troscopists (*17*) have investigated a number of nearby field stars of low metal content which appear to possess luminosities and surface temperatures comparable to those at the high-temperature end of the horizontal branch in metal-poor clusters. Preliminary results suggest that the helium abundance at the surfaces of these stars is less than 1 or 2 percent by mass. If this conclusion is borne out by further observation and analysis, then astrophysicists may be faced with the major tasks of (i) elaborating a quantitative theory of mass loss either by solar-wind mechanisms or by shocks originating in the helium flash (or both), and (ii) refining the theory of energy flow (including mass loss) so as to remove the discrepancy between theoretical time-constant loci, as derived from low-helium models, and loci for metal-poor clusters.

On the other hand, it has recently been argued (*18*) that the apparent low abundance of helium relative to hydrogen at the surfaces of stars near the blue end of the horizontal branch may be due to the fact that, under the influence of gravity, the heavier atoms of helium diffuse inward from the surface and are thus lost from view. In most other stars, the tendency for heavier elements to sink inward from the surface is counterbalanced either by convective mixing (when the star possesses a convective envelope) or by a rotationally induced circulation of matter in envelope regions (all real stars rotate to some extent). Stars at the blue end of the horizontal branch do not rotate very rapidly and do not possess convective envelopes, so that diffusion may well deplete the surface abundance of helium and thereby invalidate any attempt to gauge directly the abundance of helium below the surface. Hence it would seem that nature is conspiring to prevent the astronomer from knowing too easily the answer to that most important question: What was the initial helium abundance in our galaxy when the oldest, metal-poor stars were formed?

References and Notes

1. A much more detailed account of the evolution of a 5-$M_\odot$ star may be found in I. Iben, Jr., *Astrophys. J.* **143**, 483 (1966).
2. The most recent summary of the reactions involved in the *p-p* processes is P. D. Parker, J. N. Bahcall, W. A. Fowler, *Astrophys. J.* **139**, 602 (1964). Descriptions of the CN-cycle reactions are given by E. M. Burbidge, G. R. Burbidge, W. A. Fowler, and F. Hoyle, *Rev. Mod. Phys.* **29**, 547 (1957), and by H. Reeves, in *Stellar Structure*, L. H. Aller and D. B. McLaughlin, Eds. (Univ. of Chicago Press, Chicago, 1965).
3. The surface temperature, radius R, and luminosity of a star are related by the equation $\sigma T_e^4 = L/4\pi R^2$, where σ is the Stefan-Boltzmann constant.
4. The triple-alpha process is described in E. M. Burbidge *et al., Rev. Mod. Phys.* **29**, 547 (1957) and in H. Reeves, in *Stellar Structure*, L. H. Aller and D. B. McLaughlin, Eds. (Univ. of Chicago Press, Chicago, 1965).
5. Calculations have been carried further by a group in Germany consisting of E. Hofmeister, R. Kippenhahn, H. C. Thomas, and A. Weigert. See, for example, *Z. Astrophys.* **60**, 57 (1964); *ibid.* **61**, 241 (1965).
6. I. Iben, Jr., *Astrophys. J.* **140**, 1631 (1964); *ibid.* **141**, 993 (1965); *ibid.* **142**, 1447 (1965); *ibid.* **143**, 483 (1966); *ibid.*, p. 505; *ibid.*, p. 516; *ibid.*, in press.
7. Over most of the stellar interior, electrons behave like classical particles and matter obeys Boyle's law. The pressure due to electrons is directly proportional to both temperature and density. At very high densities, however, electrons begin to exhibit quantum characteristics, one of which is that no two electrons may be found in the same energy state. The pressure due to electrons becomes proportional to the five-thirds power of the density and nearly independent of the temperature. The electrons are said to be degenerate.
8. R. L. Sears, *Astrophys. J.* **140**, 477 (1964).
9. G. Wallerstein, *Nature* **204**, 367 (1964); *Astrophys. J.* **143**, 823 (1966).
10. The argument presented here is that of Theodore Schmidt-Kaler and also of J. Crampin and F. Hoyle, *Monthly Notices Roy. Astron. Soc.* **120**, 33 (1960).
11. See, for example, S. Chandrasekhar, *An Introduction to Stellar Structure* (Univ. of Chicago Press, Chicago, 1939).
12. N. Baker, in *Star Evolution*, L. Gratton, Ed. (Academic Press, New York, 1963), p. 369.
13. Surface temperature and luminosity are not determined directly from observations. The cluster loci in Fig. 5 are *estimates*, obtained after theoretical transformations have been performed on observational data. Observational data for M67 are given by H. L. Johnson and A. Sandage, *Astrophys. J.* **121**, 616 (1955); those for NGC188 are given by A. Sandage, *ibid.* **135**, 333 (1962).
14. J. Faulkner and I. Iben, Jr., *ibid.* **144**, 995 (1966).
15. Although relative surface temperatures and luminosities along the locus in Fig. 6 may be approximately correct inferences from the observations, the absolute value of the surface temperature (in addition to the luminosity) for any star may be considerably in error. Observational data from A. Sandage and M. F. Walker, *Astrophys. J.* **143**, 313 (1966) and from A. Sandage and L. L. Smith, *ibid.* **144**, 886 (1966), have been used.
16. I. Iben, Jr., and J. Faulkner, in preparation.
17. L. Searle and A. W. Rodgers, *Astrophys. J.* **143**, 809 (1966); J. L. Greenstein, *ibid.* **144**, 496 (1966); W. L. W. Sargent and L. Searle, *ibid.* **145**, 652 (1966).
18. G. S. Greenstein, J. W. Truran, A. G. W. Cameron, private communication.

19. The work described in this article has been supported in part by the National Aeronautics and Space Administration (NSG-496) and in part by the National Science Foundation (GP-6387). The discussion presented here is a summary of lectures given by the author for the Summer Faculty Program in Space Physics, held under the auspices of Columbia University at the NASA Institute for Space Studies, New York, 7–13 July 1966.

Coordinated Planning for Science in Communist Europe

Council for Economic Mutual Assistance coordinates national policies and plans in science and technology.

Lloyd F. Jordan

The role of the Council for Economic Mutual Assistance (CEMA) in coordinating policy and planning in support of scientific and technical collaboration of its members has grown steadily since 1956. The Council has made considerable headway, especially since 1962, yet several problems continue to impede its efforts in this sphere. Both the progress achieved by and the problems confronting CEMA in such coordination are important developments that merit consideration by those concerned with integration in Eastern Europe and with international scientific and technical collaboration in general.

In January 1949 the U.S.S.R. and its satellites met in Moscow and organized CEMA (*1*); other charter members were Bulgaria, Czechoslovakia, Hungary, Poland, and Rumania, while Albania joined almost immediately and East Germany joined in the autumn of 1950 (*2*). Since December 1961 Albania has not actively participated because of its strained relations with the U.S.S.R. (*3*). In 1962 Mongolia changed in status from observer to full member. Communist China, North

The author, a former federal executive fellow, is a political scientist and specialist on East European affairs with the U.S. Central Intelligence Agency.

Korea, North Vietnam, Cuba, and Yugoslavia are not full members but participate in various aspects of CEMA's work (*4*); the extent and nature of their participation are governed by special accords. The most recent country to join in CEMA's work is Yugoslavia, which in September 1964 concluded an agreement defining the nature and extent of its participation.

The communique announcing its establishment declared that one object of CEMA was the fostering of technical cooperation (*1*). In an obvious attempt to offset the impact on east-central Europe of the technical assistance being offered to all Europe under the Marshall Plan, the second plenary session of CEMA (Sofia, 1949) adopted recommendations providing for "the broadening of scientific-technical cooperation and the exchange of technical experience" (*5*).

While the Soviet government concluded agreements on scientific-technical cooperation with the other members of CEMA, provisions for the coordination of policy and planning in support of scientific and technical collaboration were not included; instead the agreements restricted cooperation to the exchange of documents and of scientific and technical personnel for brief periods of study (*6*).

Except for the resolution that resulted in the bilateral agreements between its members, CEMA appears to have done little if anything between 1949 and 1956 to promote scientific and technical cooperation; indeed, it led a very bleak existence during Stalin's years. For example, only three plenary sessions were reported between January 1949 and November 1953. There is no record of activity directed toward multilateral coordination of research policies and plans during the period from 1949 through 1954; rather, CEMA passed into oblivion after 1950, a development in keeping with Stalin's policy decreeing autarchic economic development of the countries in the bloc (*7*). Moreover, Stalin's policy, which called for bilateral relations within the bloc, precluded the use of CEMA as an instrument of multilateral cooperation in science and technology.

After Stalin's death in 1953, CEMA took on new life and has since become increasingly occupied with promotion of cooperation among its members in science and technology.

The first steps toward coordination of national policies in science and technology were taken by the CEMA countries in the post-Stalin period as an inextricable facet of the new political and economic policies initiated by Stalin's heirs.

The leaders of the Soviet Union from 1954 began to emphasize formal organizational mechanisms as substitutes for fiat and force in coordinating certain facets of their scientific, technical, and economic relations. To this end, the dormant CEMA was revived in 1954; and the Council forthwith adopted a resolution calling for coordination of the national economic plans of member states for the 1956–1960 period. The harmonizing of such plans was intended to promote economic integration of the bloc and to counteract the trend toward disintegration that had begun to show in the form of the 1953 riots in East Germany and Czechoslovakia. Such coordination was a necessary development in keeping with the newly proclaimed principle of "Socialist division of labor"—also decided upon by CEMA. In accord with this principle, each country in the Soviet bloc would strive to expand and develop industries in which it was particularly adept, and thus supply imports needed by the countries specializing in other fields (*8*).

The revival of CEMA as a mechanism for coordinating certain facets of the economies of the Soviet bloc countries required that its activities include the alignment of various scientific and technical fields directly related to industrial and agricultural activities. Another major impetus for coordination was revolt in Poland and Hungary in the autumn of 1956. These events further emphasized for the Russian leaders that the Soviet Union's hegemony within the bloc was seriously threatened, and that new adjustments in its relations with the Peoples' Democracies would be required to bolster it; changes in the pattern of scientific and technical relations among the CEMA countries were to serve as an important instrument of this policy. In the wake of the revolts, the importance of continued development and closer integration of scientific and technical cooperation between the U.S.S.R. and the Peoples' Democracies of east-central Europe, as a manifestation of improving relations with both their governments and political parties, was given special emphasis and recognition. Scientific and technical cooperation was expressly mentioned, and declared to be one of the future important bases of cooperation, in the communiques that followed each of the bilateral conferences, of the Party and government leaders of the U.S.S.R. and of the Peoples' Democracies, that were held in late 1956 and early 1957 (*9*).

Although CEMA's adoption of measures to coordinate the national scientific and technical efforts of its members has resulted primarily from post-Stalin changes in their political and economic relations, developments in Western Europe also have had an important impact on the thinking of Soviet-bloc leaders.

Scientific and technical cooperation in Western Europe under the auspices of the Organization for European Cooperation and Development and the North Atlantic Treaty Organization serves to spur the Communist leaders in their attempts at integration in science of the CEMA countries. The Soviet Union especially fears a united and prosperous Western Europe, which not only presents an economic, political, and military challenge to the Soviet Union but also strongly attracts the Peoples' Democracies. Moreover, within the framework of Russia's declared policy of "peaceful coexistence" and "peaceful competition with capitalism," scientific and technological advance assumes an even more important and urgent role.

The Communist leaders are fully cognizant that the campaign to catch up with and overtake the West in economic competition depends upon rapid scientific and technological advances and their application to production processes. That this factor is of central importance in the Soviet Union's policy of integrating the CEMA countries was stressed by a Soviet economist (*10*):

> In the first period, until about 1970, the world Socialist system is faced with the task of gaining time in the peaceful economic competition with capitalism. . . . Decisive advances will be made in laying the material and technological foundation of Communism and in achieving the world's greatest productivity of social labor and higher living standards. In total material production, the Socialist system will preponderate over capitalism. These changes in main will take place on the basis of modern technical achievements; the latest accomplishments of science and technology will be applied in industry on a mass scale, and existing enterprises will be automated and mechanized.

While Russians have been the most vocal about the threat of the West's international scientific and technical

collaboration in the socialist-capitalist competition, spokesmen from other members of CEMA have supported them. Henryk Jablonski, then secretary of the Polish Academy of Sciences, has stated that "Scientific competition is a part, and an important one, of the competition of the two world systems. We should not lose sight of the fact that in the Western bloc great efforts are being made in the direction of integration of scientific research" (*11*).

Last but equally important is the fact that the members of CEMA are being pushed toward scientific and technical collaboration by the rising cost of research and development—a factor that is a growing pressure on all modern nations. Fundamental research today increasingly depends on very complex and expensive equipment, notably in such fields as high-energy physics and radioastronomy. Because of these rising costs, smaller countries cannot undertake research on their own in many fields (*12*).

This factor particularly applies to the members of CEMA, all of which, except the Soviet Union, are small political entities. The importance of scientific and technical collaboration among CEMA members as a means of defraying the costs of research has often been stressed by some of their scientific and political leaders. Adam Wang, deputy chairman of the Polish State Planning Commission in 1961, stated that "We should not and we cannot afford, not only financially, to develop or conduct research in all directions. . . ." (*13*). More recently Bruno Leuschner, Politburo member and deputy chairman of the East German Council of Ministers, in discussing the vital importance of scientific and technological advance to social and economic development, pointed out that "In the present stage of the development of science and technology . . . a single country alone is not able to solve this principal task in all important fields. Socialist cooperation among CEMA countries in this field makes it possible to solve this problem internationally" (*14*).

While the leaders of the CEMA countries realize the benefits that could accrue from coordination of their national efforts, their path is tortuous, and by its very nature the task is inordinately complex.

Since 1956, when the first permanent economic and scientific commissions were created, the institutional structure of CEMA has been gradually expanded and strengthened to increase its ability to cope with its growing role in the coordination of policy and planning in support of scientific and technical cooperation.

At the 12th plenary session held in December 1959, the objects, principles, and organizational structure of CEMA were, apparently for the first time, enunciated in statute; hitherto CEMA's functions had been defined in a very brief and very broad joint resolution drafted in January 1949. The 1959 statute was more specific in detailing responsibilities and defining the functions of CEMA's various organs, the voting procedure, and the juridical nature of the Council's actions (*15*). Significantly, the statute designated scientific and technical cooperation as one of the two major responsibilities of CEMA, the other being economic cooperation.

All actions of the components of CEMA concerning the coordination of policy and planning on scientific and technical collaboration are divided into two major categories: recommendations and decisions. Recommendations refer to matters of substance; decisions are made concerning organizational and procedural problems. Implementation of the recommendations rests with the governments or the component agencies of the member countries in accordance with their legislation; decisions are effective on the day of the signing of the protocol covering the meeting of the corresponding agency of CEMA.

The structure of CEMA comprises six major components: (i) the Conference of Party First Secretaries and Heads of Governments (the Conference), (ii) the Session of the Council, (iii) the Executive Committee, (iv) the Secretariat, (v) the Conference of Representatives of member countries, and (vi) the Permanent Economic and Scientific-Technical Commissions. I shall discuss only components that play significant roles in the coordination of policy and planning.

Although the 1959 statute does not specifically provide for the Conference a role in CEMA's activities, since its first meeting in 1958 this body has gradually become the principal policy-making organ (*15*). In May of that year, the first Conference adopted several recommendations for submission to CEMA for implementation; recommended was the drafting of long-term national economic plans (*16*). Subsequent meetings of the Conference gradually established its role as the supreme policy-coordination body (*17*).

The June 1962 Conference meeting was especially significant for the evolution of the Conference as a policy-coordinating body in the field of scientific and technical collaboration. The Conference then approved a document entitled "Basic principles for the international Socialist division of labor," which had been prepared earlier at CEMA's 15th plenary session. This document contained the broad framework of policy within which future scientific and technical collaboration was to be planned; "Specialization and coordination of research and design work as one of the most important parts in a national specialization of production" was stressed. The document also called for ". . . concentration of scientific and technical forces by means of specialization and coordination of work on the solution of the most important problems" (*18*). The Conference also adopted several measures that were especially important for the coordination of the members' plans for scientific research.

Coordination of research work in various fields had been attempted by CEMA as early as 1956, when the sixth session of the Council decided to coordinate national economic plans for the period 1956–60. Coordination of research was also undertaken by CEMA's newly created Permanent Economic and Scientific-Technical Commissions (*19*). The political upheavals in Poland and Hungary in the autumn of 1956 disrupted coordination of planning for the period 1956–60. A new attempt at coordination was initiated in the summer of 1958 when the ninth session of the Council announced that long-term economic plans for 1960–75 were to be drafted; the period was extended to 1980 by the 13th session of the Council, which met in Budapest in July 1960 (*20*), and long-term ("perspective") scientific-research planning was then begun by CEMA members (*21*). The drafting of long-range plans for science and technical development was obviously intended to facilitate intrabloc coordination of research with economic development.

Concurrently with the drafting of long-range research plans, reorganization was undertaken of the institutional structure in each CEMA country, ex-

cept Rumania, for the formulation of scientific and technical plans and for the coordination of the national research effort; committees or commissions responsible for coordinating the planning of research on a national scale were established at the national level everywhere but in Rumania (*22*). Indeed, it appears that the national institutional and procedural reforms resulted from CEMA's resolution and were intended to be preparatory to more systematic and tighter coordination of science plans by CEMA.

Throughout the bloc, apart from Rumania, a common base for planning and coordination had been established by 1962; it remained only for the new planning procedures to be applied on a bloc-wide basis by CEMA itself. A series of institutional reforms were begun in CEMA in 1962 that were intended to strengthen its structure for the coordination of scientific-research planning.

Establishment of CEMA's Executive Committee in June 1962 was a major reform; comprising the deputy premiers of the member countries, it is, after the Conference, the most important organ. It has taken over the responsibilities formerly borne by the Session of the Council, whose infrequent meetings—twice yearly—could not provide the type of guidance needed for CEMA's enhanced role in plan coordination that had been decided on by the June 1962 Conference. The Executive Committee meets frequently and has broader powers than those allotted to the Session of the Council by CEMA's 1959 statute. The Executive Committee has a major role in the coordination of scientific-research plans; it determines the directions and decides the forms of organization in the field of scientific and technical collaboration (*23*).

Creation, under the Executive Committee, of the Bureau for Integrated Planning Problems, comprised of deputy chairmen of the national planning agencies of CEMA countries, was designed to strengthen the plan-coordination process. The Bureau's role is purely advisory, but its jurisdiction ranges across the whole gamut of planning problems; it probably influences to some extent the final content of the CEMA-sponsored research plans (*24*).

Expansion of CEMA's Secretariat since June 1962 has strengthened its capacity to assist the Permanent Economic and Scientific-Technical Commissions and the Executive Committee in coordinating scientific-research planning. There are two categories of departments in the Secretariat: (i) sectoral departments (for example, those dealing with specific sectors of research, development, and production activities, such as chemicals, nonferrous metals, and engineering); and (ii) general departments (for example, the departments for coordination of scientific and technical research, economic and scientific-technical information, standardization, and others having responsibilities that cut across the specialized production, research, and development sectors (*24*). Both categories are concerned with the coordination of research plans (*25*).

Creation of the Permanent Commission for the Coordination of Scientific and Technical Research in 1962 was another development of major importance for the coordination of scientific and technical planning (*26*); no earlier organization within CEMA had had the responsibility for maintaining an overall view of the efforts at collaboration by CEMA countries. In responsibilities this commission differs from most of the other 25 CEMA commissions in that it is concerned with science and technology in general, whereas most others are concerned only with their respective specialized sectors, such as radioelectronics, chemistry, and machine building.

Supranational Planning an Issue

Determination of the approach to the planning of research under CEMA's auspices apparently entailed considerable debate. Statements by Khrushchev and D. Gvishiani (deputy chairman of the U.S.S.R.'s State Committee for the Coordination of Scientific Research Work) left no doubt that Russia was a strong proponent, within CEMA, of supranational planning for science and division of labor in research. In 1962 Khrushchev declared (*27*):

> It is most obvious that the time has come for us to start planning the development of science and technology on an international basis and to promote the most important scientific and technological research work, which of course is of common concern, in accordance with uniform long-term plans. This will enable us to assign research tasks to various countries and to bring up problems which will be solved by scientists and engineers from several countries.

Approximately 2 months later, Gvishiani echoed Khrushchev's words (*26*).

The proposed formulation of a unified long-range plan for scientific research and technology was obviously intended to go hand-in-hand with Khrushchev's proposed creation of a unified long-range economic plan for all CEMA countries, and with the creation of a supranational planning organ in CEMA (*28*). What emerged from the deliberations on the planning of science and technology is, indeed, not supranational planning. The proposal to create a central planning organ in CEMA that would formulate a scientific-research plan for the member countries, and assign research tasks, failed to achieve acceptance by the members. Supranational planning and the creation of a supranational planning body within CEMA were rejected outright by Rumania on the ground that both proposals ". . . involve most serious economic and political implications likely to gravely harm the national independence and sovereignty of the member countries" (*29*).

The rejection of Khrushchev's proposal for supranational planning of the economies, including scientific research, of CEMA members was finally settled at the Conference held in July 1963. The Conference's communique stressed that "The best possible basis for multilateral coordination of plans is provided by bilateral consultations between member nations" (*30*).

It was in direct response to the new emphasis on bilateral approach to the coordination of plans that bilateral intergovernment committees for economic, scientific, and technical cooperation have been established since late 1963. Bilateral commissions for scientific-technical cooperation had been set up in the late 1940's and early 1950's; these were now made subcommissions and placed under the new committees (*31*). The committees are headed by deputy heads of governments, who also represent their respective countries in the Executive Committee. This representation is undoubtedly intended to ensure that the negotiations of the committees take place within the broad framework of policy laid down by the Conference. Representation on the intergovernment committees includes executives of the national planning agencies and representatives of scientific institutions and of ministries responsible for administering sectors of research, development, and production (*31*).

Dynamics of Planning

The first CEMA-sponsored plan for scientific research and technology was approved at the 11th session of the Executive Committee in March 1964 (Fig. 1; *32*). The first phase in coordination of plans is negotiated on a bilateral basis under the auspices of the intergovernment Committees for Economic and Scientific-Technical Cooperation (*31*). The directives for planning, which are formulated by the Communist parties in accordance with each country's needs, serve as a basis for negotiation in this first phase of coordinating what eventually emerges as a CEMA-sponsored plan (*33*). The second stage in the planning process takes place on a multilateral basis before the Executive Committee, when the results of the bilateral negotiations serve as a basis for the formulation of planning guides for the coordination of research (*33*). The third stage is carried out by CEMA's 25 Permanent Economic and Scientific-Technical Commissions, which formulate plans for specific fields of science and technology (*34*). The fourth phase is conducted by the Permanent Commission for the Coordination of Scientific and Technical Research, which reviews the draft plans of the specialized commissions and assembles a final draft for review and final approval by the Executive Committee—the fifth and final stage of the process of plan coordination (*35*).

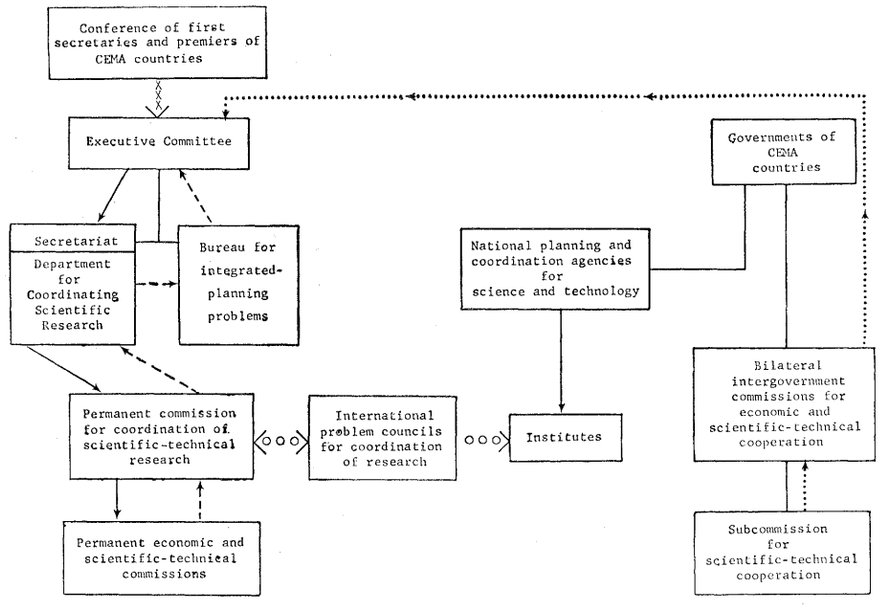

Fig. 1. Structure of CEMA and dynamics of coordination of scientific and technical policies and planning. Symbols: xxxx, policy directives; ———, plan directives; . . . ., bilaterally coordinated plan directives; — — —, draft plans; oooo, coordination of research.

Implementing the Plan

How is the CEMA-sponsored plan implemented? By the Executive Committee, each member country is assigned responsibility for coordinating research on a given problem in the plan. The draft plan is binding on a given member only after its government has signed the protocol approving it.

Each country determines which of its institutions will work on a problem or task for which it has responsibility. In Czechoslovakia such decisions are made by the top-level State Committee for the Development of Science and Technology (*36*); in Poland, by the Committee for Science and Technology (*37*). Similar organizations at the national level in other CEMA countries also make such decisions (*38*).

To coordinate the research work on the various problems (which are in turn broken down into tasks), scientific councils are organized for the various tasks (*39*). The councils include several specialists from each country engaged in work on a given task; the councils establish an operational research plan for each task, control coordination of the research work, and arrange symposia and working meetings to deal with the substantive aspects of the research.

Mutual agreement on a plan is evidently a difficult process, with each country lobbying for inclusion in the plan of scientific and technical projects that will most benefit it. Poland's deputy premier Jaroszewicz, in commenting on the Executive Committee's deliberations concerning the 1-year plan, stated that "The task was not easy, we had to select key subjects which were of interest to all the CEMA countries" (*40*). Conflicting priorities in the national research plans of the countries lead to compromises on the content of a CEMA-sponsored plan that probably sometimes result in the inclusion of research topics of less than major importance.

One-Year Plan

The 1-year research plan for 1964–65 contained a total of 42 problems in the natural, physical, and social sciences (*36*). Research in chemical engineering was assigned priority, and this emphasis was reflected in the 12 interdisciplinary problems (*38*), which were: (i) use of synthetic materials, (ii) use of chemicals in agriculture, (iii) the chemistry of natural and synthetic biologically active substances, (iv) methods for protecting metals from corrosion, (v) design of instruments for scientific research, (vi) the theory of automatic control, (vii) antipollution measures, (viii) solid-state physics, (ix) photosynthesis, (x) management, (xi) complex mechanization of loading, unloading, shipping, and storage, and (xii) systems for disseminating scientific and technical information and documentation among CEMA members (*41*).

Research problems in the social sciences include scientific methods of organizing industrial production, complex mechanization and automation of management of industrial enterprises, and the theory of management of Socialist production (*36*).

Despite the fact that the first CEMA-sponsored plan for scientific research and technology encompassed the brief period of 1 year, it was nevertheless an important landmark in that it was the first such plan sponsored. Problems inherent in the coordination of scientific research on the international scale of CEMA are obviously both numerous and complex. No doubt a major purpose of the CEMA countries in adopting this plan was to experiment with certain planning and administrative processes involved in such an un-

dertaking; their aim was to iron out some of the problems before they embarked on a more ambitious plan of longer duration.

Five-Year Plan

The 1-year plan was only a prelude to a 5-year plan. It was announced in June 1964 that the Permanent Commission for the Coordination of Scientific and Technical Research would ". . . decide on the main directions in science and technology" for the period 1966–70 (*42*). The Executive Committee approved the draft 5-year plan at its 20th session in Moscow in December 1965 (*43*); its full contents have not yet been made public. The Council's secretary, Nikolai Fadeev, recently stated that the coordinated 5-year plan includes ". . . the creation of a perfected system for acquiring electricity, . . . creation and application of new materials, perfecting engineering advancements in various industrial fields, expanding computer technology, automation and electronics, and intensification of agricultural production" (*44*).

Centrifugal Forces

While CEMA's role in the coordination of policy and planning, and in the creation of a division of labor in research, has continued to grow since 1956—more markedly since 1962—there is evidence of some resistance to this development in the east-central European countries. As early as 1959–60 there were manifestations of reluctance by scientists in Poland and Hungary to provide for the coordination of plans and the specialization of research work. Despite the officially declared support for both these principles by the Polish and Hungarian regimes, the drafts of their national plans for scientific research failed to emphasize sufficiently, in the view of high-level Party and government officials, the intrabloc coordination of science plans and the specialization of research work (*45*).

While Rumania was a participant in the 1-year plan and is currently participating in the 5-year plan, the first secretary of the Party, Ceausescu, in a speech to the ninth Party congress, warned the Rumanian scientific community that it ". . . could not neglect . . . our own scientific research activity: lagging behind in this sector can only have negative consequences . . . and lead to dependence on foreign countries" (*46*). Ceausescu's statement was no doubt aimed more at the threat of scientific and technical dependence on the U.S.S.R. and other CEMA members than at dependency on the West. And, implicit in his statement, were Rumania's strong reservations about CEMA-sponsored division of labor in scientific research and its consequences. The lukewarm interest of the Rumanian regime in the international division of labor in scientific research and technology is tied very closely to its determination to press forward with its program for many-sided economic development. This policy was dramatically presented to the ninth Party congress by Ceausescu, who stressed that "The constantly increasing needs of the national economy are indissolubly linked with the progress of science, with the intensification of basic and applied research in every field" (*47*). Ceausescu dealt not at all with the importance of specialization in research among the countries of CEMA, but stressed the need to use ". . . all that is best in world science and technology," and the importance of continued development of scientific and technical relations with all states (*47*).

While nationalist and anti-Soviet feelings are undoubtedly important factors underlying the opposition by various segments of the scientific communities of Eastern Europe to the division of labor in research among the CEMA countries, also significant is the development of lobbies or interest groups to protect vested interests. Effective implementation of the division-of-labor concept would require CEMA members to discontinue certain research and development activities and to rely on other members for research results in those fields. In Hungary, and probably in other CEMA countries, opposition has risen among segments of the scientific community that have been adversely affected, or threatened, by discontinuance or reduction of research in certain fields as a result of agreements that implement the division-of-labor concept. This opposition in Hungary has been confirmed by Otto Geszti, a university professor, who has stated (*48*):

> Expansion of the division of labor is impaired by the frequent lack of understanding and resistance when this involves the ceding of certain fields of . . . research. It should be generally realized that there cannot be any individual interest but only common interests to pursue—namely the common interest of the socialist countries.

Summary

The Council is not engaged in the supranational formulation of policy and planning on scientific research and technology, but has made considerable progress in coordinating research policies and plans on a limited number of scientific and technical problems of priority interest and of common concern to all members. The establishment of national science-planning institutions in CEMA countries and the adoption of a uniform approach to the formulation of national science policies and plans must be considered basic procedures for achieving international coordination of their efforts.

The creation of organizational units within CEMA to deal specifically with the coordination of science policies and plans represents a strengthening of the institutional framework that is necessary for coordination of an internationally cooperative effort in research and technology. Moreover, CEMA's 1-year plan for science and technology has probably been of considerable value as a pilot project for the formulation of the research plan for 1966–70. The delineation of a limited number of important scientific and technical problems of common interest to the members, and the allocation of research projects to a country having the highest capability to conduct them, hold considerable promise for financial savings and for improved utilization of the limited scientific manpower and research facilities of the CEMA countries. While all these measures are significant in CEMA's attempt to improve coordination of science policy and planning, only time will enable true assessment of their effectiveness. The Council's scheme for the specialization of labor in research and technology has met and will undoubtedly continue to meet, considerable opposition by various segments of the scientific communities because of deep-rooted and long-standing national prejudices, and reluctance of vested interests to give up research activities in which they are interested and to which their professional futures are tied. Moreover, opposition to CEMA-sponsored programs for specialization in research will continue to stem from the desire of some member countries further to reduce Russian influence in their domestic affairs.

While recognizing the financial savings that can accrue to them from division of labor in research within CEMA, the smaller countries cannot be un-

aware that there is probably a limit to which the Soviet Union, with its vast scientific and technological base, is willing to participate in the division-of-labor scheme. As a world power, the Soviet Union can hardly become dependent upon other members of CEMA in any field. Nevertheless, by promoting the coordination of research plans and a division of labor among CEMA members, the Soviet Union stands to gain by having its scientific-research effort augmented in several fields by the efforts of other members.

References and Notes

1. N. Siluianov and M. Kudriashov, "Mezhdunarodnaia organisatsiia novogo tiip," *Vneshn. Torgovlia* **1960**(9) (1960).
2. *USSR Inform. Bull.*, 11 Feb. 1949.
3. *Trybuna Ludu*, 17 Dec. 1961.
4. *Zycie Warszawy*, 21 May 1963.
5. N. Siluianov, *Vopr. Ekon.* **1959**(3), 25 (1959).
6. Min. Inostrannikh Del SSSR, *Sbornik Deistvuiushchikh Dogovorov, Soglashenii i Konventsii Zakliuchennykh SSSR s Innostrannymi Gosudarstvami* (Gospolitizdat, Moscow, 1957), vol. 14, pp. 216–23.
7. S. J. Zyzniewski, *Political Sci. Quart.* **75**, 201 (June 1960).
8. *Pravda*, 15 Feb. 1956.
9. See *Pravda*, 30 Jan., 30 Mar., 18 Apr., 14 Aug. 1957.
10. G. Karkhin, *Intern. Affairs* **1962**(8), 19 (Aug. 1962).
11. H. Jablonski, *Nauka Polska* **10**(4), 11 (1962).
12. A. King, *Daedalus* **1964** (winter), 438 (1964).
13. A. Wang, *Nauka Polska* **8**(4), 48 (1960).
14. *Neues Deutschland*, 24 Apr. 1964.
15. For a discussion of the institutional development of CEMA, see R. Szawlowski, *Ann. Franç. Droit Intern.* **9**, 670 (1964).
16. *Pravda*, 25 May 1958.
17. *Ibid.*, 4 Feb. 1960.
18. *Ibid.*, 17 June 1962.
19. K. Vinogradov, *Vopr. Ekon.* **1960**(2), 22 (1960).
20. G. Karkhin, *Intern. Affairs* **1962**(8), 16 (Aug. 1962).
21. For the formulation of long-range plans for science and technology, see T. Erdey-Gruz, *Magy. Tud.* **7**(4), 212 (1962); W. Nowacki, *Nauka Polska* **8**(4), 1 (1960); **7**(3), 6 (1959); M. Richter, *Tech. Praca* **1962**(10), 778 (1962); *Neues Deutschland*, 29 Mar. 1961; *Rabotnichesko Delo*, 16 Sept. 1962; *III S'ezd Rumynskoi Rabochei Partii* (Gospolitizdet, Moscow, 1961).
22. For discussion of these organizations and their functions, see: *Pravda*, 12 Apr. 1961; W. Olszak, *Nauka Polska* **6**(4), 80 (1958); **8**(4), 276 (1960); *Magy. Kozl.* **1961**(5), 53 (22 Jan. 1961).
23. *Trybuna Ludu*, 1 March 1964.
24. B. Miroshnichenko, *Vopr. Ekon.* **1963**(9), 24 (1963).
25. Z. Keh, *Österr. Ostheft* **6**(4), 321 (1964).
26. D. Gvishiani, *Kommunist* **1962**(14), 78 (1962).
27. N. S. Khrushchev, *ibid.*, No. 12, p. 22.
28. ———, *World Marxist Rev.* **5**(9), 8 (1962).
29. *Viata Economica*, 12 June 1964.
30. *Pravda*, 28 July 1963.
31. N. Ptichkin, *Vneshn. Torgovlia* **1964**(12), 3 (1964).
32. *Econ. Gaz.*, 28 Mar. 1964.
33. *Hospodarske Noviny*, 15 May 1964.
34. *Muszaki Elet*, 22 Apr. 1965.
35. *Ekon. Gaz.*, 28 Mar. 1964.
36. *Podnikova Organ.* **18**(8), 375 (1964).
37. *Trybuna Ludu*, 31 Jan. 1964.
38. *Izv. Nedelia*, No. 21, 17–23 May 1964. For example, planned projects in chemical research relating to agricultural problems were finally assigned as follows: (i) phytotoxic effects of herbicides on vital processes in plants, Central Biol. Inst. Acad. Agr. Sci., East Germany; (ii) determination of the most effective mineral fertilizers for growing highly productive crops of grain, beans and other vegetables, sugar beet, and cotton, All-Union Inst. Fertilizers Agr. Soil Sci. Soviet Min. Agr.; (iii) study of the absorption, transfer, and conservation of certain chemicals in plants, Sevulescu Biol. Inst. Acad. Rumanian Peoples Rep.; (iv) study of the after-effects of the use of combined organophosphates, Inst. Hyg. Czech. Min. Health; and (v) research on provision of collapsible containers for transporting aqueous ammonia and ammoniates, Bulg. Inst. Rubber Plastics Ind.
39. Task No. 10-A-7 in the 1-year plan sponsored by CEMA was entitled "The complex system and mechanization and automation of management in industrial enterprises"; its coordinator was Bulgaria. The scientific council is comprised of representatives from the following organizations; the State Commission for Science and Technology in Bulgaria; a similar organization in Hungary; an institute of the Warsaw Polytechnic and the "Orgmasz" Institute of Poland; the Central Institute for Automation in Dresden, East Germany; the Central Scientific Research and Technological Institute for Control Organization and Equipment, Minsk, U.S.S.R.; and the Czechoslovak Institute for Machine Building Technology and Economics (*36*).
40. *Trybuna Ludu*, 1 Mar. 1964.
41. *Muszaki Elet*, 11 Feb. 1965.
42. *Hospodarske Noviny*, 15 May 1964.
43. *Neues Deutschland*, 5 Dec. 1965.
44. *Rude Pravo*, 3 Jan. 1966.
45. See J. Groszkowski and W. Nowacki, *Nauka Polska* **8**(4), 1 (1960); I. Rusniak, *Magy. Tud.* **5**(1), 80 (1961); *Nepszabadsag*, 15 July 1960.
46. *Scinteia*, 19 July 1965.
47. *Ibid.*, 20 Dec. 1965.
48. *Nepszabadsag*, 21 July 1960.

Science Libraries: Prospects and Problems

New information technology will be effective only if scientists give more care to their literature.

Carl F. J. Overhage

This article is addressed to the faculties and administrations of American universities. With emphasis on science and technology, and with implications for all fields of knowledge, it is an appeal to first-rate minds to divert to the problems of our university libraries some of the effort that now goes into research and teaching.

In the first half of the article I review the critical condition of our large libraries and point to the new technology that can be invoked to provide relief. I am personally involved in attempts to apply the methods of information transfer engineering to library operations, and am sanguine about the prospects. But I am greatly concerned over the misguided optimism of those who believe that modern technology is the *only* remedy needed in the present situation of our libraries. Mechanization itself, however well conceived and executed, is not enough. The introduction of the new machinery must be accompanied by intellectual efforts directed toward improving the organization and the quality of the recorded substance in each field of learning. In dealing with this aspect of the library problem, in the second half of the article, I call upon scholars and administrators to face the challenges that are beyond the reach of librarians and information transfer engineers.

Among the many difficulties caused by the growing complexity of our civilization, the crisis faced by our great libraries is one of the most distressing, for these libraries have long been regarded as outstanding manifestations of our cultural progress. From Assurbanipal in ancient Assyria to Thomas Jefferson in America, the men who created great libraries have been recognized in history for the intelligence and depth of their interest in the welfare of mankind. The threat that the great libraries of today may become lifeless monuments, choked by the pressures of exponential growth, is viewed with deep concern by many individuals and groups. The library problem, which has nagged administrators for many years, is now being discussed in Congress and in the general press.

The library crisis has three aspects.

The author is professor of engineering and director of Project Intrex at the Massachusetts Institute of Technology, Cambridge.