Science Reunification in Germany: A Crash Program

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With the fall of the Wall in 1989, a great experiment, the unification of the two Germanies, began. It included the restructuring of the East German science and education system, a process that was looked upon, and will be looked upon, with great interest by science politicians and administrators. Although not yet history, the speed and magnitude with which changes in science and research occurred in East Germany after the *Wende* (loosely translated as the "turning point") make the last 3 years a historic period that deserves this interim analysis.

Science Management and Political Systems

Science in the East. In the former East Germany [German Democratic Republic (GDR)], science and research were regarded as a tool for advancing the success of socialist society. Science was organized, planned, and financed centrally and shaped by the "leading role" of the Socialist party (SED). Major decisions about which science and technology projects should be funded were made by an elite group of government representatives. The development of science and technology was regarded as an objective process to be imposed rather than a politically neutral process of pluralistic and competitive interaction. In some respects, science management had been similar in East and West Germany since the end of World War II, but in the East, there was a major policy change in the '60s, inspired and guided by the Russian system. It was a devastating blow to research at universities: Funding was increasingly directed to centralized research institutions, the academies, particularly those in and around Berlin. Universities slowly degenerated to advanced job-training institutions, with less and less involvement in research.

In the universities, science was at a particular disadvantage because (i) the SED neglected funding, (ii) the infrastructure was insufficiently developed, and (iii) there was a chronic shortage of Western literature and of modern scientific instruments, in particular computers. The nine universities and 39 specialized technical and medical schools employed 39,000 people. Science was dominated by the three academies (of science, of agricultural science, and of civil engineering and architecture), which had 36,000 employees. About half of the research personnel were contracted to large combines, which were noninnovative structures with declining and inefficient research activity. The industrial sector had considerably greater research capacity than state-run institutions, employing 86,000, but because of the lack of "hard currency," much of the research and development (R&D) effort was aimed at reinvention or replication of Western technology, rather than at true invention and innovation (*1*).

Science was controlled by politics (*2*): Scientific content and method were determined by Marxist-Leninist doctrine; the SED, through committees and politically well connected faculty members, largely determined research priorities; and the driving force of science was technological progress considered "useful" to socialist society, not curiosity. Individuality was discouraged. Scientists had limited opportunities to communicate with their peers as a result of various measures of censorship, control, and prohibition of publishing. In addition, career development was not solely based on merit: Scientists had to demonstrate sufficient proximity to communist values. Although the presence of informants of the State Security Agency (STASI) within all institutes was generally not realized, fear of being accused of wrongdoing had a devastating psychological influence on the individual scientist and destroyed the free and (self-)critical exchange of ideas, a vital ingredient of scientific progress.

Science in the West. In contrast with the centralized science management in the East, the West gradually adopted a pluralistic system in which science funding and management was organized by three major institutions (*3*, *4*): the federal government [primarily represented by the Federal Ministry of Research and Technology (BMFT)], the state governments of the (then) 11 states, and the major science organizations, including the German Research Society (DFG), the Max Planck Society, the Fraunhofer Society, and the Union of Large-Scale Research Institutions. In postwar Germany, science and education fell within the domain of the state governments, but during the late '60s and early '70s, the federal government became increasingly involved in science funding because of the availability of large funds. Science and technology developed through a democratic and competitive process of discussion, consensus, and majority vote. Research grants were awarded following a competitive application procedure with strict selection criteria that adhered to international standards. Although the "brain drain" after the war affected both parts of Germany, West Germany slowly overcame it by encouraging scientists to attend international conferences and to become educated abroad.

State-supported science in West Germany was carried out by state-supported universities, the "most important institutions of research" (*4*), and by independent research institutions, including the Max Planck Institutes, the Fraunhofer Institutes, and, to a lesser extent, the "blue-list" institutes and the large-scale research institutions. Most of these institutes (with the exception of the large-scale research institutions and the Fraunhofer Institutes) are funded equally by the federal and the state governments, but decisions on funding priorities are self-administered by the German scientific community. By avoiding national (federal) science and technology blueprints, the German government has deprived itself of the ability to conceive and implement national goals [similar to the Ministry of International Trade and Industry (MITI) in Japan (*5*)]. Although there are some national research initiatives, such as large-scale research projects, legislation after the war was designed such that science and education are now (theoretically) under the sole control of the state governments (*Länderhoheit*), which orient their interests along state, rather than national, goals.

Scientific cooperation in the postwar period. During the cold war of the '50s and '60s, interactions between scientists and students from East Germany and those from West Germany declined sharply. With the building of the Wall in 1961, any cooperation came to a sudden halt, and GDR scientists were no longer able to travel to Western countries (*1*). Exchange was limited to Eastern partners, particularly the former Soviet Union, but also Poland, Rumania, the former Czechoslovakia, and Hungary. This strict separation policy changed slowly with the basic treaty (*Grundlagenvertrag*) of 1972 and with the Conference on Security and Cooperation in Europe (CSCE) treaty of 1975; limited cooperation between the two Germanies was now possible. However, substantial cooperation was possible only after the cultural exchange agreement of 1985 and the agreement of scientific and

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technological cooperation (WTZ agreement) of September 1987, which led to the establishment of more than 60 joint projects (6).

The Restructuring of East German Science After the *Wende*

Although the initial intention of the first democratically elected government of East Germany under de Maizière was to find ways of integrating both systems, these intentions quickly gave way to the concept that the massive task of reunification could only be accomplished by full adoption of the Western system as quickly as possible. That an entirely new system of education and science management would have to be established in the GDR, a country of about 16 million people (West Germany: 64 million), was considered by some to be a great opportunity to implement new concepts and ideas—not so. Rather than restructuring East German science on the basis of some thoughtful, innovative concepts, what was in essence a massive "crash program" was initiated to immediately adopt the West German system. This modern "experiment" to transform the science management of an entire country was considered by most decision-makers as not having enough room for yet "another experiment within the experiment"—the introduction of new concepts and ideas. The only solution, according to the consensus of Western science administrators, was to transfer the Western system en bloc rather than to create an East German competitor with an alternative science and education structure. To leave no room for experimentation, unification had to be rapid: The time allocated for unification of the science systems was a mere 16 months, September 1990 to 31 December 1991.

According to Stucke (*3*), German-German science integration occurred in three major phases. First, there was a cooperation phase, from October 1989 to March 1990, at a time when the GDR was still considered an independent state; second, a "strategic positioning phase," from April to July 1990, which allowed discussion and the positioning of the West German science lobbies in view of the anticipated unification; and third, the extremely short negotiation phase, from July to August 1990.

German institutions entered the cooperation phase with different levels of enthusiasm. The Fraunhofer Society and the federal government took the initiative by creating funding programs at short notice. This was a crucial contribution, helping prevent a massive migration of Eastern scientists to the West. The West German state governments—those that possess the "sovereignty" and legislative power for science and education—were surprisingly inactive in the early cooperation phase. They did not feel in charge, particularly because there was no official negotiation partner: The East German states had not been established at the time. Stucke wrote that "one gets the impression that the state governments voluntarily left the decisions to the federal government (BMFT)" (*1*). A national science steering committee with executive power on national science- and education-related development did not, and still does not, exist, a clear deficiency in German science-policy management.

In the strategic positioning phase, the governments of the individual German states remained inactive, with the exception of Berlin, which, because of its dominance, had a lot to lose. The three main research societies also played an important role. The Fraunhofer Society and the Society of Large-Scale Research Institutions attempted to maintain, and even widen, their influence, while trying not to get cornered by the federal government into diverting resources earmarked for research in the West. The Max Planck Society did not want to lose autonomy and sacrifice financial resources to the East and did not consider the Academy of Sciences as an equal negotiation partner. Initially, it agreed to take over only two institutes and 28 small research groups in the East because all others were not up to their standards. This situation is now being changed, and additional federal funding for the creation of new Max Planck Institutes will become available (*7*).

Because the Max Planck Society did not see itself in the position to take over many of the academy institutes, a great number of German research institutes were up for grabs. Many were destined to close, leaving thousands of highly qualified scientists jobless and East German science in ruins. To prevent this, the federal government, through the BMFT, provided a safety net for most of the East German research institutions, financing over 34 research facilities, which are collectively referred to as blue-list institutes (Fig. 1). The creation of a Leibniz and a Helmholtz Society as umbrella organizations for positively evaluated institutes in the East was considered but was later dropped under the political pressure exerted by the West German science lobby. The science establishment of the West, fearing that their independence might be undermined (*3*), agreed unanimously not to permit an independent and competing science organization in the East.

In the short negotiation phase, the German governments agreed that Eastern science should be reorganized by a simple transfer of the Western system, as expressed in Article 38 of the unification contract (*8*). This contained the following agreements: (i) learned societies and the Academy of Sciences should separate, (ii) the German states (*Länder*) should decide which learned societies should continue, (iii) the Academy of Sciences would be placed under the jurisdiction of the state, with financial support guaranteed by the federal government until 31 December 1991, (iv) there should be evaluation of the institutes by the Science Council, and (v) methods and programs of research funding would follow the established (Western) system (*3*).

In all these developments, Stucke (*3*) sees one common denominator: the maintenance of the status quo of West German science management. No efforts were made to consider new structures and new science policies; no one, with the exception of the Science Council, wanted an "experiment within an experiment." The federal government, to maintain its flexibility, did not want to get tied up with long-term budgetary commitments; the state governments did not become involved; and the Western science organizations wanted to keep their stakes and maintain their status quo, their balance of power, and their autonomy. Thus, the process was guided more by the power struggle within West German science than by a comprehensive blueprint of national research and technology policy. Admittedly, the practical task at hand was enormous: In a short period of time, all research institutes outside the universities had to be evaluated, all academy institutes had to be dissolved and refounded, and the new states (which themselves were only formed in October 1990) had to be integrated into the existing science apparatus of the West. In addition, the universities had to be restructured, research brought back to the universities, and existing science structures decentralized. To provide a legal basis for this change, the unification contract specified the process of the evaluation and restructuring (*Abwicklung*) of nonuniversity research institutes (Article 38) and of universities [Article 13 (8)]. Although the timetable specified in Article 38 was very short (until the end of 1991), the restructuring of the universities, specified in Article 13, was significantly longer, a process that is still ongoing.

To accomplish all of these goals, the government had to initiate an evaluation process of the entire East German scientific community, which had at the time about 75,000 employees. As the government itself had neither the personnel nor the in-depth knowledge of science to handle this task, they looked to Western scientists to organize the evaluations. This was done through the Science Council (*Wissenschaftsrat*), an organization based in Cologne.

Fig. 1. Nonuniversity research institutions in Germany. Location is shown for institutes in all of Germany. Parentheses mark number of institutes. The broken line marks the former boundary between the two Germanies. In the New States (former East Germany), there exist 34 blue-list institutes (5500 employees), two Max-Planck-institutes (975 employees, including 28 Max Planck groups not shown on map), four large-scale research institutes (1730 employees), and nine Fraunhofer Institutes (1050 employees). Their names are listed by city from the top of the map down; institutions with 100 or more employees are indicated by an asterisk. **Blue-list institutes:** Kühlungsborn: Institute of Atmospheric Physics; Warnemünde-Rostock: Institute of Baltic Sea Research*; Greifswald: Institute of Low-Temperature Plasma Physics; Dummersdorf: Institute of Biology of Agricultural Animals*; Müncheberg-Eberswalde: Center for Landscape and Land-Use Research*; Berlin: German Institute of International Educational Research; Institute of Molecular Pharmacology*; Institute of Zoo and Wildlife Research; Ferdinand Braun Institute of Highest Frequency Technics*; Institute of Applied Analysis and Stochastics; Institute of Hydroecology and Freshwater Fishing*; Institute of Crystal Growth; Max Born Institute of Nonlinear Optics and Short-pulse Spectroscopy*; Paul Drude Institute of Solid Particle Physics; Research Center Rossendorf*; Institute of Regional Development and Structural Planning; Potsdam: Astrophysics Institute; German Institute of Nutrition Research*; Potsdam Institute of Climate Changes and Its Consequences; Potsdam-Bornim: Institute of Agricultural Engineering*; Frankfurt/Oder: Institute of Semicontact Physics*; Magdeburg: Institute of Neurobiology; Halle: Institute of Economic Research; Institute of Plant Biochemistry; Institute of Agricultural Development in East and Central Europe; Gatersleben: Institute of Plant Genetics*; Leipzig: Institute of Regional Geography; Institute of Surface Modification; Institute of Tropospheric Research; Kühnhausen and Großbeeren: Institute of Vegetable and Ornamental Crops Production*; Dresden: Institute of Material Research*; Institute of Ecological and Regional Development; Institute of Polymer Research*; Jena: Institute of Molecular Biotechnology.* **Max-Planck-institutes:** Berlin: Institute of Colloid and Surface Science*; Halle: Institute for Microstructure Physics.* **Large-scale research institutions:** Berlin-Buch: Max Delbrück Center for Molecular Medicine*; Potsdam: Geo Research Center *; Halle-Leipzig: Environmental Research Center*; near Dresden: Nuclear Physics Research Center in Rossendorf.* **Fraunhofer institutes:** Berlin: Institute of Software, Engineering, and Systems Engineering; Teltow: Institute of Applied Polymer Research; Magdeburg: Institute of Factory Operations and Automation; Dresden: Institute of Ceramic Technologies and Sinters; Institute of Material Research and Service Engineering; Institute of Electron Beam and Plasma Technology; Institute of Microelectronics Systems*; Jena: Institute of Applied Optics and Precision Mechanics; Chemnitz: Institute of Forming Technology and Machine Tools.* [Illustration by Doug Stevens]

The Science Council: Architect of Change

Historically, the Science Council's role was to represent the interests of the universities to the West German government. Its duties at the time included making recommendations for new building programs and commenting on science and education policy. With reunification, the Science Council not only commented on science and education but became a major driving force of change in the East. Some consider it to be one of the "winners" of unification (9). The Science Council consists of 54 members: 24 eminent scientists, 8 persons of high public standing, and 16 state and 6 federal government officials (4). To get the task of science reunification done, the Science Council appointed nine groups with a total of 500 scientists and administrators from Germany and other countries (Switzerland, Finland, France, and the United States) to participate in the evaluation process, as required by law. The enormous task, the evaluation of 130 institutions with more than 75,000 employees, culminated in 1,720 pages of recommendations (10).

The Science Council was asked by both German governments to play a key role in the establishment of new structures in the East (8). In addition to evaluating which institutions should be maintained in the united Germany, it also made landmark decisions on which scientific and technological subjects should be newly established. To accomplish this, it first evaluated the research institutions and the overall structure of the universities.

Originally, the Science Council did not want to simply transfer the Western system to the East. It saw the opportunity to introduce new principles into German science management and university education, principles it had attempted to introduce for many years without success (2). Among its 12 recommendations, the Science Council stated (6): "Everything considered, it cannot be our goal to transfer the West German system to the East. The process of unification also offers a rare opportunity for West Germany to evaluate, in a self-critical manner, the extent to which parts of its educational and research system require a new structure."

Practically speaking, the Science Council had several goals: to bring research back into the universities, to found and restructure new universities and technical schools, to restructure existing universities, and to provide a fresh new start in certain disciplines that had been dominated by communist ideology, including law, social science, philosophy, and psychology, as well as political science and economics. It was an expressed goal that universities should again become the most important research institutions. The biggest task of the Science Council, however, was to completely restructure the independent research institutions outside the universities, the institutes of the three former academies (11).

Renewal of Science in the East

The unification of science was accomplished through numerous activities initiated over the last 3 years, including the integration of professional societies and new curricula, the new research orientation of universities, and the renewal of the academy institutes. The process was accompanied by a significant decrease in the size of the science work force, and many scientists and medical personnel moved into business or private practice. Many others had no choice but unemployment or early retirement. Unfortunately, the ones that left science were often flexible and talented individuals, leading to a further impoverishment of an already disadvantaged science system.

Restructuring of the academies. The renewal of the former academies was fast, and the "changing of the guards" has already been accomplished. The intention of the government was to create independent research institutes that do not compete with basic science at the universities but supplement it with interdisciplinary (for example, environmental science) or applied research.

Initially, all institutes had to be evaluated by the Science Council. In total, 130 institutions of all scientific disciplines (the former academy institutes), among them 72 independent, nonuniversity research institutes, were visited. In contrast with the general expectations in the West, individual areas of research excellence were identified. In the "hard" science disciplines, such as mathematics, physics, chemistry, geocosmos and environmental science, and biology, up to 60% of the institutes had a high standard and were positively evaluated. In contrast, from ideologically tainted disciplines, such as the social sciences, philosophy, and psychology, as few as 11% were judged favorably. Depending on their evaluation, the institutes were continued under new leadership and new jurisdiction (formally speaking, they were refounded), scaled down, fused with universities or technology parks, or closed altogether.

Because of the relatively high overall scientific standard, the Science Council recommended that about 100 institutions remain in existence to reopen under new jurisdiction, using the previous, although significantly smaller, infrastructure and implementing the Western system. This resulted in the creation of two new Max Planck Institutes, nine new Fraunhofer Institutes, 34 new blue-list institutes, and three new large-scale research institutions (Fig. 1). New resources, accordingly, were mostly allocated to Fraunhofer and blue-list institutes, which experienced a funding increase of around 100% from 1991 to 1992, a major change in German state resource allocation.

Because applied research was a focus in the former GDR, there was a relatively large growth of Fraunhofer Institutes dedicated to technical, applied subjects: software technology and engineering, polymer science, electron beam and plasma technology, material and process technics, applied optics, and precision mechanics. The newly established blue-list institutes revolve around environmental, agricultural, biomedical, and basic physics research. The Max Planck Society now has definite plans for new institutes (biology of infection, molecular plant physiology, economic systems, and physics of complex systems) and is currently conceiving additional ones (neuropsychology, theoretical biology, and enzymology of peptides). Overall, however, the renewal process resulted in a notable decrease in the number of workers at the nonuniversity research institutes: In 1989, the three academies employed about 36,000 persons (24,500 in the Academy of Sciences alone); by the end of 1991, there were 15,500; and as of January 1993, all research institutions and associated satellite research groups combined accounted for a total of only 12,500 jobs, one-third of the original work force. In all institutes, the leadership was replaced, but the research personnel slots were filled up to 90% with scientists who had been working there before, with the rest allocated to scientists educated in the West. Most of these institutes are under pressure to perform because they will be reevaluated in 5 to 7 years.

To obtain a measure of quality control of the Science Council's evaluation activities, the government distributed a questionnaire to those individuals and institutions that were evaluated. The analysis (2) reveals a remarkably positive response: 90% of those who responded thought that the atmosphere of the evaluation was good, 10% found it "satisfying," and none found it negative. Only 4% thought that the evaluations themselves were "on the whole wrong," and 5% felt they were unfairly evaluated; in contrast, 91% thought that the evaluation result was "correct" or "overall correct." Considering how many scientists were affected by the council's work, the reaction was remarkably positive.

University renewal. The Science Council also evaluated the overall structure of the universities, making use of citation analyses to assess productivity (6). Even though no formal evaluation of the universities took

place, committees were formed to visit all universities. These committees recommended a future structure for each university, including suggestions on the focus of research activity. The goal was to create the critical mass required to compete effectively in the international science arena.

Because the Science Council evaluated only the infrastructure of the universities and not the personnel (by law, this is the responsibility of the state governments), the evaluation of professors had to be organized by the respective ministries and universities themselves. This evaluation occurred in two stages: In the first round of evaluation, all professors were evaluated for their "political and moral" standards, and in the second round, scientific merit was assessed.

Political screening was needed to decide which scientists had such close ties to the former communist government that tenured employment by the new democratic state would be unjustified. During this process, which occurred in early 1992, individuals with a questionable political past lost their jobs, sometimes overnight. As this process of political screening was conducted under the auspices of the individual states, the methods and criteria with which they determined exactly what constituted misconduct varied considerably. As an example, in the state of Mecklenburg, 1509 persons were evaluated for their personal integrity. Of these, 1214 were determined not to have displayed misconduct. The 173 guilty of slight misconduct received a warning. Another 72 scientists kept their jobs but were either temporarily or permanently prohibited from participating in university administration. The remaining 50 had their salary reduced (19 cases) or their employment contract canceled (31 cases). Thus, in this state, only about 2% actually lost their jobs.

The evaluation of merit was conducted by a second committee, composed mostly of Western professors. Its task was to identify scientists suitable for reappointment and, on a practical level, those to be reappointed as "professors of new law," with full faculty rights. In some states, the number of reappointments was limited to an arbitrary percentage (on the order of 25%). During this process of evaluation, many professors left, seeking more secure and better paid positions in private business or medical practice, particularly in the West. The remaining 75% of the professors, those not reappointed, are still working at the universities as "professors of old law," their future still undecided. They do not know who their new boss will be (most search committees are still filling chairs), whether or not they can remain at the university, and, if they can, in what capacity.

In the former GDR, all science posts were guaranteed by the socialist state. Western rules now apply, with tenure being the exception rather than the rule. Used to the Eastern system, where employment and salary had little relation to performance, many Eastern scientists found that the sudden transformation led to a feeling of helplessness and a loss of self-esteem. In addition, the old system did not want outspokenness, innovation, and open competition for resources but rather noncritical assimilation and adaptation to values imposed from the top. The system now works under different rules, many of which have not yet been assimilated by those being most affected. The fall of the Wall was an event that took place in just a few days; in contrast, the differences in personal and cultural values is a "wall in the mind" that will take many years to overcome.

Industrial Research

Some small research companies were evaluated by the *Treuhandanstalt*, a national privitization institution. Other than that, R&D in the private sector was not evaluated by anyone. The concern of East German companies was less one of development for the future than simply one of survival. Large companies, those with a noticeable R&D division, were mostly state-operated. After the *Wende*, these companies were privatized by the *Treuhandanstalt* and in the process lost a lot of their work force in order to remain competitive. At a time when mere survival mattered most, R&D was not a great concern. Consequently, R&D suffered the heaviest loss of all employment sectors. Before the *Wende*, about 65,000 persons were employed in R&D; by the end of 1991, there were only about 35,000; and as of 1993, only about 15,000 were left, a net loss of almost 80%. This is certainly the most painful setback for German research during the reunification process. The Western market system hit R&D in the private sector heavily. No one was willing to buffer the change and allow industrial research to become a mature competitor. West German industry showed an embarrassing shortsightedness. Given that each of the three companies—Hoechst, BASF, and Bayer—has a larger R&D budget than the entire BMFT, this is perhaps the biggest tragedy, which went by unnoticed. Even though politicians and science organizations repeatedly pointed out the danger, no one in industry felt responsible, not even the Federation of German Industry (*Bundesverband der Deutschen Industrie*).

The federal government, seeing the problem early on, initiated programs to enhance the industry-oriented research infrastructure as well as innovation and technology transfer. Numerous technology-transfer centers were established throughout East Germany, and the government invested heavily in the creation and expansion of technology and business incubators. A program, "Contract Scheme East," was designed to improve the transfer of external know-how into eastern industry and, as recently as 1992, the program "Contract Research West-East" was introduced to encourage West German and foreign firms to give contracts to eastern companies (*12*).

Lessons for Other Countries

It is always difficult to make generalizations by applying one country's experience to another given personal and cultural differences. Nevertheless, a few points learned from the German science reunification experiment may apply to other nations that have a need for scientific reform (Eastern European countries, for example) or that anticipate reunification (like Korea).

1) The first step should be to eliminate the conflict of interest between politics and science. Scientific careers and funding should not depend on political inclinations of the individual scientist.

2) To learn to compete internationally, scientists and students should participate freely in international exchange; free expression of thoughts and ideas should be encouraged. The reason why scientists are not internationally competitive is not their inability to conceive ideas, but their inability to plan experiments and publish results in international journals (most of which are written in English). Scientists should seek contacts internationally and request help from scientists in countries that compete effectively to support them in that effort.

3) Large-scale research institutions with thousands of employees and an autocratic structure have not proven beneficial to the system. Autocratic structures, detrimental to creative thought and individual initiative, need to be disassembled. A transformation to a more pluralistic system, with independent research groups, should be initiated. To accomplish this, input from the international scientific community is required.

4) The reintegration of science back into the universities was one of the most important aspects of the East German reform. This strengthens the teaching and research at the universities, providing the basis for future innovation and discovery.

5) In the German experiment, the national and international scientific community showed a great deal of solidarity. West German and foreign scientists helped restructure East Germany without hesitation. This human good will can be a valuable resource in the restructuring of science

management in other countries. In addition, East European countries should try to involve those scientists that left their countries many years ago and gained international experience.

A Perspective for Germany

The task of science reunification has been an enormous one that was accomplished, on the whole, successfully. But several issues remain open and deserve the attention of policy-makers.

First, the new German states have not profited equally from the restructuring process. An analysis of the distribution of the research capacity of the newly established institutes shows that while Berlin, in particular, and Brandenburg and Saxony were on the winning side, receiving a favorable number of such institutions per capita, Mecklenburg, Saxony-Anhalt, and Thuringia have been the losers of the restructuring process (4). Clearly, if new research institutes are to be established in the future, Mecklenburg, Saxony-Anhalt, and Thuringia should be granted additional capacity.

Second, Germany did not follow the request by the Science Council to use the "rare opportunity also for West Germany to evaluate, in a self-critical manner, to what extent parts of its educational and research system require a new structure" (9). German national research policy needs new ideas and structures that transcend preunification Germany. The structure that helped build German science after the war should not stand in the way of more effective participation in science and technology. No more lip service and good intentions are required, but the missing blueprint for national science and technology policy needs to be presented and legislative changes enacted to put new principles into action.

Several issues now need attention: (i) There is clearly a need for a reduced number of students in the universities, a reorientation of certain scientific disciplines, and the establishment and nurturing of an elite system to drive science and technology. (ii) Mid-level scientists need more independence and autonomy. On a personal level, more incentives for outstanding achievements should be offered, and old-fashioned autocratic structures at universities should be abandoned. This could be accomplished, for example, by asking mid-level scientists to participate more actively in study sections that award grants for research and to have more say in university administration committees. (iii) University-industry cooperation badly needs to be improved with more incentives for innovation and technology transfer at the universities. There is currently a grave lack of such cooperation, a reflection of the missing blueprint. (iv) Now that rejuvenation of the research infrastructure in East Germany has taken place, Germany needs to reflect on new funding strategies and a new structure and distribution of research sites, particularly in view of the upcoming retirement wave at the universities in the mid-'90s. (v) Because the German states have sovereignty over science and education, Germany as a country has no legislation for, nor an institution that would conceive and execute, a national science and technology concept.

As it stands now, an overhaul of German science and technology management will only take place when restricted funding or international competitive pressure in the marketplace makes it clear to the parliament that a second experiment will have to follow the first. Germany needs to act now rather than react later.

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