Agency for Technological Development for Domestic Programs

Such an agency is a prerequisite for effective social "engineering."

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The period of change of administrations in Washington is a time when federal reorganization is given special attention. Furthermore, as expenditures for R & D, especially for nonmilitary purposes, are expected to increase much more slowly in the immediate future than they have over the past 10 years, questions of the effective use of existing research facilities and manpower will gain increasing attention. In this context, reorganization is considered here as a method by which greater organizational effectiveness can be achieved, through an increase in economy and coordination. To highlight some of the issues involved in such reorganization in the "short" run (4 to 8 years), I focus on the merits and difficulties of one particular proposal.

This proposal is a variant of the often discussed idea of establishing a federal department of science, or science and education, or science and technology (*1*). Suggestions for such a department find little support among large segments of the academic community, mainly because these scientists fear monopolization of sources of support for research, a situation which could allow the advocates of one school of thought to deny funds to other promising lines of investigation (*2*). I deal here with a much more limited proposal: the creation of an agency devoted primarily to technological work and specializing in domestic—mainly urban—problems: a kind of earth-oriented NASA.

However, unlike the case for NASA, the establishment of an Agency for Technological Development (ATD) need not involve the creation of new, large-scale, bureaucratic machinery or a significant increase in total federal expenditures. A conversion of Housing and Urban Development (or of parts of it, especially the Model-Cities Administration) into a kind of R & D Department for the cities, augmented by the transfer of several "technological" units from other agencies and collaboration with still others, could provide most of the manpower, budget, and facilities that would be required. Since I favor this particular approach, I cannot completely avoid all hints of advocacy as I proceed to review first the merits and then the difficulties of this mode of reorganization of the federal R & D effort. The basic conditions I describe would, however, apply to most other attempts at reorganization and, hence, may be of interest even if an "earth-NASA" is not.

Importance of Technological Shortcuts

New applications of research and development of technologies seem essential if we are to be able to handle several of our key domestic problems within a reasonable length of time—let us say, in 4 to 8 years. The nation needs to face two facts: the funds required for the treatment of our most urgent problems with the means we now possess are not likely to be soon available, and, even if they were, the problems have elements whose resolution seems to be more than a matter of substantially increasing the investment in their treatment. The development of new means seems to be required.

As regards the first statement, the order of magnitude of the "missing" funds is great indeed. Mayor John V. Lindsay recently testifiied before Congress that he needed $100 billion to rebuild New York's slums; at the present rate, it will be 40 years before such an amount becomes available for the elimination of *all* the slums in the United States. And here I refer only to the construction or reconstruction of the physical plant. A United States senator estimated that the implementation of the key recommendations of the Kerner Commission would require *at least* $100 billion a year. With regard to all national needs, the National Planning Association calculated, in a study, that, if the United States sought to realize by 1985 the modest goals specified by the Eisenhower Commission on National Goals, even if the total gross national product were devoted only to those goals and the growth rate were as high as 4 percent per year, the country in 1985 would still be at least $150 billion a year behind.

The funds which will actually be available are of a much smaller order. A year or so ago it was argued by some that, once the war in Vietnam was ended, the nation could transfer the $24.5 to $32.5 billion now spent each year on the war (estimates of the costs vary) to the treatment of its domestic problems. Pessimists pointed out at that time that Congress could not be expected to transfer all of these funds to the domestic front and suggested a deal: part of the funds would be absorbed by reduced taxes (to satisfy the conservatives) in exchange for allocation to the domestic front of $15 billion, of which $10 billion at the least would be devoted to new domestic efforts.

As the 1968 elections drew nearer, however, the press reported that task forces working for the two major presidential candidates were estimating that, for the present, the defense budget would have to remain more or less at its present level even if the war were deescalated considerably. First, the Pentagon has convinced many people that stocks of war materiel depleted during the Vietnamese war would have to be replenished. Second, the Department of Defense maintains that several urgent military needs, especially in the area of technological development, which had not received attention during the war will require investment in the post-Vietnam period. A White House aide has indicated that he expects defense spending over the next 4 years to be between $72 billion and $77 billion a year. The defense budget

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for fiscal year 1969 is estimated as $79 billion (*3*). In short, we could expect only a few billions of dollars to be diverted from military to domestic programs in the near future even if the war were ended immediately. An additional tax increase is unlikely. Some increase in federal revenues due to an increased gross national product is expected, but much of this is already committed in the short run for items such as increased salary of government employees, veterans' benefits, and costs due to inflation and other factors.

But even if the economic resources for domestic programs were somehow miraculously to become available and the political will to use them for social improvement were present, we would still face other severe shortages, principally shortages of professional manpower. In the United States in 1966, for example, there were an estimated 556,000 patients in mental hospitals and 501,000 outpatients in mental health clinics. At the same time, there were about 1100 psychoanalysts, roughly 7000 board-certified psychiatrists, and few more than 17,000 physicians designated as psychiatrists (*4*). Most of the patients in mental hospitals are not treated at all: in 1964, only 2 percent of the staffs of mental hospitals were psychiatrists and only 10 percent were professionals of *any* sort; most of the staff members were "attendants," of whom more than half had not completed high school and only 8 percent had had any relevant training. Similar shortages are reported in almost all the domestic sectors where problems are evident. The Department of Housing and Urban Development (HUD) is encouraging city planning, but there are few city planners; many university chairs in the natural and social sciences remain unoccupied for years or are filled by persons who have not completed their training; and so on. Thus, it seems evident that, unless some shortcuts to the treatment of the nation's social problems are found, these problems are not likely to be effectively treated in the foreseeable future.

I do not wish to imply that all or even most of our domestic problems could be solved within 4 to 8 years. But it is quite likely that in this length of time several key problems might be reduced to a level where they would again seem "manageable." When this is achieved in several key areas, and as further reductions are worked out, our domestic problems will no longer threaten us, as they do now, by their appearance of unmanageability; this appearance elicits hysterical reactions, which both add to our problems and make the treatment of existing ones more difficult.

Technology as a Source of Shortcuts

The development of new technology is relevant here because it has been found that the evolution of a new technology frequently makes possible the accomplishment of a task that formerly was prohibitively expensive (if it could be carried out at all) at a small fraction of its previous cost. As Alvin M. Weinberg put it (*5*): "There is a possibility that the technologically oriented research institutions may contribute to an unexpected degree to the resolution of problems that now seem to be primarily social. I refer to the possibility of devising 'cheap technological fixes.' "

It is sometimes argued, in opposition to this position, that the cost of using a new technology, even though it may make possible the previously impossible, is greater than the cost of using its pretechnological counterpart; a jet costs more than a mule. But it seems to me that a computation of the costs *per unit of results* (or effects) would show that, once the technological items are in routine use, they tend to be much less expensive. Thus, the cost of crossing the country by jet is not to be compared with the cost of using a mule in the old days; rather, one should compare the cost of transporting one person a given distance by mule to that of transporting him by jet in the same cost environment (for example, at 1969 prices). An extremely simple example of the economies gained by the application of a technology is to be found in the reduction of the turnabout time of ships in harbors from days to hours following the development of "containerization."

An interesting illustration of this point is provided by a cost-benefit analysis conducted by the Department of Health, Education, and Welfare to assess the relative effectiveness and expenditures of several programs intended to reduce the number of injuries suffered in automobile accidents, from which 53,100 people died during 1967, the last year for which figures are available (*6*). The mechanical devices, products of technological development, were found to be much more economical, relative to their effectiveness, than the nonmechanical ones. Here are figures on the cost per death averted: use of seat belts, $87; use of restraining devices, $100; use of motorcyclists' helmets, $3000; driver education, $88,000. Even when the fact that these figures are subject to considerable error is taken into account, the difference between the costs of technological approaches (the first three items) and an educational approach (the last) is so great that it seems to indicate a clear ranking of procedures, at least for this problem area.

The prospective roles of new technologies in other problem areas may be briefly indicated. It was once said that, were we to rely on manual switchboards, all of the housewives in the United States would have to work for A.T. & T., to handle the present volume of telephone calls (I am not aware that an actual computation has been made). This point seems now to apply to teaching. The education gap now facing this country ranges all the way from the toddlers' age group (1- to 3-year-olds), in which, it is argued, poor and black children begin to be disadvantaged, to "continuing education" (a new euphemism for the education of adults), and a shortage of teachers is felt not only in the training of the handicapped and chronically unemployed but in that of all other groups up to and including M.D.'s. To state that, if this gap is to be eliminated, half of the country may soon have to be teaching the other half may well be only a minor exaggeration.

As this is highly unlikely to occur, the extent of the educational gap will be significantly affected by the development and mass use of *mechanical* instruction such as television teaching and the use of teaching machines (*7*). These approaches will not "replace" the teacher but will, rather, take over some parts of his work (quite typically, the more routine parts), as well as increase his "reach" and effectiveness.

Before the benefits of these new aids can be fully realized, however, some additional technological development is necessary. The cost of computer-assisted instruction, for instance, has to be reduced through the development of much less expensive devices. Furthermore, evaluation studies show beyond reasonable doubt that, in many areas, TV instruction is not inferior to personal teaching. What is still lacking is a combination of TV instruction with an effective mechanism to allow students to respond to the material they learn, be tested, and gain a response in return. This could perhaps be accomplished electronically through a further refinement of the systems now used in mechanical voting and in the computerized analysis of correspondence courses. The evolution of devices which can be mounted on personally owned sets, allowing the student to record a lesson and to play it back at his own pace, is essential for the increased effectiveness of this technology (*8*).

In the area of crime, approaches based on new applications of computers, laboratories, and communication systems are already serving the country, but—as the report of the Crime Commission clearly shows—we have only begun to make progress in this regard. The Crime Commission stated (*9*): "More than 200,000 scientists and engineers have applied themselves to solving military problems and hundreds of thousands more to innovation in other areas of modern life, but only a handful are working to control the crimes that injure or frighten millions of Americans each year." Particularly, it has been suggested, much benefit could be derived from better nationwide communication systems to provide data about criminals, from better local communication among police units as well as between units and headquarters, and from the reduction, by technological means, of the paper work which slows down the courts (*9*).

Developments in medicine often provide examples of the very considerable savings new technologies may provide (*10*). For instance, methadone seems to have proved four to five times as effective as psychotherapy in treating heroin addicts. The "success" rate for the rehabilitation of drug addicts through psychotherapy, a long and costly process, is below 22 percent. Methadone, which so far has been used only experimentally, is reported effective in 82 percent of the cases; it is inexpensive and easily administered. While widespread tests of this technique are still needed, so that the controversy surrounding it can be resolved, it seems much more promising than psychotherapeutic approaches.

In the areas of low-cost public housing, rapid public transportation, information systems to bring workers and jobs together, waste disposal, highway safety, reduction of pollution, and so on, the need for technological development has been frequently pointed out (*11*).

One reason why technological development may be expected to have high payoffs in these areas is that many elements of our domestic programs are still in the pretechnical stage, with most of the work performed, in effect, by the human brain. It may be argued that this is inevitable, that here men cannot be replaced or their output multiplied by the use of technologies. In some areas, this is undoubtedly true; in most, however, there are some key elements of the problems which could be helped considerably by new technologies. Thus, not all or even most teaching may become mechanized; but certain routine aspects—for example, repetition in language lessons—may be.

In other areas, services for a large number of persons cannot be provided without technological advances. Many of our social problems arise from the fact that services previously sought by relatively small groups—such as high-quality education, good medical care, and clean air—are now actively demanded by most citizens. The significant role of new technologies in bringing high-quality services to the "masses" is illustrated by the beaming of a Nobel Prize lecture into scores of classrooms equipped with television, the evolution of mechanical heart pumps (many believe these to be more practical for mass use than transplants), and the development of new devices for depolluting the air (making it possible to clean the air of central cities whose populations cannot escape to the suburbs and resort areas).

The need for, and promise of, technological development for the treatment of domestic problems seem fairly well established. How may this need be served?

Existing Organization of Domestic R & D

The technological needs of our domestic programs are now being served by R & D efforts dispersed widely among federal agencies as well as outside the government in universities, research corporations, and private industry. To some extent this arrangement is both inevitable and desirable. Most agencies have some specific research needs of their own that they themselves can probably best serve. The existence of a multiplicity of R & D centers in the private sector helps to insure that a given approach will not monopolize the funds and prematurely drive out others which may prove to be more productive in the long run. However, the existing system of R & D centers serving the government does suffer from several deficiencies that may be corrected by the proposed agency that is to specialize in domestic technological development.

1) In many federal agencies, unlike the situation in NASA, the technological division is an administrative stepchild. Only rarely are its special needs adequately understood either by the agency heads, whose backgrounds and training tend to be neither in research nor in technical development, or by the civil servants who stand between the technological division and the agency heads. It is important to note that these technological environments are not accidental; they are a result of the fact that the development of new technologies is neither the primary mission of these agencies nor the primary means of fulfilling their major missions. Thus, it is not surprising, nor is it a phenomenon limited to this country, that government agencies, staffed by civil servants, lawyers, and economists, find it difficult to provide an environment hospitable to laboratories and testing grounds, to engineers and applied psychologists. It is unreasonable to expect that a directive by a Secretary or the enunciation of a new policy will change such "structural" features. Institutionalization of a protechnological environment seems necessary if effective service of technological missions is to be possible—that is, establishment of an agency which will have technological dvelopment as its prime mission and which will be organized and staffed accordingly.

2) The budgets of most of the existing governmental domestic R & D units constitute small fractions of the total budgets of the agencies to which these units are attached (see Table 1), and only part of this budget is used for technological development.

Of the total R & D obligations, most of the funds are used for nondomestic missions; it is estimated that $13.8 billion have been obligated to the Department of Defense, NASA, and the Atomic Energy Commission and $2.1 billions to the other 27 agencies. The situation in some of the key domestic agencies is shown in Table 1.

Obviously these obligations for R & D reflect neither a high national priority nor, it seems, the potential value of the work involved. For Interior and HEW, the percentages of the budgets allocated to R & D were higher, although not high—10 and 12 percent, respectively. In Interior, R & D expenditures are concentrated largely in a few highly technological subagencies, such as the Bureau of Mines; whether or not other bureaus could benefit from larger R & D expenditures remains in doubt. The 12 percent of the budget spent on R & D by HEW is spent largely for the research R and not for technological D. Actually, out of every $4 obligated, only $1 is obligated for development (*12*, p. 31), which is, of course, the more expensive part of the R & D process.

The small and politically weak Office of Science and Technology in the White House seems unable to campaign effectively for these various R & D units, and the National Science Foundation's mission, is, by and large, limited to research, primarily of a basic nature, although NSF has been paying some attention recently to matters involving transfer of technology, engineering, and so on. It is likely that only the combination of all, or at least some, of these units and their elevation to the level of an agency will bring new technologies for domestic missions the needed support, as only then will domestic R & D be able to compete effectively in the federal give-and-take for funds.

3) The fact that many of the numerous agencies active in the domestic areas now develop their own technological facilities seems to lead to some waste and to a measure of duplication. While some of these facilities are area-specific, others—such as computer centers and testing grounds—could be combined. Establishment of a federal R & D agency specializing in domestic missions would seem more economical than support of R & D in each of the numerous agencies and subagencies with a domestic mission.

4) A significant proportion of the national R & D is, and surely will continue to be, carried on "out-of-house," in the private sector—in universities, research corporations, and private industry. However, the universities tend—quite properly—to focus on research at the expense of development, and on basic research at the expense of applied research. The forces which underlie this tendency of university research to be remote from practical needs are many and powerful. They include the prestige attached to research as compared to technological development, and to basic research as compared to applied research. Career advancement is often tied to achievement in basic

Table 1. Estimated obligations for fiscal year 1966 (*12*, p. 30 ff.).

Agency	Total R & D obligations (in millions of dollars)	Percentage of total agency budget
Department of Agriculture	243.7	3
Department of Commerce	88.9	8
Department of Labor	11.8	2
Department of State	14.6	4
Office of Economic Opportunity	60.0	4

research and, furthermore, scientists are often reluctant to accept the outside guidance that is found more frequently, and in greater detail, in applied and developmental work than in basic research (*13*).

Also, many members of academia firmly believe that the best way to solve a practical problem is to invest in basic research; research funds are to be cast upon the oceans of science in the hope that the "answers" to specific problems will someday be washed ashore. Experience, as well as the empirical testing of this belief, seems to suggest otherwise.

The first atom bombs were produced in a concentrated effort specifically designed to result in such a product (Project Manhattan). Polio vaccine was developed by Salk and Sabin task forces. A manual lunar landing is expected as a result of the deliberate efforts of Project Apollo. A study by J. Schmookler (*14*) shows that significantly more results are produced in those areas in which there are significantly greater R & D efforts (as measured by investments). A study by the Department of Defense (Project Hindsight), which sought to establish the ways in which the systems most useful to defense were evolved, lends further support to this conclusion: of the 556 "events" which led to the evolution of the desired system, 92 percent were technological (*15*). The study has been criticized (*16, 17*) for focusing on technological payoffs (only weapons were studied as payoffs) and neglecting scientific inputs (by not tracing the "events" farther back). In addition, a study of the sources of new findings in chemistry has been used to counter Hindsight's insights (*16, 18*).

The questions about the relative importance and independence of scientific and technological inputs need not be resolved before the arguments in favor of a new technological agency can be examined. The following statements seem to summarize a kind of consensus of experts which is evolving.

1) Investment in basic research must be continued because ultimately it is the foundation on which much of the later, more "applied" work builds; Hindsight findings exaggerate the importance of technological development.

2) Investment in technological development is needed because (i) there is no "automatic" route from scientific findings to useful technologies (and the costs of technological developments are 15 to 60 times those of the initial research), and (ii) some developments are intrinsically technological and cannot be traced back to scientific findings—that is, the scientists' belief in the dependence of technological development on scientific research underestimates the need for investment in technologies per se.

3) Technological developments are more "guidable" than research, especially basic research. Hence, if the goal is to increase the capacity to treat domestic problems, the payoffs from direct investment in technological development will be greater than those from research, as the former will be more "on target."

4) While universities—with the significant exceptions of some engineering schools, university-affiliated laboratories, and a few other units—are oriented toward basic research, private industry and some research corporations are quite willing and able to work on specific technologies under the guidance of the government.

An agency specializing in technological development for domestic missions would, thus, increase the "weight" of these missions both in the federal give-and-take and in the private sector.

System Effects

Another reason why an Agency for Technological Development might be more effective than the existing multiple technological units within the scores of federal agencies and bureaus entrusted with domestic missions is that such an agency would be concerned with relations among technologies, a matter to which the present dispersed system cannot give much attention. New transportation systems, for example, are often designed without sufficient regard for housing problems, housing projects are designed without recognition of the problems of crime control, and so on (*19*). To the extent that various specialized efforts are placed under one administrative roof, the likelihood will be increased that both the negative and the positive "side effects" of new technologies and their place in domestic programs will be more fully taken into account. Even within one agency there are barriers to such coordination, and these barriers are almost insurmountable between agencies.

There are exceptions: interagency cooperation between AEC and the Department of Interior on desalination and reduction of pollution is a case in point. But such collaboration is not common, and it is difficult to conceive, in view of the fragmenting forces at work, how it could become the norm. Dael Wolfle, addressing himself to this point wrote (*20*):

> Many of the large problems that confront us . . . differ from those of the space program in focusing on people rather than on rockets and space vehicles. . . . But the social programs, like the space program, call for management structures linking government, industry, and universities. The new program will involve research, planning, coordination, and testing. And they will be bothered by multiple divisions of responsibility, conflicting ambitions and interests, decisions to use existing facilities or to assemble new ones, multiple channels of communication and authority, and the problems of building up and of phasing down as priorities shift to new targets or as new opportunities open up.

Hence, I agree here with Wolfle that NASA provides a more effective administrative model.

In short, there seem to be several significant reasons for favoring an agency for domestic technological development. Many of the objections to such an agency seem to resolve around the issue of political feasibility.

Political Feasibility

When I had prepared a previous version of this article I sent it "for comments" to a number of acquaintances in government agencies, on congressional committees, and in research corporations. Of the 18 who responded, all but one live in the Washington area. Such "feedback" is quite useful even in working on a regular academic paper, as it is very difficult for most writers to anticipate all the questions that the exposition of a concept or a finding may raise. Seeking such response becomes almost inescapable when one is dealing with policy proposals. Here, it is most useful to take into account the viewpoints of those who would be affected if the proposal were to be implemented, and of those highly familiar with the political constraints which the proposal will confront.

It was the consensus of the respondents that greater technological development would indeed be helpful in handling many of our domestic problems. And almost all of them agreed that such development would entail heavy investment in the technologies themselves and not just in basic or applied research. However, practically all of the respondents questioned the political feasibility of creating an agency devoted to the advancement of technology. It was repeatedly stated, with considerable force and conviction, that the existing agencies, Congress and its committees, and industry would oppose such a plan.

Speed of Payoffs and Congress

Among those whose profession is turning blueprints into social instruments or programs, and among those who work on developing new technologies, it is commonplace to expect a period of significant modifications and "debugging." It seems impossible to anticipate, on the drawing boards or in tests with small-scale models, all, or even most, of the difficulties a functioning, full-scale model will encounter. (The same holds for the routine production of what was developed as a prototype.) Hence, considerable effort and investment are needed precisely in this phase —that is, in evolving the first "prototypes" and setting up routine "production." The more "de-bugged" these phases are, the less likely it is that revisions will be necessary once mass production is under way. An analogy is correcting a stencil before it is run off instead of editing all the finished copies.

Occasionally, the temptation to short-cut is not resisted. For instance, it was reported that construction of the landing gear for the lunar spacecraft was being advanced while close pictures of the surface of the moon were still being sought. While I cannot document the following impression, it seems to me that, by and large, the tendency to "jump" into the field, to skip preliminary testing and de-bugging, is much stronger in the domestic area than in the areas of defense and space, and that this situation is most likely to occur in regard to new social programs (for example, computer-assisted teaching). One of the surprising experiences in interviewing officials in federal agencies and members of Congress is to discover how often they are not fully aware of the effort, time, and costs involved in turning an idea, already fully "researched," into a smoothly functioning system.

The degree of "tolerance" for prolonged and repeated preliminary testing or the inclination to skip stages are not abstract character traits, some people being cautious types and others hotheads. The orientation toward preliminary testing is greatly affected by budgetary considerations (preliminary testing often costs more than the original research); by the fact that application in the field is often paid for by a body other than that which conducted the R & D effort; by political considerations (adequate preliminary testing may carry the payoff of a program launched by one administration into the lifetime of the next one); and even by international considerations (How are the Russians progressing?). Thus, it was only after we had spent an estimated $4.8 billion on programs in compensatory education that the first major relevant study was completed—a study which strongly indicated that we were going about the task in the wrong way (*21*). Many of the domestic programs launched between 1965 and 1968 had been insufficiently tested, while others, not tested at all, resulted in frequent costly reorganizations *after* the programs had been launched, or in programs that failed to "take off" (*22*).

In discussions of this approach, the argument that a program which does not promise quick results will not be tolerated by Congress is often raised. A new, more candid approach may have to be tried. Instead of overselling a program in terms of its yield and speed, perhaps it should be stated openly that the program will be innovative and experimental, and that, even if only one of every five projects were to yield a major new technology, the money would have been well spent. Also, by keeping testing "in-house," the reactions to initial inevitable failures may be more limited.

Resistance to Other Agencies

The concern of the respondents was with both the "producers" and the "consumers" of new technologies. On the producers' side, it was pointed out that many agencies already have R & D units which they would, for the most part, be quite reluctant to relinquish. These agencies can be expected to be supported by the congressional committees charged with overseeing their work—committees which would tend to oppose a reduction in the missions (and funds) they oversee. Finally, private industry, it was stated, is also working with agencies and subagencies, specific industries having built relations with those government agencies that deal with "their" technologies. Hence, industries would tend to object to a reorganization which would make "their" units disappear into a much larger technological agency, over which they would have less sway. Thus, for instance, the railroad industry would much prefer to deal with the Department of Transportation than with the envisioned Agency for Technological Development. The same holds for other groups, especially professional associations. For example, the American Medical Association would much rather be involved, it was stated, with the Dangerous Drug Division of the Department of Justice than with the new ATD.

It may be expected that the suggested ATD would encounter less resistance than earlier suggestions to concentrate science and technology in one department have met with, since neither science nor military and space technology (the nondomestic major "development" items) would be included. Some of the domestic agencies (for example, HUD) are at the very beginning of developing their R & D units and seem to be less committed to their own units than agencies in which the R & D units are well established. Still, there can be little doubt that the formation of an agency specializing in domestic, mainly urban, technological problems will encounter considerable opposition from existing domestic agencies (*23*).

Still, the proposal deserves some attention on the following grounds. First, like economists' models of free competition, it serves to point up the "diseconomies" generated by the existing system and their estimated size and location. Second, it points out that, even if only the R & D units of some of the numerous domestic agencies could be combined, part of the diseconomy would be reduced. (NASA never "internalized" all the space work; important segments were, and still are, effected by the Air Force, and through the combined efforts of NASA and the Air Force.)

Finally, such a reorganization may be introduced by a powerful President, one ready to withstand the counterpressures in order to gain what may be a significantly more effective arrangement. This is not completely without precedent; when NASA was first created, R & D units were transferred to it from the Armed Services. While this move was initially not well received by the Air Force, the Army, and some members of Congress, the reorganization was carried out nonetheless. Similarly, in recent years several reorganizations of HEW did make some parts of the Department somewhat more immune to external pressures and more responsive to the Secretary's direction. All this is to say that a measure of administrative reform is possible despite counterpressures.

One line of approach would be to concentrate first on the R & D work of the agencies in which these divisions are still relatively small or in which the division suffers more from being in an agency alien to technological missions. Among the agencies my respondents listed as qualifying on one or both of these counts were Justice, Interior, Commerce, and Labor, as well as some parts of HEW (especially the Office of Education).

On the other hand, where technological development and the major agency mission are as intimately linked as they are in the Department of Transportation and in some parts of HEW (especially the health services), attempts to separate the two and to transfer the technological component to a new agency were considered both politically impractical and of questionable value. Among the areas most often cited as areas in which full-fledged attention to technological development has not yet evolved were education (despite the recent rise of educational laboratories), job training, crime prevention, and housing. Reduction of pollution and weather control were listed by some as suitable candidates, while others held them to be more "advanced," in terms of R & D work by existing agencies, than the other four areas cited.

This list of units "more suitable" for transfer led to consideration of a second, closely related but still analytically autonomous, issue.

Relations with the Consumers of New Technologies

Two schemes for the relations between a new technological agency and the agencies which would abandon their own technological work can be envisioned. The first, which comes to mind most readily, seems to be the less practical. The second, under prevailing conditions, seems the more feasible.

A student of "pure" administration, undiluted with politics, may envision a technological agency that would serve the regular agencies, which would draw on it for their "hardware," somewhat as the three Armed Forces draw on the Joint Ordnance Service. In the language of organizational specialists, the ATD would be a "functional" service for the "line" operations carried out by implementing agencies. The latter would order the specific technologies they need, and perhaps even pay for them.

However, any scheme which assumes tight interagency cooperation seems, according to my respondents, to be about as realistic as ignoring gravity. Each federal agency is, to a considerable extent, an independent entity (often with quite autonomous subentities), and previous attempts to rely on close interagency cooperation such as the envisioned arrangement would require have been, as a rule, quite unsuccessful. Several respondents reported experiences as members of an interagency board or committee that did not "work," or told about a "system" that was developed by one agency and ignored by another because it was alien to the latter's conception, needs, interests, or ambitions. "The President can gain interagency cooperation but you cannot appeal to him too often, and even he cannot get such cooperation all the time," one veteran of the Washington scene observed. Two attempts to create "comprehensive" domestic agencies (the Office of Economic Opportunity and HUD), which were supposed to combine their efforts in specific sectors—poverty and urban problems, respectively—with the relevant work of other agencies, have not yielded much interagency coordination thus far. Above all, I was told, one cannot expect one agency to evolve a program and another to pay for it. "And who will pay for the new technologies if not the federal government?"

Consideration of this financial question points to a second view of the potential place of an ATD in the federal and general political-administrative mesh. Here, it is essential to take into account one feature of the domestic government. In the fields of space and defense the federal government is both the main source of funds for R & D and the customer for most of the products—whether it be a weapon or a spacecraft. In the domestic sphere, on the other hand, often the customer is not the funding agency or any other federal agency but, rather, the states, the cities, or various corporate bodies (for example, hospitals and universities). For reasons outlined below, these bodies are in a very different relationship to a potential "earth NASA" than the federal agencies are.

About 160 American cities have experienced one or more of the "standard" domestic crises. It is inconceivable that each city, or even each of the 50 states, will set up its own technological agency. Most of them do not have the necessary funds, and the skills needed are so rare that, even if all the specialists now living in America were recruited for these missions, they would not suffice to staff more than the technological divisions of a few cities or states.

Moreover, it must be noted that major technological breakthroughs have been made by a few talented men or by a concentration of high-quality manpower. Thus, even if each city could hire, let us say, two urban sociologists (the total number is more like several score than several hundred), only a few of these would have sufficient talent to actually benefit the cities.

Finally, if the solution to each problem—for example, the discovery of an inexpensive method of water depollution—had to be "reinvented" in 50 states or 160 cities, this would result in an extreme duplication of effort. And no one state or city can be expected to be the technological agency for the rest of the country. Hence, a national service for local authorities may be more politically feasible than one for other federal agencies.

At the same time, local autonomy will have to be preserved. The local governments could be best served, it seems, if the ATD were to institute a kind of "cafeteria"-style presentation of its new techniques, with states and cities able to choose whatever systems they wished to acquire and install. Thus, no strings would be attached to the program; a city or state seeking to build a new transportation, school, or housing system could acquire tested blueprints, specifications, and technical assistance (in the form of teams of engineers, city planners, and so on) from the federal agency and apply them where and when it wished.

So we return to the question of who will bear the costs of the implementation of the programs, once a prototype has been developed. It is very widely held in Washington that the agency promoting an innovation must pay for implementation: HUD for new housing, the Department of Transportation for new trains, the Office of Education for new teaching technologies, and so on. Most cities and states are impoverished. While it is difficult to raise federal taxes, especially to pay for the expansion of domestic programs, this is considered easier than to raise local taxes (*25*).

The implication for the issue at hand is that the agency which will pay for the implementation of a specific innovation—for example, a new type of housing—will also seek to be the one to evolve the relevant technology. Hence, it is argued, there is no place for an ATD.

This argument may well be somewhat extreme. If an agency were to develop a highly effective new technology—new computers, for instance—would not other agencies with similar requirements adopt it?

Second, the costs of the implementation of such technologies need not always be borne by the federal government. Recently, New York City *paid* the RAND Corporation to evolve new technological systems for its fire and police departments. The RAND men, it is reported, found that in responding to a fire alarm it is more efficient to send, first, a jeep with a few firemen, rather than the much more expensive fire trucks, and that, in a high percentage of cases, these jeeps sufficed; in the other instances, the large trucks could still be called. Now, if this finding is further verified and other cities learn of it, they can be expected to purchase some jeeps out of their own funds. The same would hold for other new technologies, *if* they prove to be significantly more effecive than existing ones (*25*).

Of course, many cities may not know about the RAND innovations for New York City. Here, possibly, the creation of an intercity (and interstate) technological dissemination system might be a necessary federal investment, the costs of such a system would not be too large for ATD to handle, nor would it require extensive collaboration with other agencies.

Finally, if the cities or states are unable or unwilling to pay for utilization of the new technologies, federal agencies in the near future are also unlikely to be able to finance mass programs, even if the new technologies are their own. (The reasons for this statement are discussed above.) In the longer run, all indications are that an increased amount of federal revenue will be channeled to states and cities; that is, the latter will have more "disposable" money to buy innovations and will not have to adopt the concepts of HUD or the Office of Economic Opportunity or the Office of Education but can absorb mainly those compatible with their own conceptions and needs (within some federal constraints, such as the requirement for desegregation). Hence, ultimately, the question of the value of the ATD is clearly linked to the nature and size of our future domestic drives. Whether these are going to be funded largely in the New Deal style, by way of federal agencies set up for specific problem areas, or whether funds are going to be spent increasingly by cities and states, with the federal agencies providing technical and other assistance, has yet to be decided. I expect that the tendency will be to turn over more funds to states and cities, and I see within this pattern a place for an Agency for Technological Development. It can assist local bodies in handling their problems, and the localities will pay for the technologies, even if it is the federal revenues that put the needed funds in their pockets.

References and Notes

1. The need to reexamine the arguments in favor of a department of science were stressed by Philip H. Abelson and Donald F. Hornig at the 1968 annual meeting of the AAAS in Dallas, Texas (New York *Times*, 28 December 1968). An adapted version of Hornig's address was published in *Science* [**163**, 523 (1969)]. The establishment of a National Institute of Technology has been suggested by Richard R. Nelson, Merton J. Peck, and Edward D. Kalocheck in their *Technology, Economic Growth and Public Policy* (Brookings Institution, Washington, D.C., 1967), p. 177. Another possibility (not explored here) is to make the ATD the R & D unit of HEW, if, indeed HEW comes to

encompass HUD, OEO, and ATD, in a kind of Department for Domestic Affairs or Human Resources Agency (Washington *Post*, 8 December 1968; *Time*, 13 December 1968, p. 17).
2. None of the proposals cited in (*1*) advocate the concentration of all scientific activities in one department. President Nixon, in a preelection statement, promised that there "would be no federal scientific czar," but this does not preclude the concentration of some scientific or technological efforts, especially new ones.
3. On the same point, see C. L. Schultze, "Budget alternatives after Vietnam," in *Agenda for the Nation*, K. Gordon, Ed. (Brookings Institution, Washington, D.C., 1968), pp. 48–63.
4. J. A. Clauson, *Contemporary Social Problems*, R. K. Merton and R. A. Nisbet, Eds. (Harcourt, Brace & World, New York, ed. 2, 1966), p. 47.
5. A. M. Weinberg, *Reflections on Big Science* (M.I.T. Press, Cambridge, Mass., 1967), p. 141.
6. *Accident Facts* (National Safety Council, Chicago, 1968), p. 40.
7. For two recent discussions of the promise in this area as well as references to other discussions, see H. J. Brudner, *Science* **162**, 970 (1968) and P. H. Abelson, *ibid.*, p. 855.
8. CBS is reportedly working on such a development; see New York *Times*, 11 December 1968.
9. *Task Force Report: Science and Technology* (Government Printing Office, Washington, D.C., 1967), p. 1.
10. In Britain, recently, a special nonprofit institute was set up to bring engineering closer to surgery. The organization is called the Bath Institute of Medical Engineering.
11. For a fine discussion of the technical, administrative, and political difficulties encountered in one area, see R. Starr and J. Carlson, "Pollution and poverty; the strategy of cross-commitment," *The Public Interest* **1968**, No. 10, 104 (1968).
12. *Federal Funds for Research, Development and Other Scientific Activities Fiscal Year 1965, 1966, 1967* (Government Printing Office, Washington, D.C.).
13. The relations between government and universities were examined recently from a large variety of relevant viewpoints in essays included in *Science, Policy and University*, H. Orlans, Ed. (Brookings Institution, Washington, D.C., 1968).
14. J. Schmookler, *Invention and Economic Growth* (Harvard Univ. Press, Cambridge, Mass., 1966). See also R. Nelson, *J. Business* **32**, 101 (1959).
15. "First Report on Project Hindsight" (Department of Defense publication) (Government Printing Office, Washington, D.C., 1966).
16. See D. S. Greenberg, *The Politics of Pure Science* (New American Library, New York, 1967), pp. 32–33.
17. The Illinois Institute of Technology is reported to be completing a study with more "depth" reporting and heavier emphasis on nontechnical elements (private communication).
18. *Chemistry: Opportunities and Needs* (National Academy of Sciences–National Research Council, Washington, D.C., 1965); related findings are being reported from a study now being completed under the auspices of the Illinois Institute of Technology, supported by the National Science Foundation (private communication).
19. On this point see "University units of urban study hit as failures," *Chron. Higher Educ.* **3**, No. 6, 1 (1968).
20. D. Wolfle, *Science* **162**, 753 (1968).
21. J. S. Coleman, E. Q. Campell, C. J. Hobson, J. McPartland, A. M. Mood, F. D. Weinfeld, R. L. York, *Equality of Educational Opportunity* (Government Printing Office, Washington, D.C., 1966).
22. D. P. Moynihan, *Commentary* **1968**, 19 (Aug. 1968).
23. For a fine background analysis of the relevant domestic programs, see J. L. Sunquist, *Politics and Policy: The Eisenhower, Kennedy and Johnson Years* (Brookings Institution, Washington, D.C., 1968).
24. On the position of the Nixon administration, see J. Spivak, *Wall Street Journal*, 11 December 1968.
25. The technological adaptations required to make jeeps into fire-fighting jeeps for use in urban areas are not great but are sufficient to be classified as a technological, and not only an administrative (or "logistic"), innovation.
26. The work on which this article is based was supported in part by a grant from the Russell Sage Foundation. I am indebted for comments on an earlier version to Walter G. Farr, Harold Orlans, William Rosen, Bernard Russell, Mary Helen Shortridge, Herbert Stein, and others.

NEWS AND COMMENT

The Eisenhower Era: Transition Years for Science

In his years of service in his country's highest military and political posts Dwight D. Eisenhower was at the center of world events influenced more profoundly than ever before by science and technology.

During the two terms of his presidency, the United States developed the capacity to deliver thermonuclear weapons by ballistic missiles, took the first steps into space, and made crucial advances in the peaceful uses of atomic energy. During this period also relations between science and government were fixed in forms which still prevail.

As a West-Point trained professional, Eisenhower never lost an interest in technical matters. But his career was spent largely in staff work and planning, particularly in the decade of high command when he was concerned primarily with grand strategy and military diplomacy. When he became President, the habits of a lifetime caused him to expect his science advisers to operate in the rather formal "general staff" structure he created in the White House. Those who knew him well observe that he came to place increasing confidence in his civilian scientific advisers as his administration progressed.

Eisenhower declared his attitude toward basic research in a memorandum he issued in 1946 as Army chief of staff. He emphasized that the importance of science to the military had been demonstrated during World War II and urged that scientists be given the greatest possible freedom to carry out research. In effect, he was giving his blessing to the efforts of Vannevar Bush and his associates in the wartime Office of Scientific Research and Development to insure the conversion of the wartime alliance between government and science to a system of government support of university research on a scale undreamed of before the war.

Eisenhower's presidency at Columbia University after his retirement from the Army proved to be an interlude, rather than a new career. Establishment of the Institute of War and Peace Studies at Columbia and founding of the American Assembly during that period are identified with Eisenhower, but he was increasingly involved in the moves to create a North Atlantic Alliance. This led to his return to military life as Supreme Allied Commander in Europe, the creation of NATO, and ultimately to his nomination to the presidency and election in 1952.

He took office pledged to end the Korean War and committed to a policy of "fiscal responsibility" and the reduction of federal expenditures. His party's policies and his own personal views made him uneasy about increasing spending on activities not traditionally supported by government, such as research and education.

At the beginning of Eisenhower's first term, when the domestic political scene was dominated by Senator Joseph McCarthy, relations between the academic and scientific community and the Administration were strained by loyalty battles in the universities and particularly by the withdrawal of Robert Oppenheimer's security clearance. Eisenhower was not personally implicated, but there is no question that many scientists at the time were reluctant to serve in advisory roles to the government. During this period the scientist closest to the President was probably the physicist I. I. Rabi. The two had become personal friends while Eisenhower was at Columbia and Rabi played a prominent part in establishing a NATO science program. Major credit for healing the breach between scientists and the Administration, however, is accorded by insiders at the time to