principles, Structure, Activities, CMEA Secretariat, (Moscow, 1984). ; For description of structure and functions of CMEA see Fadeev N.V., Soviet Ekonomicheskoi Vzaimpomoshi, (Moscow 1974).

Commissions on Economic and Scientific and Technological Cooperation.

In the sphere of cooperation in science and technology too, there are two levels - bilateral and multilateral. The CMEA Committee on Scientific and Technological Cooperation has been directly in charge of multilateral cooperation of CMEA countries in R&D since 1971. In its functioning it operates in tandem with the other committees of CMEA - the Committee on Cooperation in Material and Technical Supply, the Committee on Cooperation in Planning and the Committee on Machine Building. It also assists in the development of bilateral ties in conformity with the trend of multilateral cooperation in R&D.

A considerable part of the work of organising R&D ties falls to the lot of so-called branch organs of cooperation and of the organs coordinating fundamental research. This organisational level includes permanent branch commissions of CMEA, the permanent conference of representatives of the Academies of Sciences of CMEA countries and working groups for cooperation of ministries and departments. Their functions are basically coordination of policy in fundamental as well as applied research, dovetailing of branch-wise plans of R&D, coordination of the activity of research institutes, design bureaus and monitoring of scientific and technological cooperation and the implementation of its results.(41)

An intermediate level of cooperation in science and technology is occupied by those international organisations attached to CMEA which combine their functions of coordination with the development of specific research problems, viz. the International Centre for Scientific and Technical Information, The International Scientific and Research Institute of Problems of Management and the CMEA Institute on Standardisation. The international scientific councils of these organisations supervise the work of coordination and conduct of research.

The next level in the structure of R&D cooperation consists of coordination centres

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41) <u>Organizatsionno-Metodicheskie, Ekonomicheskie i Pravovie Osnovy Nauchno-Technicheskovo Sotrudnichestva Stran-Chlenov SEV</u>, CMEA Secretariat, (Moscow, 1985).

on specific and important scientific-production problems, international economic, scientific and production associations like 'Interatominstrument', 'Interetalonpribor' and others.

In the bilateral sphere the bulk of the work on coordination is borne by the permanent sub-commissions on scientific and technological cooperation attached to the Inter Government Commissions. Cooperative activity at the level of Inter-State bodies is achieved with the help of coordination of plans of R&D, mutual consultations on science policy, formulation of prognoses, tackling of specific technical problems, cooperation in exchange of scientific and technological information and training of scientific personnel.(42)

The Inter-Government Commissions have a particularly important role not only in bilateral ties but also in organising cooperation in the priority areas of science and technology in which there is multilateral interation. At

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42) See Lebin D.A., Nauchno Technicheskaya Revolutsiya i Sotsialisticheskaya Integratsia, Nauka, (Moscow, 1973).

present, for instance there exist inter-government commissions on computer technology and on nuclear power plant equipment.

The direct ties between the ministries and departments of two member countries are responsible for a considerable volume of work associated with bilateral cooperation in R&D. On the basis of coordination of state and branch-wise plans of R&D, they formulate the content and direction of scientific and technological cooperation.(43)

An integral part of the cooperation in R&D among CMEA countries is the cooperation among the respective Academies of Sciences. Every Academy chooses its sphere of cooperation on the basis of the 'interested party principle.'(44)

The structure of scientific and technological cooperation sketched above is not inflexible

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43) Bakovetsky O.D., Grinev V.S., Razvitie Pryamikh Proizvodstvennikh Svyazei v Sodruzhestve SEV, Nauka, (Moscow, 1984) gives an excellent introduction to the subject of direct ties.

44) Bykov A.N., Lebin D.A., Sotsialisticheskaya Integratsia i Nauchno-Technicheskaya Revolutsia, Nauka, (Moscow, 1981), p. 179. Academies of Sciences of CMEA countries have set up international centres for training of scientific personnel and for basic research in Warsaw (mathematics), Minsk (heat exchange) & Halle, GDR (electron-microscopy).

or immobile. It is subject to change depending on the requirements and perceptions of the member countries. With the onset of the intensive phase of development of most of the CMEA economies, the tendency of looking at the viability of the structure through the prism of cost effectiveness and net returns to the economy has gained ground. It was noted at the 41st Session of CMEA (December, 1985) that the functioning of CMEA should be directed towards acceleration of scientific and technological progress on the basis of international specialisation and cooperation and that serious changes should be effected in its structure, style and methods of activity towards this end.[45]

The organisations which have been responsible for realising on the ground, the whole range of R&D together with mass-production and marketing, are some of the International Economic Organisations (IEOs) of the CMEA member states. There are basically two types of IEOs - (1) Inter Government Economic Organisations which do not

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45) Pravda, 18 December, 1985.

indulge in commercial activity and (2) International Commercial Organisations which are set up by Government organs, individual institutes or commercial organisations. The members usually are enterprises, scientific institutes, design bureaus and foreign trade organisations. The International Commercial Organisations (ICOs) are further sub-divided into International Commercial Amalgamations (ICAs), International Commercial Cooperatives (ICCs) and Joint Enterprises depending on the structure, functions and methods of putting them into force.(46)

Towards the beginning of 1985 there existed over 30 multilateral and 20 bilateral IEOs within the framework of CMEA. Of the total number of IEOs around 10% are scientific and technological organisations.(47)

The Inter Government Economic Organisations (IGOs) were formed earlier than others and were concerned mostly with common infrastructural

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46) <u>International Economic Organisations Of CMEA Countries</u>, CMEA Secretariat, (Moscow, 1985).

47) Ibid.

or trade problems. The Unified Nuclear Research Institute at Dubna, mentioned earlier, is the flagship, so to speak of IGOs operating in the field of science. In fact the Dubna Institute is held out as an example of effective cooperation between scientists of CMEA countries. Six new elements, over 100 isotopes of different elements and new elementary particles have been discovered there. Over the past three decades, 30 major discoveries and approximately a thousand inventions have been made at this centre. Though the Institute is involved in fundamental research, a number of its discoveries and inventions have found application in the economy. Some of them are the irradiation of malignant formations by p-mesons, express-analysis, which cuts down irradiation time by a factor of 2 to 3 as compared to X-rays, nuclear filters, radio-pharmacological medicines etc. Over the years more than 3000 scientists from socialist countries have taken part in the research effort.(48)

Another major IGO is 'Interelektro' set up in 1973 for economic, scientific and techno-

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48) Vlaskin G.A., Khachaturian A.A., <u>Nauchno</u>... .op.cit., pp.155, 156.

logical cooperation in the electrotechnical industry.

Some of the multilateral International Commercial Amalgamations (ICAs) in addition to those mentioned earlier[49] are :-

- 'Intertextilmash' (1973) - for research and development of textile machinery. Over the years it has developed over 40 new types of equipment.

- 'Interkhimvolokno' (1974) - for the development of chemical fibres. At present research is going on to develop automatic lines of production of polyester filament yarn.

Two of the more prominent bilateral ICAs are :-

- 'Assofoto' (1973, between USSR & GDR) - for research and development of photo-chemicals and materials and

- 'Robot' (1985, between USSR & Czechoslovakia) - a scientific and technological amalgamation

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49) 'Interatominstrument' and 'Interatomenergo' were mentioned in Chapter I.

for research into robotics.

Among the International Commercial Cooperatives are :-

Multilateral - 'Interetalonpribor', established in 1972 for development of measuring apparatus and instruments.

- 'Interelectrotest' (1973) - for cooperation in the field of high capacity, high voltage testing laboratories.

Bilateral - 'Intercomponent' (Hungary-Poland, 1973) for research, development and production of electronic components and items.

- 'Electroinstrument' (Bulgaria-USSR, 1975) - for research, development and production of electrical instruments.[50]

At the time of formation of 'Interelectro', 117 different items of electro-technical industry were included for technical improvement and specialised

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50) Vorotnikov V.V., ed., Mezhdunarodniye Ekonomicheskiye i Nauchno-Technicheskiye Organizatrii Stran-Chlenov SEV. Spravochnik, Mezhdunarodniye Otnosheniya, (Moscow, 1980), is a good reference work on IEOs etc.

production. At present the figure has risen to over 750 items, which constitutes 57% of the total product range. It was noted at the 40th Session of CMEA (1985, Warsaw)(51) that the experience of 'Interelectro' deserved attention, particularly in view of the fact that the activities of the organisation embraced the entire gamut - from research to mass-production and mutual deliveries. In 1981, four new programmes were initiated to develop and organise mass-production of new standardised products like semiconductor instruments and asynchronous generators.

A number of machines have been constructed on the basis of coordinated plans under the auspices of 'Agromash' (an Inter Government Economic Organisation formed in 1964). They include combines for harvesting tomatoes, carrots, cucumbers and grapes. It has been estimated that the member countries saved between 50% to 70% on expenses by resorting to joint development of these machines.(52)

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51) <u>International Economic Organisations</u>.... op.cit., p.21.

52) <u>International Economic Organisations</u>.... op.cit., p.24.

The entire thrust of the IEOs is now being shifted from just serial production to development and introduction of new articles. Over the last years there is a discernible trend towards cooperation in science and technology based on long-term perspective. The need for giving top priority to the research and development stage in the activity of IEOs has given rise to another related form(53) of organisation called the International Science and Production Association, which is a projection into the international sphere and further refinement of the research and production associations functioning in the CMEA member states. These Associations, have the aims and objectives of "...comprehensive research, development, testing of new technology and introduction of the same in the economies of

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53) There is a great similarity in the legal structure of IEOs and International Science and Production Associations (ISPAs). Indeed, there is a certain ambiguity in the usage of these terms. For instance, the bilateral Czechoslovak-USSR firm 'Robot' is referred to as both an ISPA and as an ICO in International...op.cit., p.15. Evidently it is more a question of shift in emphasis of functional aspect than the formal structural aspect.

participating countries as well as ensuring supply of unique items, the development of which requires application of latest scientific discoveries and achievements and considerable research, design and testing.(54)

The fag end of 1985 saw the conclusion of agreements on the formation of a multilateral science and production association 'Interrobot' and 2 Soviet-Bulgarian associations in the field of machine building. 'Interrobot' aims to achieve a unified policy in the development and production of standardised items of robotics and organise a rational and effective international specialisation of labour in this area. It is envisaged that Bulgaria would specialise in the development and production of robots for assembling machine building equipment and electronic goods, Hungary would construct robots for assembly of instrumentation, Poland would manufacture robots for welding, Czechoslovakia for casting purposes and the USSR

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54) <u>Mnogostoronnoe Ekonomicheskoe Sotrudnichestvo Sotsialisticheskikh Gosudarstv. Sbornik Documentov</u>, Yuridicheskaya Literatura, (Moscow, 1976), pp.107,108.

for metal processing and casting equipment. The 'Interrobot' organisation has been conceived as a very flexible one. The national centres which coordinate the respective programmes of the institute and design bureaus would be working independently but they can also invite specialists from other CMEA countries to participate in their programmes. Thus we come across the interesting case of a bilateral science and production association 'Robot' (Czechoslovakia & USSR) fulfilling its task in the combined multilateral project.[(55)]

The 2 Soviet-Bulgarian Science and Production Associations that have been set up have given a fillip to the development of direct ties between enterprises and associations of various CMEA countries. The evolution of direct ties is considered a very promising development in the intensification of the cooperation process in science and technology. The Beroe Research and Production Amalgamation (Stara-Zagora, Bulgaria) and the Krasny Proletary Machine Tool Building Amalgamation (Moscow, USSR) have grouped together into an

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55) Izvestia, 23 December, 1985.

International Research and Production Association for the development of robots and robot-controlled production lines. Similarly the Metal-Cutting Machines Production Amalgamation (Sofia, Bulgaria) has formed an International Research and Production Association together with the Machine Tool Building Amalgamation (Ivanovo, USSR) for the development of automated modules and units.(56) Two special design bureaus have been set up under the framework of these organisations to develop new technologies and products. The leading departments of both these bureaus are located in the USSR with branches in Bulgaria. The design bureau affiliated to the Ivanovo-Sofia combine deals with the development of machining centres and the bureau attached to the Moscow-Stara Zagora organisation develops flexible automatic systems of production.(57)

At present there are 3 modes of cooperation in the structure of International Research and Production Associations. They are :-

(1) Research and production cooperation on the basis of direct ties and separate ownership.

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56) Soviet Export, No.5, 1986, p.13.

57) Izvestia, 26 October, 1985.

(2) Joint organisation.

(3) Cooperation on the basis of partial unification of partners' assets.

The Joint Organisations[58] are further subdivided into :-

(1) Joint Enterprises

(2) Coordinated Agencies

(3) Scientific and Technological Organisations.

Some scholars tend to favour the cooperation mode based on partial unification of partners' assets e.g. when the scientific research institute is created on the basis of joint ownership and participating enterprises which are fed by the results of research remain as assets owned by individual countries. As Shiryaev states - "...this version seems to be the most viable because it is in total conformity with the functions of these associations whose activity include both coordination of international economic activity and the internal economic activity of consituents."[59]

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58) Vneshnaya Torgovlya, No.2, 1987, pp.7-9.

59) Shiryaev Y.S., Mekhanizm Sotsialisticheskoi Ekonomicheskoi Integratsii, Mysl, (Moscow, 1976) p.47.

The debate is still continuing. The lack of a tradition of an efficient management system in the field of R&D as well as the production and marketing spheres has resulted in a number of 'trial and error' methods. 'Management by objectives', a concept developed in the West, which takes into its fold the entire range of activities, from R&D to marketing, has yet to take hold in the CMEA countries. The very act of bringing together this range of activities under the framework of one organisation is a comparatively new phenomenon for the CMEA countries. To add to the complications this is being attempted in the international sphere when the experience of doing the same in the national systems is not very extensive as yet.

Unlike the IEOs though, whose major function is mass-production of items and goods already designed and developed, it is evident that in the case of the International Research and Production Associations primacy is being accorded to R&D. As noted by Vlaskin and Khachaturian though "...the structure of the present International Research and Production Associations does not have a strictly determined character.... it is necessary that the leading role in the set-up should be played by science."(60)

Among the plethora of organisational forms that have emerged in pursuance of the desire of CMEA-countries to adopt the intensive mode of development of their economies and therefore to give an impetus to the process of introduction of ever newer technologies, are the coordinating centres. The coordinating centres, joint laboratories and departments are set up in affiliation to some national research institute or design bureau. Coordinating centres are bodies which carry out the R&D programmes of member countries in selected problem areas. The function of a coordinator per se, is entrusted to one of the research institute or design bureaus which has the appropriate scientific and technological potential. A council of representatives is set up to take decisions on policy questions and to manage the activity of the coordinating centre and which is usually composed of leading scientists.

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60) Vlaskin G.A., Khachaturian A.A., Nauchno.. ..op.cit., p.160.

Obviously the desire is to avoid the mammoth organisational hierarchy involved in the International Research and Production Associations and to organise R&D around narrow target areas.

A number of coordinating centres (of which there were 65 in 1985) have shown commendable results. For example in the years 1981-85, 30 new technologies of welding and smelting and cutting were developed and introduced in the economies of CMEA countries under the framework of the Coordinating Centre formed on the 'Svarka' problem. Nearly 30 test models of welding equipment based on required specifications were developed including equipment for ultrasonic, electron radiation and plasma welding and for friction welding. As a result of joint research in Bulgaria GDR, Czechoslovakia and USSR, the production of welding robots has begun.[61] Joint research in the field of biophysics has brought about the development of automatic systems for processing spectrophotometric data, automatic analyses of microstructures and other equipment . This

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61) Ekonomicheskoe Sotrudnichestvo Stran Chlenov SEV, No.9, 1985, p.42.

equipment has been introduced into production and finds wide application in medicine, biology and agriculture.[62]

Another new and what is considered, an effective form of organisation in the cooperation of R&D which has emerged as a result of direct ties at the micro-level, are the temporary joint collectives of scientists and specialists, which is perhaps the most informal level of international contact and a form very widely and successfully employed in the West, with certain modifications. These collectives are set up to tackle concrete and specific problems and operate in one of the participating countries. The life of these collectives is determined by the time-frame required to achieve the task in hand. Toward the beginning of 1985 there were 10 temporary international collectives of scientists and specialists.[63] On a bilateral basis a great number of them came to the fore in the cooperation between GDR & USSR.

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62) Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV, No.2, 1982, p.25.

63) Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV, No.1, 1985, p.70.

At certain times their total number was in the region of 20.[64] The projects 'Polymer-50' and 'Polymer-60' which dealt with production of polyethylene threw up over a 100 inventions jointly conceived and developed by 4 combined collectives.[65] The joint Soviet-Polish group, formed in 1976, has developed cranes of capacity of 63 and 100 tons equipped with a special chassis and a caterpillar track.[66] A trilateral design bureau, composed of technologists from GDR, USSR and Czechoslovakia has been functioning at the Czechoslovak enterprise ZDAS which manufactures metal rolling equipment and machines for pressure processing. It is claimed that numb er of machines, developed by this firm are now being produced on the basis of international specialisation and have substituted machines which were hitherto being imported from West Germany and Japan.[67] Significant successes have been reported in the work of a joint Soviet -Hungarian collective in the development of a

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64) <u>Ekonomicheskaya Gazeta</u>, No.33, 1981, p.20.

65) <u>Izvestia</u>, 20 February, 1985.

66) <u>Ekonomicheskoe Sotrudnichestvo Stran Chlenov SEV</u>, No.11, 1983, p.10.

67) <u>Ekonomicheskoe Sotrudnichestvo Stran Chlenov SEV</u>, No.4, 1985, p.49.

comprehensive system based on the application of mini-computers, for the collection, processing, dissemination and storage of data relating to scientific research results and production trials of prototypes. A real-time navigational geophysical applicational programme has also been worked out which reportedly saves the Ministry of Geology of USSR 950,000 rubles annually.(68)

In the wake of the process of economic liberalisation launched by Gorbachov in the USSR, a number of Soviet enterprises acquired the right of dealing directly in the foreign market. This measure was followed by a 'Regulation on Realization of Direct Production, Scientific and Technical Ties between the USSR's Associations, Enterprises and Organisations with other CMEA-Member countries' Enterprises and Organizations' which created favourable grounds for the establishment of direct scientific and production ties between lower level organisations. To a greater or lesser degree a similar groundwork had either already been laid in other CMEA countries or is in the process of being laid.(69) In effect a manifestation

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68) Ekonomicheskaya Gazeta, No.38, 1983, p.20

69) Vneshnaya Torgovlya, No.8, 1987, pp.3,4.

of decentralization and devolution of powers to the basic economic units, these measures would enable national organisations to choose partners in other CMEA countries, carry out R&D with them and form for this purpose, joint groups and teams of scientists and specialists, exchange scientific and technical documentation and specialists and jointly set up councils of chief designers and technologists.

The Associations and Enterprises have been granted the right to conclude contracts, to specify commercial terms of scientific and production cooperation, including coordination of prices.(70)

The organisational structure of cooperation in R&D displays a considerable abundance of forms and modes - from Inter Government Commissions and apex coordinating CMEA organs to establishment of International Research and Production Associations on the basis of direct ties between enterprises of different CMEA countries.

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70) Shkarenkov Y. "Direct Ties as an Instrument Intensifying Foreign Economic Activity" in Foreign Trade, No.8, 1987.

The lack of significant success in one form has led to the establishment of another. Another reason for the proliferation of organisational structures is the change in emphasis in functions. Thus we find that the IEOs and the International Research and Production Associations coexist and the latter form has not displaced the former.

It is admitted that as an object of management and administration, cooperation in science and technology presents a particularly complex problem, embracing as it does various elements like the different aspects of the national R&D potential of member-countries, which in their turn have extraordinarily extensive inter-connections in terms of planning, material and informational characteristics. The integral connection of R&D cooperation with the process of integration of industrial production or in other words the formation of a unified 'Science-Technology-Production' process in the development of economic integration demands mutual compatibility of the economic, organisational and technical aspects of both the elements. This compatibility or unity would have to be based on the wide usage of planning and coordinating methods for the development of commercial incentives and levers, legal instruments and organisational forms.

It is noteworthy that till very recently, i.e. till the stage of formation of direct ties, it was considered practically impossible to conclude a comprehensive commercial agreement between organisations in two different countries that would cover the entire range of cooperation from R&D, testing of new models, production on the basis of specialisation and cooperation. This was so because the different aspects of cooperation were arranged for by different government departments, which moreover concluded agreements of a very general character. At the same time, the commercial side was looked after by the foreign trade organisation.[71]

The organic interconnection of scientific-technological cooperation and production cooperation is therefore perceived as not just a specific

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71) <u>Voprosy Ekonomiki</u>, No.5, 1987, pp.138,139.

case of integration and cooperation but the central theme and substance of the paradigm as a whole.[72]

The development of direct ties between the primary economic units of CMEA member states for setting up scientific, technological and production cooperation is envisaged as overcoming a number of impediments and obstacles which were considered endemic to the system. The attempt at removal of red-tapism and devolution of greater managerial powers lower down the structure has however created certain other problems which were not encountered earlier by the management of these enterprises.

The system of economic management prevalent earlier, during the phase of administrative control methods and industry's actual isolation from the world market, did not demand of this management a study of the world market situation, the products of competitors and the need to be 'competitive' in the fullest sense of the word. The most significant reform therefore, would be to change and mould managerial personnel's thinking. The manager-

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72) Bogomolov O.T., Bykov A.N., eds., Strany ....op.cit., p.94.

ial staff must now use new methods of 'management' which require initiative and a business like approach.[73] They have to independently identify prospective partners, develop cooperation measures and create new modern technologies assuring better quality products.

The problems facing the CMEA countries in the development of scientific and technological cooperation are two-dimensional: national and international. In the national systems it is the stifling effect of the huge bureaucracy and the systemic inflexibilities and rigidities which hinder the development of science and technology within the national system. They also hinder the development of the integral linkage of science with production. The inflexibility of the economic management system gives rise to a number of phenomena - the lack of easy access to information, the lack of managerial initiative, the lack of economic incentives etc. which affect the whole range of activities of a modern enterprise adversely.

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73) Shkarenkov Y., "Direct Ties...."op.cit.

It is easy to perceive that when these mammoth bureaucracies interact at the international level bringing with them their attributes of rigidity and orthodoxy, these very problems would acquire another dimension.

The bane of the CMEA countries' efforts at developing viable forms of scientific and production cooperation is expressed succinctly by Bykov - "...the formation of effective and stable production and technical ties between enterprises of socialist countries is hindered by the insufficient development of horizontal relations in the national, as well as the international system and by the multiplicity of steps and procedures involved in tackling the problems of their organisation and realisation."(74)

The changes being effected in the organisational structures, both national and international, testify to the fact that the CMEA countries are seized of the problems. The gradual changeover from administrative control methods to the system of modern management is a sign that the CMEA

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74) Kommunist, No.18, 1983, p.61.

countries are trying to come to grips with the realities of developing a viable and effective structure of cooperation in science and technology.

The two basic trends which have manifested in the development of the organisational forms for cooperation in science and technology, i.e. the strengthening of the science-technology-production linkage and the establishment of direct ties, have therefore to be seen in the light of the efforts made by the CMEA countries to mitigate the stultifying effect of the rigidity and inflexibility of the economic management systems of these countries.

CHAPTER III

The Comprehensive Programme For Scientific And Technological Progress Of CMEA-Member Countries Up To The Year 2000 (The CPSTP)

A host of factors - historical, economic and political led the CMEA - member countries to adopt the CPSTP in December 1985; a Programme which can be construed as a watershed in the history of their scientific and technological cooperation. Indeed in many ways, it signifies the coming of age of the integration process in Science and Technology in the CMEA countries.

In the first phase (late 1940s, 1950s and major part of 1960s) the development in scientific and technological cooperation between CMEA countries relied heavily on the capabilities of the USSR to supply technical "know-how" etc. and assist in the task of reconstruction of the war-devastated economies. Things began to change in the late sixties when the "barter trade" in science and technology, goods and products and the extensive character of economic development began to reach its limits and the more integrated and intensive forms of cooperation had yet to gain widespread currency.

In this situation there arose the possibility of importing technology from the Western countries helped by the general relaxation of tensions in the world arena and the onset of the process of detente. The rapid and spectacular strides taken by the economies of the Western countries in the 1950s and 1960s due to the efficient harnessing of the achievements of the scientific and technological revolution in their national economies was noted by many Soviet scholars.(1)

The objective need to hasten the process of modernisation of industrial production on the basis of the latest technology, to set up entire new branches of industry like radioelectronics and petrochemicals was sought to be fulfilled with the help of western technology, which in those days was readily forthcoming.(2) In 1976-77

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1) Hoffman Erik. P., Laird Robin F., The Scientific-Technological Revolution and Soviet Foreign Policy, Pergamon Press, (New York, 1982).

2) Shmelyov N.P., Ekonomicheskie Otnosheniya Stran SEV s Zapadom, Nauka, (Moscow,1983), pp.33-59.

for example, hi-tech goods constituted 49% of all goods exported by OECD (Organisation of Economic Cooperation and Development) countries to CMEA countries. Western technology played a significant role in the development of entire branches of industries and in development of a range of products like synthetic fibres, pesticides, plastics, light and heavy duty automobiles, high quality steel and aluminium rolling equipment electronic equipment and others.(3)

In the early 1980s, due to the changes in the political climate as well as hard currency constraints, the purchase of Western technology by CMEA countries took a sharp down swing. The countries of the North Atlantic Treaty Organisation also ensured that a number of 'Critical technologies' that could possibly have some application in the defense industries of the

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3) Mirovaya Ekonomika i Mezhdunarodniye Otnosheniya, No.7, 1984, p.133; Technology Transfer between East and West, (P., 1980), pp.69-71.

Warsaw Pact countries were made unavailable to them.[4] Thus, in 1980 for example, the share of hi-tech items exported by OECD countries to the CMEA member-states had come down to 10% of the total goods exported.[5]

On the other hand the realisation had been deepening that despite possessing nearly 1/3rd of the world's scientific potential the contribution of CMEA countries to the store house of world technology had been quite unimpressive. The political as well as economic significance of possessing a high technological development of the economy has come to be appreciated by an increasing number of CMEA scholars. It was conceded that the global alignment of forces can not merely be reduced to its military - strategic nuclear parity etc. Recognising the other ramifications, it is admitted that the

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4) In November 1984, the Pentagon published a hitherto secret list (compiled annually since 1980) of technology banned for export to USSR and other CMEA countries because of their military strategic nature; see New York Times, November 19,1984.

5) International Herald Tribune, July 29, 1982.

'correlation of forces can shift in favour of socialism' only if the developed socialist societies manage to harness the productive forces of the Scientific-Technological Revolution. In other words the very survival of attraction of socialism as an economic system now depends on its ability to compete in the hi-tech sphere with the advanced Western countries. CMEA policy makers and analysts have come to recognise that East-West competition is not limited to the quantitative growth of major industrial sectors, but is also related to the emergence of complex new economic growth models, which emphasise the stimulation of basic scientific research, the technological modernisation of industries and the pressing need to increase labour productivity.(6)

The conviction has therefore grown that the role of the policy of imitation in the sphere of science and technology is unacceptable, particularly in the present stage of rapid

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6) Shukardin S.V., Gukov V.I., eds., Nauchno-Technicheskaya Revolutsia, Nauka, (Moscow, 1976).

development of revolutionary and path breaking new areas in science. Soviet analysts are of the view, that in the era of scientific and technological revolution the economy of any country is based, to a greater or lesser degree on technological leadership in areas which determine technological progress as a whole or it develops those areas which for some reason or the other have not been developed by the leading nations or, thirdly it adopts the path of mass-production of common goods. They feel that the first model largely corresponds to the scientific-technological and production potential of USSR.(7) Others however, taking a more pragmatic and realistic view of the R&D potential of the USSR and other CMEA countries concede , "The CMEA countries possessing 1/3rd of the world's R&D potential... cannot be in the forefront of all the new areas of continuous and rapid development of science and technology and therefore with a view to economise resources and time, are interested like all other countries in the

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7) <u>Voprosy Ekonomiki</u>, No.5, 1987, p.140.

effective usage of the advantages of the international division of labour, in cooperation with the countries of Western Europe, U.S.A. and Japan, which are the major scientific and technological centres of the capitalist world."(8)

The strategy of development of science and technology was therefore conceived as stepping forward along a broad front of science and technology and concentrating all the resources at hand in the key sectors. The key problem therefore, was seen as consisting of the choice of the priority areas for cooperating in science and technology. The Soviet Prime Minister Mr.Ryzhkov, speaking at the adoption of the CPSTP remarked "...we proceed from the basic assumption that the world is entering a new stage of scientific and technological progress, characterised by a comprehensive transformation of production, increasing demands placed on the training, education and qualification of personnel and on the forms and methods of management. This stage is witnessing the changeover from incomplete,

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8) Bogomolov O.T., Bykov A.N., eds., Strany SEV v Mezhdunarodnom Obmene Technologiyei, Mezhdunarodniye Otnosheniya, (Moscow, 1986), p.166.

ad-hoc technologies to entire systems of technologies of a totally new generation."(9)

The stage for the adoption of CPSTP was set by the enactment of a number of other documents of long term orientation in the field of science and technology. In 1978-79, 5 long term target programmes of cooperation were adopted to coordinate the strategy of development of economic, scientific and technological cooperation on a long term perspective. Similar plan documents were also signed on a bilateral basis. Thus, toward the beginning of 1985 there existed 17 such bilateral and more than 230 multilateral programmes.(10)

By 1985, the CMEA countries had accumulated some experience in the field of prognostication and forecasting in the area of development of the national economies, which became the basis of joint exploration of the prospects of development of science and technology of the CMEA bloc as a whole. Thus, in the process

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9) Izvestia, 18 December, 1985.

10) Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV, No.10, 1985, p.52.

of formation of plans and programmes of cooperation over the years 1981-85, the results of 130 scientific and technological forecasts, made in the framework of CMEA were used. Later certain long term cooperation programmes in specific areas were also worked out. The problems of long term all round development of atomic energy were studied by a group of scientists and specialists, set up by the Committee of CMEA on Science and Technology, with the aim of preparing an inter-branch forecast - 'The Development of Atomic Energy in CMEA member countries beyond 1990 (1990-2010).' This forecast attempts to determine the future role of atomic energy in the fuel and energy complex of the socialist countries on a long term perspective and analyses the scientific, technological and organisational prerequisites necessary for the greater utilization of atomic energy in the civilian economy.(11) Similarly a forecast for the development and application of computer and microprocessor technology in the economy was made together with the projected demand in robots and their constituent

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11) Ekonomicheskoe Sotrudnichestvo Stran-Chlenov SEV, No.12, 1984, p.58.

elements upto the year 1990-1995.[12] Also, during the process of formulation of CPSTP itself another collective document was prepared - 'The Prognosis of Basic Problems of Science and Technology of Common Interest to CMEA member countries over a 20 year Perspective.'

The adoption of CPSTP has therefore come about for a number of reasons. On the internal, domestic front of the CMEA countries - it is seen as helping to solve the acute economic problems that have piled up over the years. On the international economic front - it is a response to the difficulties involved, financial, political and otherwise in the purchase of hi-tech equipment and machinery from the West. On the politico-ideological level - it is seen as a vehicle for demonstrating the capacity of socialism to undertake innovation and modernisation in its stride and present a new side to the world.[13] Finally, at the CMEA policy

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12) Ibid. p.60.

13) The CPSTP document itself notes "...as a result the socialist positions in the peaceful competition with capitalism will be considerably strengthened."; see CPSTP. The Main Points, Novosti, (Moscow, 1985), p.6.

level, it is seen as the latest and one of the most important steps taken on the road to integration of science, technology and production and formation of a common technology pool of the CMEA countries.(14) It was admitted that one of the ways of achieving greater cooperation in R&D among CMEA members was to concentrate its efforts on certain priority areas and to remove areas of duplication and scientific pluralism. It was also deemed necessary that depending upon the scientific potential of individual member countries, each one of them was to specialise in certain specific areas within the priority items. As declared by T. Zhivkov at the February 1985 Plenum of the Bulgarian Communist Party - "We do not intend to develop all areas of science and technology, but would like to concentrate our efforts in those areas which are intricately linked with our economy and with our

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14) Bykov A.N., "Novie Rubezhi Kooperatsii Stran SEV" in Kommunist, No.18, 1983; Simanovsky S.I., "Sovmesny Bank Technologii Stran Chlenov SEV" in EKO, No.11, 1983, discuss formation of common technology pool of CMEA countries.

participation in the international division of labour."[15]

The official document of the CPSTP, in Section I, gives the justification for the adoption of the Programme as "...CMEA member countries... have entered a new, higher stage of development and cooperation in every area of social life .... and that the intensification of production on the basis of accelerating scientific and technological progress, constitutes the main element in the fulfilment of tasks facing them...." Later - "...the CMEA member countries have agreed to act concertedly for the development and use of fundamentally new types of machinery and technology concentrating their efforts and organising close all-round cooperation within the CMEA framework along five priority lines:-

- electronicization of the national economy
- comprehensive automation

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15) Quoted in Vlaskin G.A., Khachaturian A.A., Nauchno Technicheskie Issledovaniya i Razrabotki v Europeskikh Stranakh SEV, Nauka, (Moscow, 1986), p.124.

- nuclear power engineering
- new materials and technologies for their production and processing.
- bio-technology."[16]

The aims and objectives as set forth in the Programme are -- to achieve the highest level of science, technology and production in the most important areas of scientific and technological progress, doubling the production of social labour and drastically reducing the specific expenditure of energy and raw material per unit of national income in CMEA member countries as a whole by the year 2000.[17]

The key sectors have been chosen "...on the basis of the summation of both our own and world experience, as well as of the results of joint scientific and technological forecasting."[18]

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16) CPSTP...op.cit., pp.4,5.

17) Ibid., p.6.

18) Ibid., p.12.

It is interesting to note the striking similarity in the choice of the priority areas of the CPSTP and the choice of the priority areas of the Eureka Project on European Technological Cooperation, adopted in November, 1985 by 12 member states of the European Economic Community together with Sweden, Finland, Norway, Austria and Switzerland. The Eureka Project aims to organise large scale scientific and technological cooperation in five areas of latest technology :-

(1) Microelectronics and informatics

(2) Automation facilities and laser equipment

(3) Telecommunication

(4) Bio-technology

(5) New materials.[19]

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19) European Unification. The Origins and Growth of the European Community. Office for Official Publications of the EEC, (Luxemburg, 1986), p.48 ; Plucinsky Eugeniusz, "Main International Trade Trends in the Ongoing Scientific and Technological Revolution" in Foreign Trade, No.8, 1987, p.46.

ELECTRONICIZATION OF THE NATIONAL ECONOMY

There are three major thrust sectors in this priority area of cooperation. They are:-

(1) **Computers**

The development of supercomputers with an operating speed of over 10 billion operations/second using the principles of artificial intelligence, including pattern recognition, voice recognition and knowledge based expert application systems. At the same time, at the other end of the computer spectrum it is planned to introduce personal computers on a large scale to broaden the base of 'computer culture' and introduce it into every sphere of activity.

This would be accompanied by the development of high quality peripherals including laser printers, magnetic tapes and discs, high resolution liquid crystal display and light electric diode display monitors etc. Corresponding demands would be placed on the software to run the machines - both operating systems software and the application packages for general and specific usages. The development of computer-aided-design systems and computer-aided management systems is also in the pipeline.

(2) **Microelectronics**

The development of microelectronics hardware base is to receive special attention. This involves the development of manufacture of an entirely new generation of very large scale and very high speed integrated circuits which are the building blocks of computers. This in its turn entails the search for new super pure materials and the construction of specialised equipment and machine tools for their manufacture. The development of microelectronics is also supposed to give a boost to the construction of new electronic sensors, control instrumentation and microprocessors.

(3) The proper and efficient realization of an effective computer network is impossible without a concomitantly high level of technological development of the telecommunications infrastructure. Therefore, the development of an integrated system of transmitting digital information figures high on the priority list. The telecommunication network would have to ensure a considerable increase in throughput and reliability and would also involve the development of the state-of-the-art high speed fibre-optics technology.

The construction of a new generation of a satellite systems network of telecommunications and telecating is also considered a high priority area. At the level of consumer goods it is envisaged that high quality digital television and FM (Frequency modulated or stereophonic) radio broadcasting and digital audio and video recording facilities would be developed.[20]

20) Soviet Export, No.3, 1987.

The expected net upshot of the realization of the programme of electronics is a sharp increase in the growth rates of national incomes and labour productivity. It is also supposed to result in a drastic reduction upto 33-50%, of materials and energy consumption per unit of output. Even in the area of R&D cooperation of CMEA countries, it is envisaged that the creation of data banks and information and knowledge -bases on various parameters of R&D potential of individual countries, the stage of development of specific new products and technology would go a long way toward eliminating duplication of research work and ensure swift and prompt setting up of R&D ties. It would also cut down the lead time for working out and implementing scientific and engineering projects.[21]

It should be noted at the very outset that most of the elements of this area

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21) Voprosy Ekonomiki, No.5, 1986.

of cooperation are very much in the initial stages. As mentioned earlier, so far the most conspicuous success of the CMEA countries in the field of computers has been the development of the Ryad Series, together with the accompanying assortiment of standardised and compatible components and software systems. The Ryad-2 Series phase is now being implemented, involving the diversification toward both ends of the computer system from mainframe systems toward supercomputers on the one hand and personal computers on the other.(22)

The lag in the development of computer technology vis-a-vis Western countries led to considerable imports of computers, peripherals and software from them, particularly in the 1970s. During 1972-78 the East European countries (not including USSR) imported $ 639

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22) Mir Sotsializma v Tsifrakh i Faktakh 1985. Spravochnik, Politizdat, (Moscow, 1986), p.24.

million worth of computer equipment from the West; in 1978 alone, the USSR imported $ 352 million worth of computers and related items.(23)

In May 1985, at a meeting of the Inter-Government Commissions on Computer Technology, it was decided to act jointly in the field of 5th generation computers, artificial intelligence and personal computers under the aegis of 'Inter-set' sub-programme.(24) A certain amount of progress has been reported in this field. Gennadi Ryabov, Director of the Precision Mechanics and Computing Technology Institute of the Soviet Union has outlined(25) the active cooperation of CMEA nations in the task of R&D of super-computers of unparalled capacity (memory) and speed. He states that the design of the super

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23) Tasky Kenneth, "East Europe:Trends in imports of Western Computer Equipment and Technology" in East European Economic Assessment, Joint Economic Committee, Congress of the U.S., (Washington D.C., 1981), Part II.

24) Elorg, No.1, 1986.

25) Hindustan Times, 15 May, 1987.

computer will be based on 'parallel processing' method, carried out by 16 processors. The basic principles, according to Ryabov, have already been tested in the serially manufactured Elbrus computer (125 million operations/second), which is the current top-of-the-line CMEA countries' model. He further elaborates that Soviet scientists are considering increasing the operational speed upto 10 billion operations/second based on chips using latest materials and physical principles. In this venture, the CMEA partners will undertake to contribute entire functional sub-systems rather than individual components. For instance, Hungary is to upgrade the level of programming languages and devise new ones and Poland will develop unified power sources for the supercomputer.

On a bilateral basis, the Soviet association 'Vneshtechnika', which deals in cooperation of R&D on a commercial basis with foreign countries in general, has concluded a contract for the development of operational systems for unified computer facilities. The work reportedly involves the Soviet Scientific Research Centre for Electronic Computer Technology and the Robotron Integrated Works of GDR. At the same time unified computer graphics software is being developed jointly with Czechoslovak partners.(26)

The Soviet Union is taking the leading part in promoting development of computer technology cooperation. The ambitious plans of the Soviet Union itself call for the production of nearly a million personal computers in the 12th Five Year Plan (1986-1990). The importance accorded to the programme of computerisation is also underscored by the fact that a new, division for informatics, computing technology and automation has been set up under Academician Evgeny Velikhov, at the Academy of Sciences of USSR. Another recent development is the formation of the Scientific Committee for Computer Technology and Informatics.(27)

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26) Soviet Export, No.3, 1987, p.45.

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A number of contracts have reportedly been concluded for the development, manufacture and installation of digital information systems and microprocessor based communication equipment, involving organisations in the Soviet Union, Bulgaria, Hungary, GDR, Poland, Rumania, Czechoslovakia and Cuba.(28)

Contracts have also been signed for the joint development of a unified system of switching facilities. From the Soviet side the work will be carried out by the Riga Production Amalgamation - VEF and research groups from all European CMEA member countries and Cuba will take part.(29)

GDR's VEB Spurenelemente Freiberg Enterprise has developed the manufacture of silicon wafers which is the base material for the productions of chips and integrated circuits, thus giving GDR a leading role in the plans of CMEA for electronicisation in general and microelectronics

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28) <u>Soviet Export</u>, No.3, 1987, p.44.

29) Ibid.

in particular.(30) According to an Information Bulletin of the Kiser Research Inc., a Washington D.C. based consultancy organisation, specialising in East-West Trade and Technology Transfer, the Soviets have apparently developed an advanced method for manufacture of gallium arsenide, which is the latest material used in the manufacture of chips and which assists in a much higher degree of miniaturisation and speeds.(31) Soviet scientists are reportedly also pioneering methods for applying thin coatings of diamond film to make computer chips radiation resistant. Dr. Rustum Roy of the Pennsylvania State University is of the opinion that Soviet research in this field is far ahead that of the West.(32)

At the risk of belabouring the point, it may however be stated that the CMEA countries are still very much behind technologically, in the sphere of electronics as a whole, notwithstanding the priority accorded to it over

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30) Business East Europe, 14 April, 1986.

31) Kiser Research Inc. Guide to Soviet Gallium Arsenide Technology, (Washington D.C.) (obtained in the form of a photocopy).

32) New York Times, 16 December, 1986.

the last decade and particularly in the aftermath of the CPSTP. For instance, while the CMEA nations are very much in the process of construction of a supercomputer together with the software, algorithms et al, the West has been manufacturing them for quite a few years now. The U.S. supercomputer models 'Cray' and the Japanese 'Fujitsu' and 'Nippon Electronic Corporation' supercomputers are well known throughout the world. Studies in artificial intelligence, and expert systems have taken great strides in a number of Western Universities like Carnegie-Mellon, Stanford etc. A number of expert systems have even been introduced into the economy, for example in oil exploration, offshore oil drilling etc. The Japanese have undertaken the construction of a 5th generation computer incorporating principles of artificial intelligence on a war footing and are reportedly within striking distance of success. Personal computers too, have been around on a mass scale in the Western countries for a number of years now and consumers have a vast range of models to chose from - starting from the American 'Apple', 'IBM' PC to the German

'Nixdorf' and others. They are accompanied by a bewildering variety of software packages for conceivably every possible business, domestic or leisure application. All these advances at the end - stream of computerisation have been made possible by a very highly developed level of micro-electronics technology, including very large and ultra-large scale integrated circuits, microprocessors and peripherals as well as by tremendous progress in the telecommunication infrastructure using satellite channels for computer communication, etc.

According to Loren Graham, there are a number of factors which inhibit the growth of the computer culture in CMEA countries. Among others they are : (1) A lack of tradition of free access to information (2) A lack of tradition of creating large amounts of reliable and accurate data about the economy, (3) A lack of widespread education in business and technological skills, including typing and programming, (4) Poor telecommunications infrastructure and (5) Lack of consultancy services, maintenance and spare parts.(33)

While it remains to be seen what CMEA countries' authorities do about (1) and (2) on a consistent basis, there are attempts to tackle the other factors within the framework of the CPSTP as well as national programmes. For instance, in 1985-86, a course in Fundamentals of Informatics and the Use of Computers was introduced in the 9th grade of Soviet schools.(34) However, the lack of 'hands-on' training, a characteristic feature, particularly of the higher education establishment would probably hinder the growth of knowledge in this vital sphere.

The low level of development of the telecommunication system is another area which hampers modern communication and computer networking. Acknowledging that "...the development of infrastructure is a precondition for intensive

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33) Graham Loren, "Science and Computers in Soviet Society" in The Soviet Union in the 1980s, Hoffman Erik P. ed., Academy of Political Science, (New York, 1984).

34) Frolov K., We Count On Machine Building, Novosti, (Moscow, 1986), p.32.

growth", the Hungarian scholars R. Koch, Corresponding Member of Hungarian Academy of Sciences and E. Radnoty bemoan the fact that it is "...lack of telephone lines which hampers computer network growth."(35)

Another point which is significant is that in the West the most dynamic aspect of the computer business is the development of sofware. In the U.S., in particular, software programming seems to be an activity akin to a cottage industry. A lot of software packages are developed by individuals, small groups, or firms. It remains to be seen how the Soviets and others tackle in future this aspect of computerisation of their economies; the present trend is to hand over development of software to enormous research institutes and appoint large groups to handle its production.

On the other hand CMEA scholars display considerable optimism regarding the development of computer technology in the socialist countries,

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35) Koch R., Radnoty E., "Infrastructura i Uroven Zhizni" in Voprosy Ekonomiki, No.4, 1987.

relying basically on the planned nature of their economies. Thus, according to Ilyin "...the opportunity for conscious management of economic and social processes throughout the entire society, allow for the much broader and more effective application of ... automatic cybernetic technology than under capitalism"(36) and "...centrally directed utilization of the state budget toencourage technical innovation is one of the most significant advantages of the planned socio-economic system over capitalism."(37)

COMPREHENSIVE AUTOMATION

In this priority area the CMEA countries have set themselves the task of developing flexible manufacturing systems, as well as completely automated man-free plants, systems for automated design and for management of production, technological processes and integrated control systems, industrial robots including robot-man interfaces using visual and oral commands, automated technology for production of super

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36) Ilyin S.S., Volkov F.M., eds., Soedinenie Dostizheny NTR s Premushestvami Sotsializma, MSU, (Moscow, 1977), p.50

37) Ibid., p.27.

precision equipment and instruments, standardised components like thyristors, microprocessor controls etc.[38]

The introduction of these technologies aims to cut the expenditure involved in the design and manufacture of products by 1.5 times, halve the amount of labour required for their manufacture and increase shop-floor labour productivity in the sphere of material handling and storage by at least 4 times. Automated design and control systems of technological processes, would, it is envisaged, help raise the quality of planning, accounting, managing and organisation of production and reduce the lead-time of technological preparation 1.5 to 2 times.

The implementation of these technologies on a wide scale in the CMEA countries would, it is planned, increase labour productivity 1.5 - 4 times, increase the capacity of production equipment by 30%, cut down maintenance and other

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38) <u>CPSTP</u>....op.cit., pp.16, 17.

expenditure on factory equipment by about 15% and sharply reduce the gestation period of producing new items and goods by nearly 40%. The considerable expense involved in the development and manufacture of this new generation of technology would be recovered, it is claimed, in 2-3 years thanks to the rise in labour productivity, improvement of technical and economic characteristics and quality of products and a significant fall in maintenance and other costs in subsequent years.[39]

It should be noted that all the five priority areas, earmarked for development by the CMEA countries, are interconnected in a myriad ways. The development of one is not possible without the corresponding improvement in any of the other four. This is particularly true of the priority area of automation which embraces in its fold the entire gamut of the engineering industries. Machine building for instance, is the core specific engineering area of the automatization programme which is very intricately connected not just with the priority

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39) <u>Mir Sotsializma</u>....op,cit., p.25; <u>Ekonomicheskie Nauki</u>, No.3, 1985, p.5.

development of automation but also with the programme for electronicisation and the new materials programme.[40] While the automation programme as a whole is an end-user of the results and products of the 'new materials' sphere and the 'electronicisation' sphere, it is also in its turn the supplier of automated systems of production, to be used in every field of technical production including electronics and new and composite materials. The same holds true for the production areas of electronics and new materials.[41]

The importance accorded to the programme of automatization is underscored by the fact that according to CMEA - economists the European CMEA countries have approached the limits of saturation in so far as the traditional methods of automatization like mass-production lines, process industry lines etc. are concerned. According to them these limits are reached at the level of 50-60% complete or partial automatization of production of the entire production

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40) Soviet Export, No.3, 1986, pp.20,21.

41) Aganbegyan A.G., Make The Economy Responsive to Innovations, Novosti, (Moscow, 1986), p.22.

sphere (in money terms) and at the level of 12-18% mechanisation/automatization of labour.(42) Thus, toward the end of the 1970s, the share of automatised equipment in the Hungarian industry was 62%, in the GDR 51% and in Czechoslovakia 57.8%.(43) The introduction of traditional means of automatization had also resulted in serious disproportions in the level of automatization in different branches of industries. Its level was much higher in the process industries like the chemical industry, energy sector, and textile industry and lower in the branches where discrete products are manufactured for example, the machine building sector, construction materials manufacture etc. in which the implementation of traditional, automatic equipment is fraught with some technical difficulties. The constraints of economies of scale have also contributed to the disproportion as well as highlighted the limitations of introduction of these technologies of automatization. Even in the USSR, a country of mass scale production of industrial

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42) Tromplakova E.G., Effectivnost Proizvodstva v Europeskikh Stranakh SEV, Nauka, (Moscow, 1986), p.55.

43) Ibid.p.54.

items, it is reported that 70% of the entire nomenclature of machine building production has a product-run of less than 100 numbers and of parts - upto 600 numbers annually.[44] On the other hand, it is a well-known fact that traditional means of automatization are most effectively applicable in industries where large scale production is involved. Moreover the introduction of automatic production lines and other traditional technologies, further sharpened the contradiction between automatization of production (in large-scale manufacture) and the need for innovation of products as it led to down-time, required for refashioning the line etc.[45]

The further introduction of these technologies of automatization is therefore seen as not contributing to the growth of production efficiency, creating further problems in the form of disproportionate growth of the automatization level of different sectors of industry and inhibiting the development of new products

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44) Ibid.,pp.55,56.

45) Rowen Henry, "The Soviet Economy" in <u>The Soviet Union in the 1980s</u>, Hoffman Erik P., ed., Academy of Political Science, (New York, 1984).

and goods. The solution therefore is seen in the form of flexible production modules and manufacturing system, programme control devices for all types of production equipment, and the grouping together of these component elements into what are known as 'programmable or unmanned manufacturing systems.'

The unmanned manufacturing systems or the automatic production systems, the base technologies for the new plants and factories in the offing, would basically consist of 3 components - numerically controlled machine tools (based on microprocessor element and mini computer; a new type to be developed are the laser-beam tools), coordinate measuring machines for feedback on the machining process and industrial robots. These 3 elements tied into a whole by a computer would make a programmable manufacturing system. The modular design would facilitate changes in the production structure as well as development and innovation of new products and goods.(46)

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46) Soviet Export, No.3, 1986, pp.10,11.

The Soviet Union is called upon to play a leading role in the development of this priority area in general and the priority sector of machine building in particular. It is interesting to note that the imports of the USSR of machines and equipment from the European CMEA countries are greater than the exports, a situation which is inextricably connected with the structure of Soviet-European CMEA trade, based on the export of fuel and raw materials and import of machines and equipment.

However, at the same time, it is suggested by the Soviets that notwithstanding the smaller share of products of the machine building sector in Soviet exports, the technological role of the USSR should increase constantly and constitute the nucleus of the socialist countries in their joint efforts for intensification of the production process in these countries.(47) This is sought to be ensured by involving the CMEA countries in mastering the base technologies worked out by the Soviets, in the process of cooperation in scientific and technological projects.

47) Voprosy Ekonomiki, No. 6, 1987.

In an effort to strengthen the links between science and production in the development of new machines about 3/4th of sectoral research institutes in the USSR are now affiliated to the respective production amalgamations.(48)

As a result of Soviet-Bulgarian cooperation in the field of machine building, Soviet machine tools would be equipped with Bulgarian hydraulic equipment and electric drive systems. The Bulgarians would also be specialising in the manufacture of workhandling robots and linear transducers for machining centres.(49)

The Fritz Heckert Kombinat of the GDR would also be involved in the work relating to the development of flexible manufacturing systems and machining centres.(50)

On the whole a total of more than 200 agreements on specialization and cooperation

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48) Aganbegyan A.G., Make....op.cit.p.22.

49) Soviet Export, No.1, 1987.

50) Ibid.

have been concluded by CMEA countries including a number of bilateral ones.[51] In 1985 the CMEA countries also set up a coordinating council for creation of flexible production systems.

In purely quantitative terms the CMEA countries have certainly made big strides in the past few years in the manufacture of products of the machine building industry as a whole, including flexible production systems (totally automatised factories, factory shop-floors etc.) as well as robots.

In 1985, in the USSR itself 3600 new models of machines, equipment and automatic control systems were prepared for introduction. Moreover 11000 production flow lines, automatic and rotor transfer lines and 193 flexible automatic production systems were also introduced.[52] The country produced 13200 robots in 1985, which made it the second largest manufacturer of robots in the world after Japan. The 12th Five-Year Plan envisaged producing 28600 robots in the

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51) Soviet Export, No.3, 1986.

52) Ibid.

year 1990; the total number of robots employed in the economy by then would be in the region of 100,000. Over the years 1986-90, the USSR would also be developing 2000 flexible production systems.[53]

Similarly, in the GDR the total number of industrial robots and manipulators introduced into production was to reach 56500 by the end of 1985.[54] Czechoslovakia was slated to manufacture more than 3000 robots and manipulators in the period 1981-1990 and approximately 13000 by 1990.[55]

The great advances in the quantitative output of robots in CMEA countries is also underscored by the fact that if in the mid-1970s the CMEA countries possessed one robot out of 20 in the world, then by 1983 more than half of the world's total number of robots were employed

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53) <u>Economicheskoe Sotrudnichestvo Stran Chlenov SEV</u>, No.2, 1986, p.46.

54) Ibid., p.50.

55) Quoted in Tromplakova E.G., <u>Effectivnost</u> ...op.cit., p.59.

in the CMEA economies.[56] By the year 1990, the total pool of robots in the CMEA countries would comprise of nearly 200,000 robots.[57]

ACCELERATED DEVELOPMENT OF NUCLEAR POWER ENGINEERING

The tasks in this priority area are - improvement in and further construction of nuclear power stations with VVER-440 and VVER-1000 type water-cooled, water-moderated reactors having higher technical and economic efficiency, a high degree of equipment standardisation, and improvement in the use of natural uranium. The development and adoption of new, reliable and safe methods of processing, transporting, and disposal of radio active waste, the construction of nuclear heat-supply stations, the development of equipment for fast-neutron reactors and the conduct of research in the development of new source of energy - controlled thermonuclear fusion are also high priority tasks within this area.

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56) Yurigin O., "Novaya Otrasl - Robot -ostroenie" in SEV Commentary i Informatsia, No.23, 1983.

57) Mirovaya Ekonomika i Mezhdunarodniye Otnosheniya, No.11, 1984, p.30.

The economic objectives of this programme are - building up the energy potential of the CMEA member countries, lower investments in the traditional fuel sectors and the release of considerable quantities of scarce organic fuels for other needs.

Cooperation in the field of nuclear power engineering is one of the traditional areas where joint development and specialised manufacture of nuclear power plant equipment has been well established under the framework of 'Interatomenergy'. The cooperation in the sphere of development of the nuclear power industry based on the VVER-440 and VVER-1000 would therefore simply be an improvement in degree and not in kind. (See Chapter I).

There are certain other sub-areas in this priority line which are however comparatively new and perspective fields of cooperation. The development of reactors on fast - neutrons, the so-called fast breeder reactors is one such line. One of the major advantages perceived in the introduction of fast breeders is the capability of fast breeders of not only generating power but also of ensuring the production of fuel for the nuclear power industry. A combination of thermal and fast reactors according to the well-known nuclear scientist Alexandrov "...makes it possible to create a fuel cycle in the nuclear power industry practically unlimited in both scope and time." (58)

The Soviet Union already has a number of breeders in operation including one of the world's largest - the 600 MW fast-breeder at the Beloyarskoe nuclear power station in the Urals.

At present, Bulgaria, Hungary, GDR, Rumania, Czechoslovakia and the USSR are carrying out research in the field of controlled thermonuclear fusion under the framework of a general agreement in the field upto year 1990.(59) It

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58) Alexandrov A., Possessing Energy Resources Is Not Enough, Novosti, (Moscow, 1986), p.22.

59) Kommunist, No.12, 1984, p.82.

is planned to build prototypes of thermo nuclear reactors based on the 'Tokamak', the Soviet designed installation for magnetic retention of plasma, which has gained world-wide acceptance in this field as a promising line of development of thermo-nuclear reactors.(60)

At present the total capacity of nuclear power stations in the CMEA countries has exceeded 35 million kilowatts and the realisation of the programme for accelerated development of the nuclear power industry is envisaged to create a total capacity of 100 million kilowatts by 1990.(61)

Incidentally, it is interesting to note that the development of the nuclear power engineering industry does not figure as a top priority R&D programme in any of the major industrial nations. On the other hand, in the CMEA countries and the Soviet Union in particular, even the Chernobyl disaster does not seem to

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60) Tokamak; Towards Thermonuclear Energy, Novosti, (Moscow, 1982).

61) Mir Sotsializma....op.cit., p.26; Kommunist No.10, 1984, p.11.

have dampened official enthusiasm for nuclear energy. Its implications are sought to be confined to the sphere of ensuring greater safety measures and the question of construction of new nuclear power plants, per se, is not brought into question at all.(62)

NEW MATERIALS AND TECHNOLOGIES FOR THEIR PRODUCTION AND PROCESSING

This priority area sets before the CMEA countries among others, the task of :-

- The establishment of industrial production of a broad range of new, high strength, corrosion and heat resistant, composite and ceramic materials and their wide application in electronics, chemical industries and medicine.

- The development and introduction of new plastics capable of replacing the scarce natural materials, ferrous and non-ferrous metals and alloys and considerably improving the operational charac-

62) Alexandrov A., Possessing....op.cit.,pp. 25,26.

teristics, qualities and durability of machines and equipment.

- The development, using methods of powder metallurgy of new wear-resistant materials on the basis of ferrous and non-ferrous metals, as well as of refractory compounds.
- The development of amorphous and micro-crystalline materials, possessing a unique combination of mechanical, electrical, corrosion resistant and other properties.
- The development of new semi-conductor materials for micro-electronics.
- The improvement of continuous steel casting technology.
- The development of technological lasers for metal and material processing.
- The use of plasma, vacuum and detonation technologies for applying hardening coatings.

The economic objectives of this programme are - to raise the technological level in mechanical engineering, metallurgy, radio-electronics, electrical engineering and the chemical industry, to increase the reliability and durability of machines, reduce their per-unit consumption of materials, labour and costs and achieve a considerable saving of other conventional metals and resources.[63]

The tremendous significance of this priority area is stressed by Marchuk, according to whom "...in the next 15-20 years, scientific and technological progress will be determined by achievement in the materials sciences."[64] He however, goes on to add that "...steel will continue to be the principle material for a long time to come."[65] and that improvement in the technology of steel production is of crucial importance which explains the inclusion of steel, the traditional metal in the development programme.

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63) <u>CPSTP</u>...op.cit., pp.21,22.

64) Marchuk G., <u>Science Will Help Speed Production</u>, Novosti, (Moscow, 1986),p.15.

65) Ibid.

As in the other priority areas the Soviet Union is to play the dominant role in the R&D of new materials. Referring to new materials, their manufacturing technology and treatment, L.Papp, the Deputy Chairman of Hungary's State Committee for Technological Development pointed out that European CMEA countries are able to obtain knowledge that would be hard to get in other conditions and much slower, if it were not for Soviet research in this field. Soviet-Hungarian scientific and technological cooperation in the past 5 years has resulted in expanding the assortiment of chemical agents and super-pure substances and 26 new technologies were developed.[66]

Soviet-Bulgarian cooperation concentrates on problems, the solution of which will help supply both countries' economies with progressive structural plastics and secondary polymer materials from rubber and plastic wastes etc. The Soviet-Polish programme envisages joint efforts in

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66) From The CMEA Countries' Press. An Informative Review, CMEA Secretariat, No.20, 1986, p.7.

developing new types of structural plastics and the Soviet-Czechoslovak project centres on greater specialisation in research and in the production of super-pure materials for electronics etc.[67]

The Soviet Scientific and Production Association 'Plastmassy' has been appointed Head Organisation for the polymerised plastics sector of the new-materials programme. It is to cooperate with Science and Production Associations in other CMEA countries, in particular the Bunawerke enterprise of GDR.

The Soviet Research and Production Association 'Plastik' is the Head Organisation handling another vital problem - the development and introduction of automated methods of manufacture of and designing products from polymerised materials. The basic form of cooperation here will be joint, contract based R&D involving organisations and enterprises in Bulgaria, GDR and Rumania.

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67) Vneshnaya Torgovlya, No.3, 1987.

Of late, the potentialities of composite materials, combining a metal and a polymer, or a metal and ceramics or a metal reinforced with carbon, boron, silicate or even organic compound fibre, are coming to be recognised widely. This fact was brought home recently by the non-stop round the world flight of the American plane 'Voyager', which was made almost entirely from composite materials. Reportedly, composite materials have been widely used in the Soviet AN-124 Ruslan aircraft, the largest freight plane in the world.(68)

The special conditions generated by weightlessness in space have created favourable grounds for developing super-pure materials and special alloys. In conjunction with other CMEA countries, the Soviet Union has designed and conducted over 600 experiments on new materials and semiconductors on the Salyut 6 and 7 space stations. The new 'Mir Station' reportedly has 'crystallization facility' for manufacture of super-pure crystals and an electrophoresis unit for pharma-

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68) Frolov K., We Count.... op.cit.

ceutical and biological substances.[69]

ACCELERATED DEVELOPMENT OF BIOTECHNOLOGY

Under this programme top priority has been given to the development of the following:-

- New biologically active substances and medicines (interferon, insulin, human growth hormones etc.) for early diagnosis and treatment of serious diseases.

- Microbiological means of plant protection; development of new highly productive varieties of agricultural plants, obtained by principles of genetic engineering.

- Valuable feed additives for raising productivity of cattle breeding.

- Biotechnologies for effective processing of agricultural, industrial and urban waste etc.

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69) Pesavento Peter, "Sputnik's heirs: What The Soviets are Doing in Space" in Technology Review, October 1987, MIT.

The social and economic objectives of the programme are to develop rational use of renewable, biological resources in the national economy, raise health standards, ensure fuller and wider variety of food and medicine and to improve the state of the environment.[70]

It is admitted that "...on the whole the biotechnology industry in CMEA member countries is in the stage of organisational and technological formation."[71] As pointed out by Business East Europe, though the comprehensive programme envisages bloc-wide cooperation "...in practice however most biotechnological developments have been achieved by individual countries."[72] There appear to be 3 major problems in this sphere - (1) The enormous resources required in terms of personnel, laboratories and facilities, (2) The difficulty in coming to terms with broad implications of this technology, and (3) The lead time.

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70) CPSTP....op.cit.

71) Bogomolov O.T., Bykov A.N., eds., Strany ....op.cit., p.150.

72) Business East Europe, 28 April, 1986.

Czechoslovakia reportedly has a developed level of research in this area. A government resolution of 1982, identified 49 projects in basic and applied research as a result of which individual sub-technologies are already in use and others close to realization. The Czechoslovak R&D Institute of Antibiotics and Biotransformation and the Soviet R&D Institute of Genetics and Selection of Industrial Micro-organisms are conducting joint research in aminoacids and ferments and generation of threonine, needed in livestock farming as well as of riboflavin.[73]

Some of the other bilateral projects in this area include - the Soviet-Polish project on the stability of enzymes and the Soviet-Czechoslovak research project on new biocompatible polymers. The Cardiological Research Centre of the USSR Academy of Medical Sciences together with GDR organisations is studying the chemical properties of substances and medical preparations for carrying drugs inside the patients organism to the desired area.[74]

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73) Licensintorg Panorama, No.13, 1984.
74) Licensintorg Panorama, No.12, 1984.

On the whole, the Biotechnology section of the programme provides for the development through the joint efforts of the CMEA countries, of a wide range of products including chemical agents, additives and catalysis, bio-chemicals for agriculture etc.

The basic organisational structure chosen for implementation of the CPSTP is based on the extensive use of direct ties with a Head Coordinating Organisation controlling scientific, technological and production cooperation, the R&D of new equipment, technologies and materials. Soviet organisations act as Head Coordinating Organisations on all the specific 93 problems included in the CPSTP.(75) The Head Coordinating Organisations are among the best equipped research and design institutions and science and production associations. The establishment of direct ties therefore brings together the basic economic units - the enterprises, the research and production associations and similar organisations and the basic research units - the research institutes

75) Vneshnaya Torgovlya, No.7, 1987.

and design bureaus of the CMEA countries in direct contact for cooperation in R&D, and manufacture by passing to a considerable extent the vertical proliferation of red-tape in these countries.

Among the Head Coordinating Organisations functioning in this context on various specific problems included in the CPSTP are :-

- The Paton Electric Welding Institute
- The USSR Research Centre in Electronics and Computer Technology: for the develop-ment of a fifth generation of ES computers tentatively called the Ryad 4 Series.[76]
- The 'Robot' organisation of the USSR Ministry for the Machine Tool and Instrument Making Industry: for the development of robotics.

A number of other fields, some of them not connected in a very direct way with the

76) Ibid., p.15.

priority areas of the CPSTP in which joint research and development is being carried out, are :

- Research on solar and chemical energy involving 80 R&D organisations of 9 CMEA countries is being carried out. The research project includes development of technological processes and equipment for production of inexpensive, semi-crystal monocrystal strips and amorphous silicate for land-based solar plants.

- Development of tungsten-less alloys.

- Development of cryogenic power transmission lines and cryogenic power equipment to cut down energy losses.(77)

At the bilateral level too a number of projects are under way :-

- Between USSR and Poland for a new generation television set.(78)

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77) <u>Soviet Export</u>, No.5, 1985.

78) <u>Soviet Export</u>, No.1, 1987.

- Between Soviet Union and Rumania for development of magneto hydrodynamic power generating units.

- Between Soviet Union and Hungary for hydrogen and water-cooled turbo generators, numerically controlled machine tools and modern medical equipment incorporating micro processors.[79]

- Between Soviet Union and Czechoslovakia in chemicals and in nuclear magnetic resonance spectro-meters.

- Between Soviet Union and GDR for development of X-ray spectrometry and for automatic telephone exchanges.[80]

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79) Vneshnaya Torgovlya, No.4, 1987.
80) Soviet Export, No.6, 1986.

CONCLUSION

The success of the policy of cooperation in science, technology and production in general, and of the CPSTP, which has emerged as the central thrust area within this policy, in particular, is going to be measured largely on two counts.

Firstly, it revolves around the capability of the CMEA-countries to jointly develop major breakthroughs at the level of basic and applied research. The idea is to come out with basic innovations, scientific discoveries, inventions and technologies that would place the CMEA countries, among the forefront of the technologically advanced nations of the world, in terms of possessing the technological know-how.

Secondly, it concerns the success achieved by the CMEA countries in introducing these technologies and inventions in their national economies and thus ensuring the primary economic objectives that have been set in pursuance of the programmes in R&D cooperation as well as production cooperation.

Regarding the first aspect it may be said that in spite of the fact that the CMEA countries together possess around 1/3 of the world's R&D potential, their share in the world trade of technology, patents, inventions is very meagre. The advanced industrialised countries of the capitalist world account for an overwhelming proportion of the world export in licenses and patents. The major problems therefore appear at the very outset of the entire cycle of science-technology-production, a fact which is sometimes underestimated by both Soviet and Western scholars who tend to stress on the problems inherent in the subsequent stage viz. the stage of implementation and introduction of scientific discoveries and technology. It is a well-known fact that by any measure - whether Nobel prizes, frequency of citations by fellow specialists, origin of breakthrough or simply quantity of publications, U.S. has a great lead over the Soviet Union in most disciplines and in many there is little competition.

The areas of traditional strength of Soviet and other CMEA countries'scientists, including

Polish and Hungarian are mathematics and pure physics etc. which are not directly applicational in nature unlike certain other basic sciences like biology and chemistry. Though cooperation in physics is a part of the policy of cooperation in science, the major priority areas now under development have been chosen precisely because of their tremendous importance for the qualitative restructuring of the economies of CMEA countries. Indeed, it has become something of a truism in international science and technology circles that the development of CMEA science and technology in general and Soviet science in particular is governed by the blackboard rule, i.e. CMEA scientists would be strong in those areas where the research tools are just a blackboard and chalk, e.g. mathematics and theoretical physics, and weak where research calls for sophisticated laboratories, instruments, facilities, an efficient network of exchange of information and contact with industry. The problems regarding laboratory equipment are so acute that it is reported that in certain scientific organisations in the USSR only around

35% of the total level of scientific equipment and instrumentation is available.[1]

At the level of applied research, it is lamented that "...a considerable proportion of the technical solutions put forward do not possess a sufficient content of novelty and are usually just an improvement on the earlier technology of production of goods and items. A very significant proportion of results have a general-informational character and do not embody any practical, applicational characteristics."[2] In the USSR for example, it is reported that out of the total quantity of innovations achieved by ministerial institutes only 7-8% exceeded the world standards.[3]

Moreover despite the efforts expended at working out modalities of joint research

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1) <u>Pravda</u>, 26 March, 1984.

2) Bogomolov O.T., Bykov A.N., eds., <u>Strany SEV v Mezhdunarodnom Obmene Technologiyei</u>, Mezhdunarodniye Otnosheniya, (Moscow, 1986), p.94.

3) <u>Voprosy Ekonomiki</u>, No.6, 1987, p.67.

etc. a major part of the research is still conducted on the basis of the early and traditional form of cooperation viz. the coordination of scientific research. The elimination of duplication and parallelism which was one of the early aims of the policy of R&D cooperation and which, it was claimed, was a comparatively easy task for socialist countries in view of the fact that there was no economic competition among them, has still not been achieved because of lack of easy and prompt access to information, both horizontally across borders and vertically in every individual country. According to some estimates the CMEA countries lose 5-7 billion rubles every year because of the duplication of R&D efforts.[4]

The problems are compounded when it comes to the question of introduction of the technologies and discoveries that would be worked out in the first stage, in the national economies. The problems of quick and efficient introduction of technology devised by the research institutes

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4) Bogomolov O.T., Bykov A.N., eds., <u>Strany</u> ....op.cit., p.108.

and design bureaus has been the central problem of the R&D policies of individual CMEA countries, dogging them constantly now for many years. Considering that this is a dilemma confronting every CMEA-country to a greater or lesser degree, the joint development and introduction in production now envisaged can only add another complicating factor to the scenario. The lead time in CMEA wide scientific and production cooperation is sometimes worse than in corresponding national systems. Apropos national systems, it may be pointed out that in the case of the USSR - the average timeframe for the passage of a new technology from the stage of the beginning of applied research upto the stage of production implementation is in the region of 5-7 years,[5] sometimes greater. As pointed out by Beshelev and Gurvich, there are real possibilities for reducing by a factor of 1.5 - 2 the entire cycle, which includes the development of an article, its manufacture and placement on the market. This concerns above all the R&D stage which accounts

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5) Voprosy Ekonomiki, No.6, 1987, p.62.

for around 70% of the complete cycle of creating new articles. Moreover, since there is a lack of a unified and consistent policy embracing all the social, economic and technical factors involved in the introduction of a new technology, it is overlooked that the optimisation of the lifecycle of a new technology or product is a compromise between its quality, expenses and gestation period.(6)

A considerable role in the effective introduction of new technology into production is to be played by the economic management system of individual countries. The problems facing them are illustrated by the introduction of robots in the GDR economy, exemplified by the existence of two factors - the highcost of the new technology and the insufficient replacement of labour as a result of automation. The cost of one robot is equivalent to 10-man-years of a worker's salary and in individual sectors of the economy, one robot has replaced from

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6) Beshelev C.D., Gurvich F.G., Nevospolnimy Resource (O Factore Vremeni v Nauke i Technike, Nauka, (Moscow, 1986),p.40.

0.6 to 2.4 workers only.(7)

In the USSR, the low economic returns achieved by the new technology is highlighted by the fact that annual net economic effect of every innovation introduced into production is getting lower and at present constitutes about 6500 rubles. In spite of the fact that a number of innovative technologies, contribute to a sharp increase in labour productivity, on the whole they substitute only about 550,000 workers annually, or in other words less than one man per innovation.(8)

The much touted form of cooperation over the whole range of science-technology-production cycle, the International Research and Production Associations also face considerable problems associated with the development and formation of long-term stable scientific and production cooperation of the partners. As a rule ad-hocism still rules the roost and stress is by and large

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7) Tromplakova E.G., Effectivnost Proizvods -tva v Europeskikh Stranakh SEV, Nauka, (Moscow, 1986),p.60.

8) Voprosy Ekonomiki, No.6, 1987, p.62.

laid on the comparatively limited range of scientific and technological problems to be concentrated upon for cooperation.

The mechanism of direct ties between CMEA enterprises, which is the basic form chosen for implementation of the CPSTP, and which was hailed as overcoming a lot of the bureaucratic problems endemic to CMEA countries, is as yet quite weak and far from perfect. The problems generated by this shift to the lower micro-level in countries traditionally employing strict centralised planning methods touch upon a whole range of social, economic and political factors which have come to the fore in recent years in the East European CMEA countries. It should be noted that the central agencies are still very much in the picture and are of the tasks to be addressed soon is the delimitation of spheres of influence of the Head Coordinating Organisations on the one hand and the central organisations on the other, in the fields of planning, obtaining resources and fulfilling CPSTP assignments.

The feasibility studies of Soviet and other CMEA countries' Head Organisations often fail to accurately define the volume of required resources and the expected gain or loss, particularly in terms of faster scientific and technological progress. There is a lack of experts in specific fields and head organisations experience difficulty in unifying the technical policy in their sector and solving problems of uniformity, standardisation and quality of products.

Unlike in the Western countries, where the universities and other higher educational establishments conduct a sizeable part of the national R&D and maintain close liaison with industry on the basis of funded projects, contracts etc. in the CMEA countries the contribution of the higher educational establishment to the research effort is not substantial. In the USSR nearly half of the total scientific personnel having advanced degrees are employed in the so-called VUZ system i.e. the universities and other higher educational institutes. The lack of effective research at these VUZ has come in for criticism and steps are reportedly being taken to involve them in applied research on a contractual basis.

On the other hand the cooperation of CMEA countries in R&D has yielded favourable results and continues to do so. Annually approximately 2000 different projects are carried out which result in the construction of 200-300 new machines, or significant improvement in them, around 100-150 new technological processes are devised and 100-120 new materials and substances are developed. The total economic effect achieved from the introduction of these new inventions and technologies has reached 5 billion rubles annually.(9)

Over the years the realization has dawned that the division of labour and specialisation and cooperation in the field of R&D and subsequent joint introduction into the economy cuts down the development costs in comparison to the costs that would have been incurred by individual countries. It also helps to bring down the lead time.

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9) Ekonomicheskoe Sotrudnichestvo Stran Chlenov SEV, No.9, 1985, p.39.

The CPSTP has now become the crucial test of success of the policy of cooperation in R&D among CMEA member countries. Apart from its economic objectives it would be interesting to see how its realisation manages to change and improve the process of cooperation and integration in science and technology.

On the whole it is a bit premature to judge the prospects of success or otherwise of the integration process of R&D in general and of the CPSTP in particular. The next decade or so would demonstrate the prospects of viability of this form of cooperation.

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