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Reorganization of Science and Research in the U.S.S.R.

A new top-level government committee will coordinate interdisciplinary basic and applied research.

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On 12 April 1961, while the world was caught up in the excitement of the Soviet cosmonaut, *Pravda* published a major decree of the Central Committee of the Communist Party of the Soviet Union and the Council of Ministers of the U.S.S.R., entitled "Concerning Measures To Improve the Coordination of Research and Development Work in the Country and the Activities of the Academy of Sciences of the USSR." This official decree, first disclosed at a meeting of the Academy of Sciences on 10 April, resolved, finally, the protracted institutional debate which had raged since the mid-1950's concerning the management of the Soviet Union's burgeoning research and development effort, a debate overshadowed by Soviet technological spectaculars.

Some observers have looked upon the Soviet scientific organization as a carefully charted administrative pyramid with a well-developed decision-making mechanism. In some strategic areas of research, the Soviet principle of centralized decision-making has indeed been often and easily translated into the mobilization of human and material resources for the attainment of given objectives. Without separating civilian or military, political or scientific, objectives, once a decision was reached, the planning mechanism set in motion the priorities to allocate the human and physical resources from different institutions and from diverse jurisdictions and localities. This was not true, however, of all areas of Soviet research and development. The current decree of the Soviet government and Communist Party forcefully pointed up the problem: "The presence at the Academy of Sciences of the USSR of a large number of specialized research institutions diverts its attention from the long-run basic problems of science, splinters its work force and material resources on many technical problems of a departmental nature, which can be handled successfully in specialized research and development institutes. These shortcomings in the work of the Academy and in other research and development organizations are largely a result of the absence in the country of a single governmental unit which could coordinate research on a national scale. The absence of such a unit in many cases has led to unjustifiable duplications in research and the irrational use of scientific personnel and material resources" (*1*).

While this problem has existed in the past, it is the recent expansion of the Soviet research establishment which has brought it most clearly to the fore.

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Growth of the Soviet Research Establishment

Table 1 provides data (*2*) on professional higher-education graduates and on research and academic personnel engaged in the Soviet economy in general, and in the research establishment proper. During the last two decades, while the total nonagricultural employment of workers and salaried employees about doubled in the U.S.S.R., the over-all number of professionals and of research and academic personnel increased about four times. If we consider employment in the Soviet research establishment only, however, the number of professional graduates of institutions of higher education and of researchers increased at rates substantially higher—five and eight times, respectively.

What is particularly important, however, is that the most rapid growth of the Soviet research establishment has taken place in the last 5 years. Between 1956 and 1961 the total employment, the number of professional graduates, and the number of research and academic personnel engaged in Soviet research establishments has about doubled. This enormous quantitative expansion of the Soviet research establishment has constituted the moving force behind the recent institutional reorganization.

Soviet Research Effort by Field

In the last two decades the dominant emphasis of Soviet research activity has been in the area of the natural sciences. This is shown by the data in Table 2, which indicate that in January 1960 an overwhelming 73 percent of all Soviet research and academic personnel were concentrated in the physical and biological sciences. Within these areas, engineering fields alone accounted for over one-third of all research and academic personnel.

Furthermore, the expansion of the Soviet research establishment in the late 1950's was again most rapid in the

Table 1. Total employment of professional graduates and research personnel in Soviet research establishments, in January of the year indicated (figures in parentheses, index).

Item	Number employed (in thousands)		
	1941	1956	1961
Workers and salaried employees in the national economy (total)	31,500.0 (100)	47,900.0 (155)	62,000.0 (197)
Workers and salaried employees in research and development and science service (total)	361.0 (100)	992.0 (275)	1,732.0 (480)
Workers and salaried employees in research and development only	267.0 (100)	585.0 (220)	1,220.0 (457)
Graduates of professional institutions of higher education employed in the national economy	908.0 (100)	2,340.0 (258)	3,570.0 (394)
Graduates of professional higher-education institutions employed in research and development establishments	91.0 (100)	240.0 (256)	449.0* (494)
Research and academic personnel (total)	98.3 (100)	223.9 (227)	354.2 (361)
Research and academic personnel employed in research and development establishments only	26.4 (100)	96.5 (365)	200.1 (760)
Research institutes			
Total number	1,821	2,797	3,548*
Number of main research institutes	786	1,210	1,608*

* Data as of January 1960.

fields of physical sciences and engineering, as revealed by a comparison of the numerical growth of research and academic personnel by field between 1956 and 1960 (Table 3).

The current trends in training professionals (two-thirds of all graduates of institutions of higher education are in engineering and scientific fields) and research personnel (about three-quarters of them in the natural sciences) indicate that the emphasis in physical sciences and engineering will undoubtedly continue in the 1960's. This quantitative expansion, though achieved at the expense of the humanities and social sciences, has not lowered the quality of scientific or engineering education, which has improved steadily over the years.

The Soviet research establishment today employs a total of 995,000 workers and salaried employees; among them 449,000 are professional graduates, and of these, 188,000 are research personnel. Well over half of the researchers work in the physical sciences or engineering. They are employed in a maze of institutions united under different lines of subordination.

Historical Roots

The Soviet scientific research and development effort is presently an extremely complex and highly organized area of human activity, where external institutional machinery determines to a large degree the vitality of scientific progress. In the last few decades in the Soviet Union, as well as in the rest of the world, the role of the individual scientist as a vehicle of theoretical discovery has remained strong, and in many fields Soviet theoretical and basic research has displayed excellence precisely because the scientist was left to his own devices. In other fields of research, however, individual endeavors gave way to a mass experimentation approach with two notable characteristics: on the one hand, a continuing process of differentiation of fields and ever-increasing specialization within each field, and, on the other, the emergence of the "problem approach," the interpenetration of distinct fields of science in the study of various natural phenomena and the resulting establishment of interdisciplinary fields. It is the latter which requires increasing attention to basic and theoretical research.

Table 2. Soviet research and academic personnel, by field, January 1960.

Field	Number	Percent
Physical sciences		
Engineering	106,960	34.5
Physics-mathematics	24,831	8.0
Chemistry	22,724	7.3
Geology-mineralogy	8,990	2.9
Subtotal	163,505	52.7
Biological sciences		
Biology	13,611	4.4
Agriculture and veterinary science	20,210	6.5
Medicine and pharmaceutical science	31,004	10.0
Subtotal	64,825	20.9
Arts, education, humanities, social sciences		
Philology	19,489	6.3
History and philosophy	17,490	5.6
Pedagogy	13,099	4.2
Economics and planning	12,227	3.9
Art and art history (fine arts, painting, sculpture; music; theater, cinema, and related fields)	4,805	1.6
Architecture	1,339	0.4
Geography	3,890	1.3
Jurisprudence	2,112	0.7
Subtotal	74,451	24.0
Other (unspecified)		
Subtotal	7,241	2.4
Total	310,022	100.0

Ever since the golden age of Russian theoretical science, in the second half of the 19th century, there has been an institutional separation of scientific functions. Russian universities and institutes of higher education concerned themselves with professional education primarily and, to some degree, with broad theoretical research. In addition, however, there was a separate network of scientific research establishments which dealt with experimental research, applied sciences, and highly specialized theoretical investigations. In the latter category there were two types of institutions: (i) the Academy of Sciences, dating back to 1724, under whose auspices a number of specialized institutes were set up, and (ii) a number of independent research institutes, which began to emerge at the turn of the century, serving the applied technological demands of various industries or the research needs of specific fields in medicine, agriculture, and so on. The Soviet regime inherited this institutional setup, in which the bonds between universities and research institutes were loosened long before the Communist Revolution.

Until 1929 all Soviet research and development organizations (except those concerned with military areas) were directly subordinate to the Supreme Council of the National Economy, the highest governmental body in charge of industry, agriculture, and other production activities. It coordinated all research activity. In 1929, Pandora's box was opened, however, when individual research and development institutes were placed under separate departmental auspices in order to intensify their work on practical applications and to identify them more closely with service to individual sectors of industry. In the 1930's the Supreme Council of the National Economy itself was broken up into a variety of administrative departments, called "commissariats" (renamed "ministries" in 1945), each of which took charge of a given sector of industry. Under their auspices, specialized, functional research and development institutes were established and expanded in number and size.

The Academy of Sciences of the

U.S.S.R., since 1933 subordinate to the Council of People's Commissars (later Ministers), was under increased pressure to engage in applied research. In response to this pressure it set up many specialized engineering and technological institutes. In 1935, in order to handle these applied-research tasks, a new Division of Engineering Sciences was added to the Academy's other two divisions—those of natural sciences and mathematics and of the humanities. The Academy was again reorganized in 1938, when the number of its divisions reached eight; and in order to broaden the regional base in scientific research, it was empowered to supervise the regional academies of science set up in the various Soviet republics first as branch offices, then as divisions, and, ultimately, as quasi-independent union-republic academies of science.

It should be noted parenthetically that the Russian word *nauka,* though translated as "science," has the broader connotation of the German *Wissenschaft* and is not limited to the natural sciences; rather, it embraces all fields of human knowledge, and accordingly the Soviet academies of science and various departmental research institutes concern themselves not only with basic and applied natural sciences but with the whole spectrum of knowledge—the humanities, fine arts, and social and political disciplines.

But whatever the agglomeration of the fields of knowledge included in the term *nauka,* there are essentially three distinct pyramids in the Soviet research establishment. As of January 1960, these were as follows.

1) Institutions of higher education—universities and institutes (766 institutions in all), employing 138,000 research and academic personnel, of whom about one-third were actively engaged in research. Their research was coordinated by the Scientific-Engineering Council, established in 1956, within the Ministry of Higher and Secondary Specialized Education.

2) The Academy of Sciences of the U.S.S.R. and the 13 union-republic academies of science (603 institutions), employing 39,317 research workers (*3*). Their research was directed by the Presidium of the Academy of Sciences of the U.S.S.R., which had a special Council for the Coordination of Research Work of the union-republic academies of science.

3) Departmental (ministerial) research and development establishments (1005 institutions), employing 125,413 researchers (of whom 18,830, in 494 research institutes, were under the jurisdiction of 13 functional, specialized academies). No central body for coordinating the research activities of these establishments existed until recently, and "institutional research" mushroomed along functional lines, research institutes being formed by the appropriate commissariat or ministry as the need arose—whether for steam turbines, coal mining, school construction, or space research.

The growth of the Soviet research establishment in the last three decades, and particularly since the mid-1950's, was most intensive in pyramids 2 and 3. Table 4 provides data, as of January 1960, on the number of institutions and of research personnel in the Academy of Sciences of the U.S.S.R. and its regional units (the 13 union-republic academies of science) and in the 13 functional academies. The remaining research personnel (106,653 in 509 research institutes) were employed in departmental research and development institutes under a variety of auspices—of state committees, ministries, and other administrative bodies.

Table 3. Research and academic personnel in the U.S.S.R., by field, 1956 and 1960.

Field	Jan. 1956		Jan. 1960		Index of growth
	Number (thousands)	%	Number (thousands)	%	
Physical sciences and engineering	103.3	46.0	163.5	52.7	159
Biological sciences, medicine, agriculture	51.5	23.0	64.8	20.9	121
Arts, humanities, social sciences	62.6	27.9	74.4	24.0	119
Other	6.5	2.9	7.2	2.4	110
Total	223.9	100.0	310.0	100.0	138

Table 4. Soviet academies of sciences, research institutes and research personnel, January 1960.

	Year founded	Academicians: full and corresponding members (No.)	Research institutes (No.)	Research personnel (No.)
Academy of Sciences of the U.S.S.R.	1725	503	238	23,150
Republic academies*				
Ukrainian S.S.R.	1919	208	60	3,274
Belorussian S.S.R.	1928	76	30	1,250
Uzbek S.S.R.	1943	60	30	1,838
Kazakh S.S.R.	1945	76	37	1,500
Georgian S.S.R.	1941	70	44	2,084
Azerbaidzhan S.S.R.	1945	39	24	1,612
Lithuanian S.S.R.	1941	35	15	499
Latvian S.S.R.	1946	37	20	819
Kirgiz S.S.R.	1954	26	12	544
Tadzhik S.S.R.	1951	29	27	709
Armenian S.S.R.	1943	59	28	1,074
Turkmen S.S.R.	1951	37	21	466
Estonian S.S.R.	1946	32	17	498
Subtotal, republic academies		784	365	16,167
Academy of Construction and Architecture of the U.S.S.R.	1956	196	33	2,642
Academy of Construction and Architecture of the Ukrainian S.S.R.	1956	31	26	1,628
Academy of Arts of the U.S.S.R.	1947	109	4	92
Academy of Medical Sciences of the U.S.S.R.	1944	216	32	2,678
Academy of Pedagogical Sciences of the R.S.F.S.R.	1944	92	13	577
Academy of Communal Services of the R.S.F.S.R.	1931		4	359
Subtotal, functional academies		644	112	7,976
All-Union Academy of Agricultural Sciences	1929	142	165	4,758
Academies of Agricultural Sciences of				
Ukrainian S.S.R.	1957	45	76	1,744
Belorussian S.S.R.	1957	28	23	833
Uzbek S.S.R.	1957	15	41	1,222
Kazakh S.S.R.	1957	20	51	1,142
Georgian S.S.R.	1957	21	11	564
Azerbaidzhan S.S.R.	1958	6	15	591
Subtotal, agricultural academies		277	382	10,854
Grand total		2,208	1,097	58,147

* The Moldav branch of the Academy of Science of the U.S.S.R., which had eight institutes and 272 researchers in 1960, is scheduled to begin functioning as a republic academy of sciences in 1962.

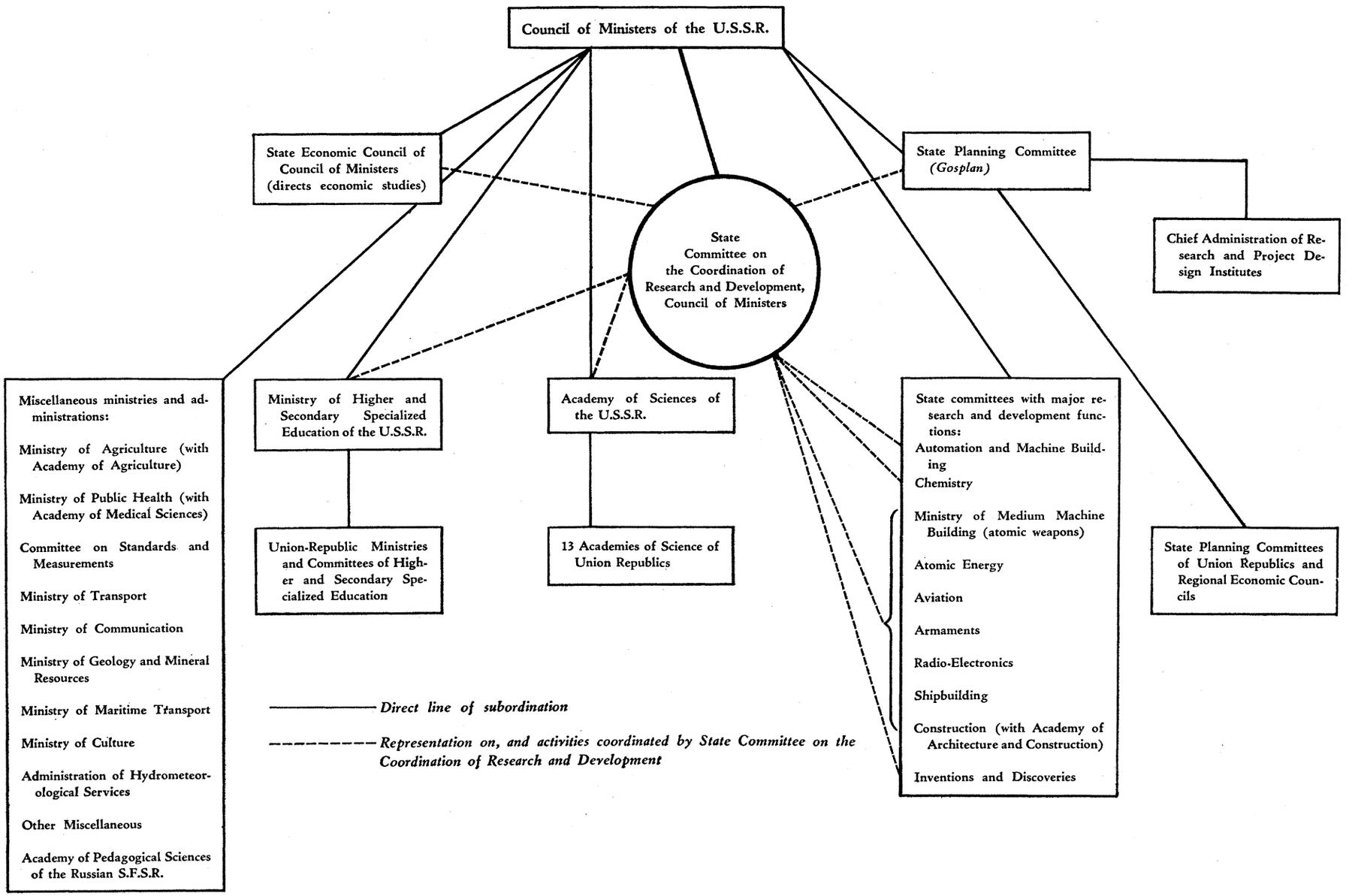

Fig. 1. Organizational structure of Soviet agencies concerned with research and development.

Early Steps in Reorganization

The debate concerning the Soviet science and research setup originated in July 1955. In February 1956, at the 20th Communist Party Congress, Khrushchev declared: "The separation of research activity of the Academy of Sciences, departmental research institutes and higher educational establishments can no longer be tolerated. This separation and lack of coordination prevent the concentration of research activity on the solution of major scientific and engineering problems, lead to duplication of effort and waste of resources, and retard the introduction of research and engineering achievements into production" (*4*).

Although similar thoughts had occasionally been expressed by other Soviet leaders, the demand to streamline the organization of Soviet research and development had never before been presented so forcefully. In 1956 and 1957 a veritable flood of proposals by prominent scientists appeared in the Soviet press, all aimed at streamlining the research organization along the lines of consolidating the fragmented, specialized units and breaking up departmental boundaries.

Meanwhile, beginning in May 1957, the management of Soviet industry was also reorganized, and as a result, a number of departmental research institutes, originally under the auspices of central ministries in charge of particular branches of the Soviet economy, were transferred to regional economic councils or to the newly formed state committees. Among these, the most important was the State Planning Committee, the *Gosplan,* and to it was delegated supervision of the major industrial research and development institutes. By 1958, 323 industrial research institutes, employing 19,000 researchers, were subordinated to the *Gosplan,* which formed a new directorate, the Chief Administration of Research and Project Design Institutes (*Glavnüproekt Gosplana*). This new directorate was to coordinate applied technological research and project-design activity in areas not under the jurisdiction of other state committees. The research and development institutes of other state committees were to carry on both applied and basic research in areas under their jurisdiction, —that is, in radio electronics, aviation engineering, armaments engineering, chemistry, shipbuilding, automation, and machine building. The *Gosplan,* together with the Academy of Sciences of the U.S.S.R., was to participate with these committees in delineating their research functions and coordinating their research objectives. Still, there was no central body to coordinate *all* research and development activity.

In order to speed up the introduction of new technology and scientific discoveries into industry, a separate State Committee on Science and Technology was established (called *Gostekhnika* in 1955, and since May 1957, *Nauchno-Tekhnicheskii Komitet*), which was to conduct research on the uses of new technology, disseminate technological information, and supervise the adaptation of foreign technology.

Academy of Sciences in a Squeeze

During this reorganization turmoil, the Academy of Sciences of the U.S.S.R. came under particularly heavy fire, being pressed not only to intensify its activities on applications for industry but also to direct and coordinate research applications in the other research pyramids. There were three external pressures upon the Academy: political, industrial, and educational.

Political. The Communist leadership insisted upon certain results: an efficient and economical way of conducting research and development activities, a reduction of departmental barriers and unnecessary duplication, and especially a speeding up of the application of research results (particularly in engineering technology) to industry. It wanted the Academy's work geared to these objectives and made "closer to production."

Industrial. The managers of Soviet industry, who were sometimes not eager or were even reluctant to use new technology for fear of disrupting production activity, wanted the Academy's researchers not only to make general scientific investigations and to engage in design and development of products and processes but also to engage in model production and testing and, thereafter, to participate in getting the "bugs" out.

Educational. Although much has been said about the research activities of Soviet universities and other institutes of higher education, for the last three decades the main preoccupation of these institutions has been with academic tasks largely separated from applied research. Universities had indeed carried out some highly theoretical work, but they had only limited access to experimental research facilities. Their applied (contractual) research for industry was small in terms of funds and facilities, though academic personnel frequently participated in the research effort through multiple-job holdings in facilities outside higher education. The educational reforms introduced in 1958 demanded the expansion of research work in higher educational institutions proper, and universities and institutes turned their attention toward the possibility of merging with or absorbing some of the separate research institutes. In order to strengthen instruction in practical applications and to increase research activity, demands were made that a number of the research institutes of the academies should be transferred to higher education auspices.

These three external pressures, however, were counteracted by one fundamental internal force. The scientists engaged in fundamental and theoretical research and the leaders in numerous research institutions of the Academy not concerned directly with applications desired greater emphasis on basic research. They urged the separation of activities and the setting up of new research institutes, not along specialized functional lines but as research task forces or problem areas with an interdisciplinary orientation. In effect, the working theoretical scientists and the leaders of the Academy wanted to rid it of activities which were not genuinely scientific. Largely in compliance with this view and, indeed, in full recognition of the problem, A. N. Nesmeianov, then Academy president, suggested in 1958 that Soviet science "can no longer rely upon foreign basic science . . . what we need now first of all is to develop the fundamental sciences. . . . We need to take decisive measures for the speediest and most widespread development of basic science" (*5*). He then proposed a sharp reorganization of scientific inquiry, with the Academy dealing only in basic research; applied research in technical and engineering fields was to be carried on by industrial institutes. The radical nature of Nesmeianov's proposals—that is, the separation of basic and applied research activities—was a blow at a cardinal assumption of Soviet dogma, that the "unity of theory and practice" is fundamental to dialectical materialism and that the separation of applied and theoretical objectives in research is inadmissible.

In the summer of 1959 Khrushchev recognized that a "difficult situation exists in some institutions of the Academy" (*6*) and suggested that some technical institutes be removed from its jurisdiction since the work of the Academy had become too big and complex for it to continue to have so many technological research functions. The Academy was to continue with experimental research in biology, geology, and some other areas of the natural sciences, but not in such areas of technology as mining, coal, metallurgy, transportation, and other kinds of industrial research.

In keeping with Khrushchev's proposals, Academician N. N. Semenov suggested that the technical sciences division of the Academy be abolished altogether and that its other divisions be consolidated into three major groups: experimental, geological, and social sciences (*7*). Research in engineering and the humanities should be carried on elsewhere. Such an arrangement would break down the narrow disciplinary lines of former Academy divisions and institutes. In the newly organized institutes, the departmental assignment of specialized fields to separate research institutes would thus be abolished. In the ensuing debate Semenov's proposals were supported by many leading scientists but were opposed by the applied-technology hierarchy within the Academy's Engineering Sciences Division, who wanted the Academy to retain tasks in applied technology so as to have a link with industry and production. Despite the opposition, Semenov continued to contend that the "responsibility to the state for developing science should rest with the Academy, and for its technical application with the appropriate research institutes elsewhere" (*8*). The same note was struck again in 1960 by other theoretical sci-

Who's Who in the New State Committee on the

Konstantin N. Rudnev (b. 1911), appointed Chairman of the State Committee on the Coordination of Research and Development of the Council of Ministers of the U.S.S.R. with the rank of Deputy Chairman of the Council of Ministers of the U.S.S.R. on 10 June to replace Khrunichev. Former Chairman of the State Committee on Armaments Engineering of the Council of Ministers of the U.S.S.R. since its establishment in 1958. Mechanical engineer; graduate of Tula Mechanical Institute, 1934. Chief design engineer in armaments research office, 1934–40. Chief engineer, then plant director, in armaments plant, 1940–47. Head of division in the Ministry of Armaments, 1948–52; Deputy Minister of Armaments Industry, 1953–57. Member of the Communist Party since 1941.

Mikhail V. Khrunichev (b. 1901), briefly chairman of the State Committee. In the 1920's was in the Red Army and secret police administration. In 1930–32 studied first in the Voroshilovgrad branch of the Ukrainian Industrial Management Academy, subsequently transferring to the All-Union Industrial Management Institute in Moscow. Industrial management work and later a director of armaments plant, 1932–37. Deputy Head of the Commissariat (Ministry) of Armaments Industry, 1938. Deputy Head of Commissariat of Aircraft Industry, 1932–42. First Deputy Commissar of Armaments Supply and Procurement, 1942–46, with the military rank of lieutenant general. Minister of Aircraft Industry of the U.S.S.R., 1946–53. First Deputy Minister of Medium Machine Building (Soviet atomic energy, weapon development, and production industries), 1953–55. Deputy Prime Minister of the Council of Ministers of the U.S.S.R., 1955–56. Deputy Head of the State Economic Commission, 1956–57. Deputy Chairman of the State Planning Committee, 1957–10 April 1961. Received Stalin prize twice (for aircraft development work) and seven Orders of Lenin. Hero of Socialist Labor (highest civilian award). Member of the Communist Party since 1921. Member of the Central Committee of the Communist Party of the Soviet Union since 1952. Died suddenly on 2 June.

Mstislav V. Keldysh (b. 1911 in Riga), newly elected President of the Academy of Sciences of the U.S.S.R. (19 May 1961). Applied mathematician, expert in aerodynamics and rocket development. Son of a prominent civil engineer (Major General V. M. Keldysh, of the Kuibyshev Military Engineering Academy and the Academy of Construction and Architectural Sciences of the U.S.S.R.). Graduate of Moscow State University, 1931. Doctor of physical-mathematical sciences, 1938 (defended his thesis at Steklov Mathematics Institute of the Academy). Professor of mathematics and member of the academic council (governing board) of Moscow State University, 1932 to the present. Joined the Soviet Union's major aircraft development center, TsAGI (Central Aero-Hydrodynamics Research Institute), in 1931, where during the 1930's he directed research on dynamic properties of wings, vibration problems, landing gear, and other problems of aircraft design and development. In 1943, was chosen to head the research work in the then top secret "Research Institute No. 1" of the Ministry of Aircraft Industry, which engaged in Soviet rocket development. Did research and development work at a "research institute" (classified) of the Ministry of the Aircraft Industry in the 1940's and early 1950's. At the time of his election to the Academy's presidency was "director" and "leader of research" (classified) of "several research institutes conducting work in mathematics and mechanics and charged with the solution of major scientific and engineering development problems in the area of special technology"—that is, the group of research and development centers for missiles and space vehicles managed mainly

entists, and Nesmeianov declared anew his belief that the Academy should engage primarily in basic research (*9*).

The new governmental decree resolves the issue in part at least. It declares: "Institutes of applied specialized profiles, upon the recommendation of the Academy's Presidium, will be transferred to other state committees, ministries and departments" (*10*). If all the Academy's institutes with a technological profile were thus affected, it would mean the transfer of up to 50 research institutes with an estimated 8000 researchers. Furthermore, the regional branch offices of the Academy of Sciences of the U.S.S.R. will be transferred to the jurisdiction of the Council of Ministers of the Russian S.F.S.R. and will be operated by regional economic councils.

In fact, such a decision has already been adopted at the plenary session of the Presidium of the Academy of Sciences of the U.S.S.R., held on 10 April (*11*). Accordingly, exclusive of the Academy's affiliates (branch offices) (*12*), the transfers have so far affected about 30 research institutes, employing bewteen 2000 and 3000 researchers. Affected were not only the industrial research institutes of the Academy's Engineering Sciences Division (*13*) but also institutes under other divisions of the Academy (*14*), the latter also engaged primarily in applied technical research. Despite these proposed cuts, the Academy will still remain the U.S.S.R.'s largest research unit.

The decree stipulated further that "the work of the Academy should be focused primarily on the most important long-run problems of science undergoing rapid development." These functions are precisely the ones which the Academy leadership has been asking for. The Academy will continue to (i) exercise scientific and methodological

Coordination of Research and Development

by the State Committee on Aviation Engineering, Ministry of Medium Machine Building (weapons development), and Ministry of Defense. Was elected corresponding member of the Academy, 1943; full member, 1946; member of the Presidium, 1953; vice president, 1960. Received two Stalin prizes (1942 and 1946, for work in aerodynamics and aircraft development); received the Lenin prize (sometime after 1956, for undesignated work). Is noted for theoretical work in mathematics (calculus of variations, boundary-value problems), applied mathematics (computers), and aerodynamics (has published no research papers in the latter field since 1939). Has received five Orders of Lenin and three Orders of the Red Banner and was named a Hero of Socialist Labor (presumably on 22 December 1957 at the time of the awards for the development of the first Soviet satellite). Communist Party member since 1949.

Viacheslav P. Eliutin (b. 1907), Minister of Higher and Secondary Specialized Education. Engineer; graduate of Moscow Institute of Steel, 1930. Worked as engineer and plant manager in the 1930's. Received degree of doctor of engineering sciences in 1947 and was simultaneously certified in the rank of professor. Director of the Moscow Institute of Steel, 1945–51. Deputy Minister of Higher Education, 1951–54. Received Stalin prize (in metallurgy) in 1952. Communist Party member since 1929. Candidate member of the Central Committee of the Communist Party of the Soviet Union since 1956.

Anatolii I. Kostousov (b. 1906), Chairman of the State Committe on Automation and Machine Building of the Council of Ministers of the U.S.S.R. (set up in 1959), with the rank of minister. Mechanical engineer; graduate of Moscow Machine Tool Institute, 1932. Worked as engineer, manager, and plant director in a number of machine building plants, 1933–46. Deputy Minister (1946–49) and Minister (1949–53) of Machine Tool Industry of U.S.S.R. Minister of Machine Building Industry of U.S.S.R., 1953–54 (which was reorganized as Ministry of Machine Tool and Instrument Industry of the U.S.S.R. 1954–57). Chairman of the Moscow Regional Economic Council, 1957–59. Communist Party member since 1925. Candidate member of the Central Committee of the Communist Party of the Soviet Union since 1952.

Victor S. Fedorov (b. 1912), Chairman of the State Committee on Chemistry of the Council of Ministers of the U.S.S.R. since its establishment in 1958. Chemical engineer; graduate of Groznyi Institute of Petroleum Engineering, 1932. Taught there and received candidate degree in engineering in 1937; was certified associate professor and headed the department of petroleum processing technology, 1937–40. Petroleum plant manager and petroleum trust executive in the newly developed oil region of the Volga, 1940–53. Mainly responsible for the development of fields, cracking installations, and petrochemical plants in that region. Deputy Minister of Petroleum Industry, 1953–57. Chairman of the Bashkir A.S.S.R. Regional Economic Council, 1947–58. Received two Stalin prizes (for petrochemical research). Made a Hero of Socialist Labor in 1952. Has been a member of the Communist Party since 1939.

Alexandr F. Garmashev (b. 1907), Chairman of the Committee on Inventions and Discoveries of the Council of Ministers of the U.S.S.R. since its establishment in 1956. Mechanical engineer; has the degree of candidate in engineering sciences. In the late 1930's and 1940's was manager and director of several shipbuilding, locomotive, and military ordnance plants in the Ukraine. Received Stalin prize (for work in welding technology). Communist Party member since 1938.

leadership and conduct research in the area of the natural sciences (physics, mathematics, biology, and sciences of the "universe and earth"—that is, geology, oceanography, astronomy, and so on); (ii) aid the academies of science of the union republics in their research; (iii) coordinate the activities of all the Academy's institutions; (iv) maintain scientific ties with foreign countries; and (v) engage in the training of research personnel.

The Academy's role in regard to the first of these functions was clarified further to include the coordination of work in those areas conducted not only at the Academy but by other institutes as well, especially by institutes of higher education (*15*). Although the decree does not make it clear, according to Topchiev, the Academy's role in maintaining scientific ties with foreign countries (function iv) will be to coordinate scientific exchanges with foreign countries, and particularly to expand its activities in the exchange and dissemination of scientific information.

Replacement of Academy President

Closely associated with the reorganization moves was the sudden replacement of the Academy's president, A. N. Nesmeianov, by academician Mstislav Vsevolodovich Keldysh, who was elected to that post at an extraordinary general meeting of the Academy on 19 May 1961 (*16*).

The official version of the meeting was that former president Nesmeianov had petitioned to be relieved of his duties because of the "expiration" of his second 5-year term. Technically, however, his term would not expire until October 1961, for he had been elected by the general assembly of the Academy on 13 October 1956. Furthermore, the extraordinary plenary session of the Academy was called together on 19 May by its presidium (governing board) to "ratify" the resignation of Nesmeianov, which had already been "accepted," and to elect a new president, whose candidacy was already endorsed by the Academy's presidium, the "Communist Party group" of the Academy, and by the Academy's eight divisions. Each of these moves indicates clearly that Keldysh, the new president, was co-opted prior to the formal election.

The new president, professor and doctor of mathematical sciences, had a meteoric rise in the largely conservative body of the Academy. Elected as a corresponding member in 1943, he became a full member in 1946 (the span between the two ranks is usually at least 10 years). In 1953 he was elected a member of the Academy's ruling body, the Presidium, and became its vice president in February 1960. He did not at any time belong to the internal managerial hierarchy of the Academy; all of his research work in mathematics, aerodynamics, and aircraft and rocket technology was done outside the Academy's research institutes. He thus belonged to that group of academicians (about half of the total of 161 full and 369 corresponding members) who are in the Academy of Sciences of the U.S.S.R. as honorific members and top-level research coordinators rather than staff scientists in one of its many research institutions. Kelydysh has strong ties with the new head of the Committee on Coordination, having worked in research organizations headed by Khrunichev. In addition, he has a long-standing working relationship with other members of the new committee active in the Soviet military research and development effort.

Keldysh's appointment to the presidency was undoubtedly influenced by the fact that in addition to his scientific competence he has had wide organizational experience with the large-scale research and development effort outside the Academy. It is this research-management experience which is needed in the institutional rorganization and streamlining of the Academy's research functions that are presently under way.

Functions of the New Committee

The State Committee on the Coordination of Research and Development will supervise the work of research and development establishments in fulfilling the most important scientific research and engineering objectives in accordance with the directives of the party and the government. It will coordinate work of the Academy of Sciences of the U.S.S.R., of the academies of science of the union republics, and of ministries and departments in fulfilling the most important research objectives of an interdepartmental or interdisciplinary nature, and it will guide the direction of research and development work up to the point of its adaptation in the national economy.

On the recommendation of the Council of Ministers of the U.S.S.R., the councils of ministers of the union republics, and ministries and departments, the State Committee on the Coordination of Research and Development, together with the State Economic Council (*17*) and the State Planning Committee, will develop plans for research and development work in the country at large and for the introduction of scientific and engineering accomplishments in production. The task of the new committee will be to propose these plans for approval to the Council of Ministers of the U.S.S.R.

The Committee on the Coordination of Research and Development will have the following specific areas of responsibility.

1) National control over the fulfillment, by all ministries, departments, and organizations, of the most important research objectives, and supervision, on an operational basis, of the introduction of scientific and engineering accomplishments into production.

2) Preparation of proposals for research and development work of greatest national significance, and concern with problems posed by new discoveries and inventions.

3) Preparation of proposals concerning the supplying of research and development organizations with special equipment, installations, and instruments.

4) Study and evaluation of scientific and engineering accomplishments (both domestic and foreign) with a view toward their possible introduction into the national economy.

5) Coordination of all interdepartmental activities of ministries, departments, and research and development organizations in the area of science and technology.

6) Preparation of annual and long-run plans for financing material-technical supply of research and development work, including plans for capital investment for the development of science.

7) Certification of major research and development institutes; such institutes may be opened only with the committee's consent. Particular attention of the committee will be devoted to designating "major" institutes (*golovnyi instituty*) which are interdiscipli-

nary or "problem" research centers. They have been set up under different departmental auspices in recent years, and it is anticipated that a number of additional such centers will be established in the near future.

The former State Committee on Science and Technology has been absorbed by the new State Committee on Coordination. The All-Union Institute of Scientific and Technical Information, which was originally subordinate to this State Committee (though operated jointly with the Academy of Sciences of the U.S.S.R.), has now been transferred to the new State Committee on Coordination. As in the past, the Institute of Scientific and Technical Information will be the central translating, abstracting, and disseminating organ for domestic and foreign scientific information.

Except for this scientific information institute, the new State Committee on the Coordination of Research and Development will not operate any research institutes directly; rather, its function will be to guide research activities of an interdisciplinary nature, or of great importance, in research units under the jurisdiction of other state committees or departments. However, as in the past, specialized research and development work not of national significance and not of an interdepartmental or interdisciplinary nature will be coordinated by ministries, departments, and regional economic councils.

Soviet Leaders in Charge of Other State Committees Concerned with Research and Development

Petr V. Dement'ev (b. 1907), Chairman of the State Committee on Aviation Engineering of the Council of Ministers of the U.S.S.R. since its establishment in 1957. Aviation engineer; graduate of Zhukovskii Air Engineering (Military) Academy, 1931. In the 1930's was in air force development and procurement work. Deputy Minister of Aircraft Industry, 1953–57 (until its reorganization into the State Committee on Aviation Engineering). Hero of Socialist Labor (highest civilian award). Communist Party member since 1938. Candidate member of the Central Committee of the Communist Party of the Soviet Union since 1952; has been a full member since 1956.

Leonid Smirnov, new Chairman of the State Committee on Armaments Engineering of the Council of Ministers of the U.S.S.R., appointed 10 June.

Valerii D. Kalmykov (b. 1908), Chairman of the State Committee of Radio-Electronics of the Council of Ministers of the U.S.S.R. since its establishment in 1957. Electrical engineer; graduate of Moscow Power Institute, 1934. Worked as chief design engineer in communciations research and development institute, 1934–49. Headed division of shipbuilding industry, 1949–51. On "special assignment" with the Council of Ministers, 1951–54. Minister of Radio-Electronics Industry, 1954–57. Communist Party member since 1942. Candidate member of the Central Committee of the Communist Party of the Soviet Union since 1956.

Aleksandr I. Shokin, Chairman of the State Committee on Electronic Engineering of the Council of Ministers of the U.S.S.R., which was formed on 8 March 1961. Electronics engineer. In the mid-1950's, Deputy Minister of the Radio-Electronics Industry, and since 1958, Deputy Chairman of the State Committee on Radio-Electronics.

Boris I. Butoma (b. 1907), Chairman of the State Committee on Shipbuilding of the Council of Ministers of the U.S.S.R. since its establishment in 1957, with the rank of minister. Naval engineer; graduate of Leningrad Naval Engineering Institute, 1936. Headed a number of shipbuilding works, 1936–48. Deputy Minister of Shipbuilding Industry, 1944–53. Received Stalin prize (for shipbuilding technology) in 1949. Communist Party member since 1928.

Vasilii S. Emel'ianov (b. 1901), Chairman of the State Committee on Atomic Energy (peaceful uses) of the Council of Ministers of the U.S.S.R. since its establishment in the summer of 1960. Metallurgical engineer; graduate of Moscow Mining Academy, 1928. In the 1930's worked in research and development organizations on ferro alloys, armor plates, and electric furnaces. Deputy Chairman of the Committee on Standards and Measurements, 1940–47. On "special assignment" with the Council of Ministers of the U.S.S.R., 1948–57. Chairman of the Main Administration on Uses of Atomic Energy of the Council of Ministers of the U.S.S.R. (subsequently reorganized into Committee). Candidate member of the Academy of Sciences of the U.S.S.R. since 1953. Received Stalin prize (for ferro alloys). Communist Party member since 1919.

Efim P. Slavskii (b. 1898), Minister of Medium Machine Building Industry [Soviet Atomic Energy, Weapons (including rockets) Development and Manufacturing Industry] of the Council of Ministers of the U.S.S.R. Metallurgical engineer; graduate of Moscow Institute of Polymetals and Gold, 1933. Director of Dnepropetrovsk and Ural Aluminum Combines in the late 1930's and 1940's. In the 1950's was Deputy Minister of the Polymetal Industry and Deputy Minister of Medium Machine Building Industry. Received Stalin prize. Communist Party member since 1918.

Composition of Committee on Coordination

The new decree, which establishes for the first time in Soviet history a central coordinating agency (see Fig. 1) for research and development for the country at large, is to be headed (see pages 1986 and 1987) by a Deputy Chairman of the Council of Ministers (Rudnev, replacing Khrunichev who died on 2 June).

It is to be composed of the President of the Academy of Sciences of the U.S.S.R. (Keldysh); the Minister of Higher and Secondary Specialized Education (Eliutin); the Chairman of the State Committee on Automation and Machine Building (Kostousov); the Chairman of the State Committee on Chemistry (Fedorov); the Chairman of the Committee on Inventions and Discoveries (Garmashev); one of the deputy chairmen of the State Economic Council; and one of the deputy chairmen of the State Planning Committee.

There will also be "other members" of the Committee on the Coordination of Research and Development from other state committees dealing with research and development work (see page 1989). They were not identified by position in the official decree, but definitely the heads of other governmental departments dealing with research and development will be represented. These are chairmen of the following agencies: state committees on aviation engineering (Dement'ev), armaments engineering (Smirnov), radioelectronics (Kalmykov), electronics (Shokin), shipbuilding (Butoma), and atomic energy (Emel'ianov) and the Minister of Medium Machine Building (atomic, and other, weapon development and production) (Slavskii).

The State Committee on the Coordination of Research and Development will form a permanent scientific council, consisting of leading specialists and scientists of the country, with advisory functions, and when the occasion arises, will call for special boards to study specific problems. Particular significance should be assigned to this latter function. Soviet sources indicate that "although about 80 permanent scientific councils are in existence today . . . about one-half of these are inactive" (*15*). The new State Committee on Coordination will thus streamline and activate the work of scientific councils in diverse areas of research, whose activities will now be coordinated by a permanent scientific council (*18*). Through these measures, it is hoped, the "leadership role of scientists now working within the Academy of Sciences of the U.S.S.R. will intensify in the work of the nation's research organization" (*19*).

The new measures to coordinate research and development are obviously designed to give even more emphasis to the physical sciences and engineering and to complex interdisciplinary problems. The important consideration is that the new chairman of the State Committee on Coordination, Khrunichev, is a person with a strong military research and development background. This is also true of the new president of the Academy, who has not only general background in military research and development but also specific experience in rocket and space technology. In addition, most of the heads of the state committees with research and development functions have similar backgrounds. All are former engineers active in defense fields, now turned industrial managers and political leaders. Upon examining their background, it is hard to resist the view that their past interests have profound implications for the future of Soviet efforts in applied research—that these efforts will be technological in nature, with strong military overtones.

Whatever the outcome may be, however, the intended result of the establishment of the State Committee on Coordination will be the synchronization of the Soviet research and development effort in the distinct institutional pyramids—academies, institutions of higher education, and departmental research institutes. What is even more significant, perhaps, is that responsibility for decisions on scientific research and development has now been lodged at the pinnacle of the Soviet power hierarchy; for the first time in Soviet history the Deputy to the Prime Minister (that is, Khrushchev himself) has been charged with the supervision of these tasks.

In regard to other areas of research, it appears that the earlier setup will continue, as follows.

1) Research on economics will be coordinated by the State Economic Research Council of the Council of Ministers, which was set up in 1959, with the chief role assigned to the economic research outlets of the *Gosplan* and with ever-increasing use of mathematical methods of centralized planning and production programming.

2) As in the past, the Academy of Medical Sciences will supervise and conduct medical research, largely sponsored by the Ministry of Public Health.

3) The Ministry of Agriculture, with its All-Union Academy of Agricultural Sciences and five other regional agricultural academies set up since 1957, will coordinate agricultural research and manage experimental agricultural stations. In the areas of medicine and biology, the Academy of Sciences of the U.S.S.R. will not be involved, save for basic research in biology.

4) The State Committee on Construction, with its own Academy of Architecture and Construction (organized in 1956), will coordinate construction and architectural research.

5) Political studies (especially "philosophy") will be guided largely by the Academy of Social Sciences of the Central Committee of the Communist Party.

6) In the field of education, the Academy of Pedagogical Sciences of the Russian S.F.S.R. remains the national clearinghouse and conducts major research.

The new centralization of the decision-making mechanism in Soviet research and development will no doubt be manifested in the near future. Freed from burdensome technological tasks, the Academy of Sciences will be able to concentrate more effort on basic research. Many of its institutes are expected to be reorganized. The Soviet authorities hope that the new measures will (i) improve the system of both long-run and current planning of research and the coordination of research and development activity; (ii) further strengthen theoretical research on the most important scientific problems (within the Academy); (iii) allow for closer ties between departmental research institutes and industry; and (iv) allow more rapid introduction of research-and-development results into production technology and the economy.

The separation of functions must be clearly recognized. On the operational level the Academy will delegate some of its former functions in applied industrial research to other agencies, and within the Academy, institutes will be reorganized in such a way as to cope with complex interdisciplinary and basic research problems, including a very likely increase in the Academy's

role in space exploration. On the consulting and decision-making level the prestige and resources of the Academy will, as in the past, be utilized, though now there will be an intermediate link —the Committee on Coordination— which will in turn exert pressure upon the Academy.

Perhaps these measures are a recognition of a turning point in Soviet technological development: the point of diminishing returns from adaptation of Western technology has been reached, and new and vigorous domestic technological development becomes a necessity. The Soviet political leadership appears to be convinced that the invigoration of technological research activities can be more profitably achieved by separating functions, and by freeing the Academy of Sciences of the U.S.S.R. to concentrate its attention on basic research and the long-run problems of science. Reorganization of the Soviet research setup could provide an effective mechanism for channeling scientific manpower and material resources into strategic areas of the physical sciences and engineering toward the achievement of the most ambitious long-run goal of Soviet power —world leadership in science and technology.

Note added in proof. Right after this article had gone to press, Mr. Khrunichev died of a heart attack on 2 June. His successor, Konstantine N. Rudnev, was named on 10 June.

References and Notes

1. *Pravda* (12 Apr. 1961).
2. Some of the statistical information in this article is taken from N. DeWitt, *Education and Professional Employment in the U.S.S.R.* (National Science Foundation, Washington, D.C., in press).
3. A 14th union-republic academy of sciences is scheduled to begin functioning in the Moldavian S.S.R. in 1962; it is presently a branch of the Academy of Sciences of the U.S.S.R.
4. *Pravda* (14 Feb. 1956).
5. *Uchitel'skaia gazeta* (20 May 1958).
6. *Pravda* (2 July 1959).
7. *Izvestiia* (9 Aug. 1959). Semenov was a Nobel prize winner in chemistry.
8. *Ibid.* (16 Dec. 1959).
9. *Pravda* (31 Dec. 1960).
10. *Ibid.* (12 Apr. 1961).
11. This information was given me by A. V. Topchiev, vice-president of the Academy of Sciences of the U.S.S.R., in Washington, D.C., on 26 and 27 April. Dr. Topchiev attended the plenary session just before his trip to the United States. He indicated that no public announcement of this decision has been made as yet, since the Presidium is still considering the possibility of additional transfers of research institutes.
12. There are seven branches: Bashkir, Dagestan, Karelian, Kazan', Kola, Komi, and Ural. An eighth branch—Moldav—is currently being reorganized into a union-republic academy. The seven branches are being transferred to the jurisdiction of the Council of Ministers of the Russian S.F.S.R.
13. Dr. Topchiev gave as examples the Institutes of Complex Transportation Problems, Metallurgy, and Hydraulic Engineering and Water Economy. In addition, the Institute of Mining will be transferred from the Academy [*Vestnik Akad. Nauk.* **31**, No. 4, 3 (1961)].
14. Dr. Topchiev gave the following as examples: in the Geography-Geology Division, Institutes of Geological Prospecting and of Coal Geology; in the Chemical Division, Institutes of Silicate Chemistry and of Forestry and Wood Chemistry; in the Biological Division, the Institute of Soil Sciences.
15. *Ekonomicheskaia gazeta* (20 Apr. 1961).
16. *Pravda* (20 May 1961); *Ekonomicheskaia gazeta* (20 May 1961).
17. Some of the Academy's institutes which deal with long-range planning, such as the Institute of Complex Transportation Problems, have been transferred to the operating auspices of the State Economic Council.
18. This was especially emphasized by Dr. Topchiev.
19. *Pravda* (21 Apr. 1961).

Radionuclide Fractionation in Bomb Debris

The fractionation systematics for high-yield bursts at sea-water and coral surfaces are delineated.

E. C. Freiling

In radiochemical studies of nuclear detonation debris, the term *fractionation* is used to indicate any alteration of radionuclide composition occurring between the time of detonation and the time of radiochemical analysis which causes the debris sample to be nonrepresentative of the detonation products taken as a whole. The phenomenon has recently been discussed by Adams *et al.* (*1*) and Edvarson *et al.* (*2*) and treated theoretically by Magee (*3*). The alteration observed may have taken place in various stages, and it is helpful to classify these according to the type of processes involved, to list them in approximately chronological order, and to group them under two headings—natural and artifactitious.

Natural fractionation begins with the condensation of radioactive and inert material from the fireball, some radionuclides being preferentially taken up by the condensed phase. The intimate mixture of condensed and solid phase may begin to separate while condensation is still in progress, with further separation of the condensate, according to size, density, and shape, occurring under the influence of wind, gravity, and the turbulence of the cloud. The fractionation taking place through these processes is called primary fractionation in this article.

Further fractionation may then occur through contact of debris with radioactively inert surroundings. For example, soluble radionuclides may be preferentially leached from fallout by sea water, or small particles may preferentially adhere to available surfaces. Fractionation occurring by processes such as these is called secondary fractionation.

Artifactitious fractionation can be induced by sample-collection processes which result in biased samples, by incomplete removal of debris from sampling apparatus, and by faulty analytical procedures.

At this point it appears advisable to introduce two further terms to describe primary fractionation. It is conceivable that in one burst only a small portion of the debris will be sensibly fractionated with respect to two given radionuclides, but that highly unrepresentative ratios of these radionuclides will be produced. In a second burst this pair of radionuclides may be fraction-

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