

Transportation Research in Universities

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Before university research is discussed, the relation between research and educational programs in universities should be established so that we have this larger context before us. To do this rather simplistically, one can observe that essential elements of educational programs are students and teachers. Research supports students directly through some form of graduate assistantship and professors both directly through salary maintenance and indirectly by providing students in the classes they teach. Beyond this, however, there are other benefits to the university such as faculty improvement, introduction of students to the real problems, and enhanced faculty-student interaction.

One should not, however, become complacent with any current view of this relation. From an objective, overall effectiveness perspective, the tie between research and educational programs can and is being questioned. The following are some of the issues.

1. Does the tendency of faculties to reproduce themselves in their graduate students make this training mode inappropriate in a time of rapid change?
2. Are there more cost-effective ways to do both advance training and research, e.g., forgivable loans and grants to students who can choose the most responsive institutions and nonprofit research organizations?

In launching its university research program, the U.S. Department of Transportation gave several reasons why high-level transportation research was important.

1. The transportation industry is large, approximately 20 percent of the gross national product.
2. The industry is technology-intensive, and U.S. technological leadership is lagging.
3. Problems are severe and touch all of society.

The conclusion was that universities should be involved because they are needed!

What then is the current level of university involvement with research in this critical area both in absolute and relative terms? In 1972, total interaction of the U.S. Department of Transportation with universities was given as only \$10 million per year (see Fig. 1), which was concentrated at 10 institutions. This was only some 5 percent of

Figure 1. U.S. Department of Transportation obligations for research at universities.

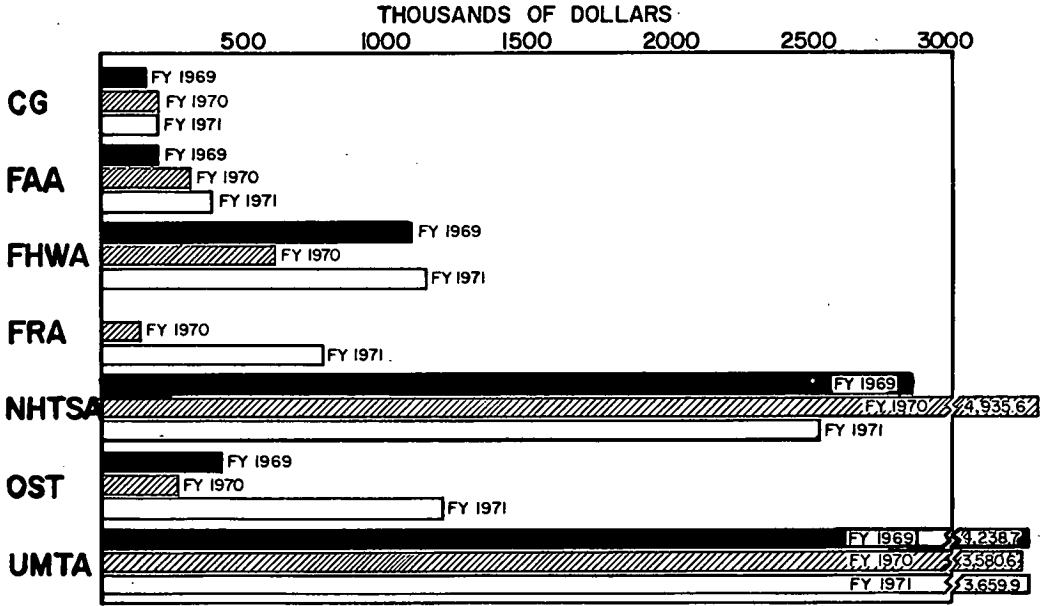
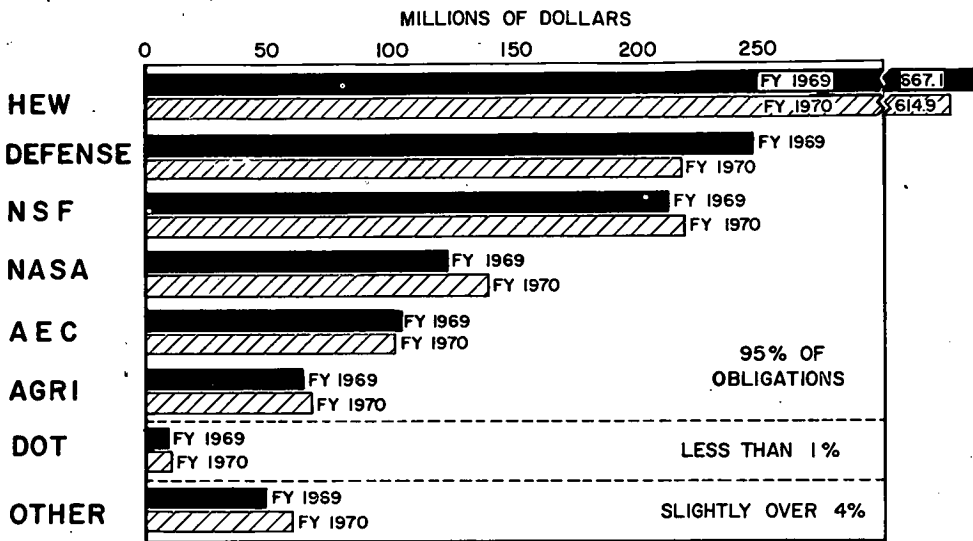


Figure 2. Federal obligations for research at universities.



the total research and development effort of the department. Furthermore, the total transportation department funding accounted for only 1 percent of federal research and development support to universities (Fig. 2). Several conclusions might be drawn from these data. One is that the allocation of 1 percent of federal research money to universities for research on a function that represents almost 20 percent of the GNP is wholly inadequate, or alternately that transportation research is largely inappropriate to universities.

CURRENT PROGRAMS

Various programs provide support for university transportation research. Some are old, are well-known to almost everyone in the university community, and have well-established philosophies, operational guidelines, and clientele. Others are newer, some of which are still in a shakedown period. However, old programs are changing and new ones are increasingly directed to changing emphases in transportation. Therefore, a review of current programs is chiefly of value in providing a context for discussion. I will now discuss briefly the history, philosophy, impact, and current status of several well-known federal programs.

Research Applied to National Needs Program

The Research Applied to National Needs (RANN) Program of the National Science Foundation began in 1971. It was developed through an extensive planning, coordination, and evaluation process that focused special attention on national needs and capabilities to meet them as viewed by leaders of the scientific and technical communities, universities, industries, other federal agencies, and state and local governments.

The purpose of the RANN program is to focus scientific and technical research on societal problems of national importance with the objective of contributing to their practical solution. RANN supports problem-focused research in areas that hold promise of technical, environmental, or socioeconomic payoff through the application of scientific knowledge derived from basic research.

Among the criteria used to decide whether a specific problem should be addressed by RANN are the following: the importance of the problem, the payoff potential in relation to the anticipated costs, and the readiness of scientific and technical people to deal with the problem.

Several of the RANN program elements relate to transportation: social systems and human resources, with initial problem areas including municipal systems and evaluation methodologies for social programs, and advanced technology application, with initial problem areas including urban technology and energy resources research and analysis. As a more specific example, a solicitation by NSF Division of Social Systems and Human Resources had as one topic "Decision-Related Research in the Field of Local Government Management." The specific problem was that of developing measures of the effectiveness of local service, including housing, public health, local employment, recreation, and transportation.

Since RANN is a recently developed program, it is not possible to assess its impact. However, it has a significant and increasing support level—\$53.8 million or 9 percent of NSF funding in 1972. The impact of this program may well turn on how the transportation system planners relate their research to the larger societal context. At an even more abstract level, future prospects may depend on a prevalent philosophy among university researchers, namely, that they are not the most effective in responding to predefined problem statements on societal problems. Many researchers feel that the environment established by rigidly defined problem statements could not be worse, that it tends to stultify creativity, and that they become circumscribed by administrative procedure. More will be said on this later.

Urban Mass Transportation Administration Programs

The Urban Mass Transportation Administration research had its origins in the small test and demonstration programs that accompanied an emergency loan program inaugurated in 1961 under a provision of the Housing and Urban Development Act. Section 11 of the Urban Mass Transportation Act of 1964 authorized a modest follow-on in research and development, and a 1966 amendment to this act directed that a comprehensive research and matching grant program be initiated. In 1968 most federal urban transportation functions were assigned to UMTA, the organization now having cognizance over the Section 11 program of research and training.

The actual wording of Section 11 of the 1964 act provides a philosophical background:

Section 11. (a) The secretary is authorized to make grants to public and private nonprofit institutions of higher learning to assist in establishing or carrying on comprehensive research in the problems of transportation in urban areas. Such grants shall be used to conduct competent and qualified research and investigations into the theoretical or practical problems of urban transportation, or both, and to provide for the training of persons to carry on further research or to obtain employment in private or public organizations which plan, construct, operate, or manage urban transportation systems. Such research and investigations may include, without being limited to, the design and functioning of urban mass transit systems; the design and functioning of urban roads and highways; the interrelationship between various modes of urban and inter-urban transportation; the role of transportation planning in overall urban planning; public preferences in transportation; the economic allocation of transportation resources; and the legal, financial, engineering, and esthetic aspects of urban transportation. In making such grants, the secretary shall give preference to institutions of higher learning that undertake such research and training by bringing together knowledge and expertise in the various social science and technical disciplines that relate to urban transportation problems.

Congress placed considerable stress on bringing together knowledge and expertise from various disciplines. Indeed this program was a pioneering one in this regard. In information provided for applicants other important objectives are noted:

1. To encourage the development of new and revitalized academic curricula designed to attract and to educate increasing numbers of professionally trained people for research and operational positions in the urban transportation industry;
2. To expand and strengthen the national capability for and to carry on high-quality research and analysis of problems in urban transportation and to provide expertise in urban transportation for federal, state, and local government needs; and
3. To assist in establishing facilities and activities that can be used by local, regional, state, and federal governments and private industry to help solve transportation problems in urban areas and eventually to make these facilities and activities self-sustaining by reason of their excellence and their involvement with local and regional problems.

The UMTA programs for support of research and training in urban transportation problems have had major impact on universities, but a rather more modest influence on urban transportation. More will be said of this differential later. At this point, the impact on universities will be examined. Why was it so significant? First, this was a grant program; and, thus, it encouraged the entrepreneurial spirit that lurks beneath academic robes. Second, it encouraged institutionalization under objective 3; and although this in itself may be questioned, the university participation in real-world affairs that was fostered brought excitement and challenge to teacher and student alike. Finally, and perhaps most important, it brought support to an area that academicians had long identified as one of growing national concern. To paraphrase the RANN problem selection criteria, there was a readiness on the part of scientific and technical workers to deal with urban transportation problems.

From fiscal year 1969 to 1973, the UMTA Section 11 program granted approximately \$12.8 million. Fifty universities have been involved in either the research or training components. These are tangible indicators of what I will call internal impact.

Comment was made earlier concerning the effect of this program on urban transportation—its external impact. Here its influence appears to be limited, perhaps for the following reasons. First, the development of influential university programs takes time. Among the required components are top-flight professors, line of communication to top administration, quality students, respected outlets for research findings, and career tracks to receive graduates. Stated otherwise, external impacts will lag even with significant internal program stimuli. Also, the urban transportation field is developing so rapidly that it is difficult to identify and assign relative values to the forces behind this state of change. In other words, the level of effort involved here would be unlikely to produce a highly visible impact—the competition for visibility simply is too great.

Highway Planning and Research Program

A discussion of the Highway Planning and Research Program of the Federal Highway Administration requires rather more emphasis on history since it was the first transportation research program in this country. Prior to the 1960s the United States willingly provided resources for all aspects of highway transportation. The early thrust of highway building was the opening up of the country begun by the canal and railroad builders. Government was involved almost at the beginning, acting through the Federal-Aid Road Act of 1916 to launch a massive federal-state program of highway construction. But from the outset, federal and state officials felt that their knowledge concerning road building and the related planning and administrative tasks was inadequate. In 1919, Anson L. Marston of Iowa State College said, "There is a very urgent need for the immediate inauguration of scientific highway research in accordance with a comprehensive national program. The country is about to spend untold billions of dollars in the building of paved roads, yet there is a very serious lack of fundamental scientific data which are absolutely essential to the correct design and construction of these roads." This recognition of urgent need was to be the keystone of the most extensive transportation research program ever undertaken.

By the Hayden-Cartwright Act of 1934, the federal government provided for the expenditure of 1½ percent of the annual federal highway money for highway planning and research under what has come to be known as the HPR program. This generous and continuing funding led to an extensive federally coordinated highway research program with much of the research under state supervision, though often undertaken by universities—in particular by civil engineering departments at the various land grant universities.

NCHRP Report 55, *Research Needs in Highway Transportation*, provides one view of what has been done and what is yet needed in highway research. It notes that there has been a changing emphasis in research from the time that highways were needed to get farmers out of the mud to the time that they are a service function in a very complex social, industrial fabric. Research through the 1930s and 1940s was needed in all aspects of highway technology, but the priority questions were largely of the "how" variety. How do we build concrete roads that will not deteriorate? How do we stabilize existing materials and base courses? How do we determine the needed thickness of the flexible pavement layer?

In the decade of the 1950s the high-priority questions typically had a different emphasis. What is the rational method of determining highway capacity? What are the relations among speed, volume, and capacity on freeways? What is the optimum freeway network for a city? What is the developmental impact of major highways? It is important to note that many of the questions of the 1930s were still being asked since rigorous solutions had not been provided, but now many were beginning to suspect that (a) we could live without perfect and immediate solutions to all the "how to" problems and (b) we had better redirect more of our attention and resources to more pressing problems.

In the decade that has just passed, the emphasis shifted again. Do we need this highway at all? How can it be maintained? What will it do to the environment? Is it as

safe as it should be? How effectively is it being used? And through much of this, the old questions continued to be asked and research continued to be directed at those problems as well.

Several important observations should follow this commentary on how the highway research philosophy and its emphases have changed over time.

1. Given the proper climate, a coherent, tenacious research community with instincts and assets for survival will develop.
2. Universities contribute to this community's survival assets through the incestuous tendency of professors to reproduce themselves in the person of their best graduate students. (It is important also to note that the ever-expanding highway program provided rewarding career tracks for the thousands of graduate student-researchers supported by HPR funds.)
3. This sustained but flexible effort has had a high level of overall research productivity in spite of, or perhaps because of, the extensive institutionalization that developed.

To state the philosophy of the HPR program in simple terms, it is to enhance and thereby promote highway transportation.

The internal and external impact of highway research by universities has been enormous. Externally, it has contributed in an integrated fashion to the development of the world's finest highway transportation system. Internally, it has provided massive, continuing funding that has attracted outstanding professors and students, made possible up-to-date laboratories, supported numerous scholarly journals, and supported workshops, seminars, national meetings and conferences (including the Transportation Research Board). In short, it has had positive payoffs within its frame of reference. (The massive funding involved must not be underemphasized in a consideration of this program's impact. To illustrate, Pennsylvania's HPR program in fiscal year 1972 totaled \$9.6 million.)

The more than \$200 million of HPR money that has been spent in transportation planning since 1962, and the dominant influence of that planning on urban transportation, is perhaps an appropriate illustration of the external impact of this program. This money was, of course, not spent by universities; its spending was, however, dominantly influenced by HPR-supported research.

As noted at the outset, the HPR program is tied to federal construction expenditures for highways. Its status is, therefore, rendered uncertain by indecision over Highway Trust Fund diversion, by actions taken to reduce fuel consumption since all money comes from highway users, and most important by changing public values.

National Cooperative Highway Research Program

According to its 1972 annual report,

The National Cooperative Highway Research Program is supported on a continuing basis by funds from participating member departments of the American Association of State Highway and Transportation officials....Each year AASHTO refers to the NCHRP a research program that consists of a group of high-priority operational problems for which solutions are urgently required by the member departments of the Association....Those contemplating proposals are advised that the NCHRP is a program of applied contract research; it does not function on a grant basis....Proposals are desired only from agencies having strong capability gained through the extensive successful experiences in the subject problem areas....It is expected that the personnel constituting this high level of capability will be used extensively in meeting the commitments of the proposal—capability cannot be developed at project expense.

The National Cooperative Highway Research Program was established in 1962 to provide for a continuing program of highway research. As noted above, problems come from AASHTO members, who contract with the National Academy of Sciences to commit

4½ percent of their 1½ percent federal-aid highway planning and research (HPR) funds to this program. In this way a continuing annual budget of approximately \$3.5 million is provided. The philosophy of this research effort, evident from the above statements, is essentially one of satisfying the sponsors—50 member departments of AASHTO.

This has been translated into specific operational concepts, e.g., applied research on operational problems by experts working under tight contract agreements. Other elements of NCHRP philosophy include careful attention to problem statements by a panel of experts, significant size contracts, close project monitoring, and rapid dissemination of findings.

By 1973, some \$28 million had been expended on 203 projects in 24 program areas. Some 14 projects were advertised per year, each attracting an average of some 12 proposals. The spectrum of highway concerns covered by this program and the level of university involvement are given in Table 1. From this a significant impact on university research is evident. Educational institutions have been the most heavily involved class of agency, accounting for 40 percent of all projects (research institutes account for approximately 28 percent, and industry, consultants, trade associations, and others for approximately 32 percent). This significant amount of university funding in spite of the rigorous terms and conditions is worth noting.

During 1972, the program went through a period of uncertainty while the federal-aid highway act was delayed. This served to emphasize that this program is tied to traditional state-federal highway construction funding programs—programs in transition as noted in the previous section. In 1973, some 9 new project proposals having an estimated cost of \$1.2 million were solicited. Three of the projects were directed at studying and modifying the traditional urban planning package, cited earlier as being a product of HPR research.

Program of University Research

The Program of University Research (PUR) of the U.S. Department of Transportation was announced in September 1972, so its history is brief. President Nixon's promise to reorder national priorities provided the basic impetus. In his 1972 message on science and technology he said:

We must appreciate that the progress we seek requires a new partnership in science and technology, one which brings together the Federal Government, private enterprise, state and local governments, and our universities and research centers, in a coordinated, cooperative effort to serve the national interest.

Regarding philosophy and intended thrust, there have been extensive communication efforts by the transportation department. At the inaugural ceremonies for this program, the Secretary of Transportation said:

Brainpower, pure and simple, is absolutely vital in these most complicated times in which we live. I would like to discuss with you briefly the nature of some of the broad, interdisciplinary problems affecting the vitality of national transportation and to emphasize the urgent need for universities to tackle some of these problems while they fulfill their classical, educational responsibilities.

Society needs a new quality of excellence, an incentive to weld academic idealism to innovative research that will serve our country. So let me pose a challenge: that your works be directed toward improving the quality of our society.

Your government has a great deal of confidence in the ability of universities to accept this kind of invitation and to make constructive contributions to our national life that transcend the education of our young. Your contributions are especially needed in transportation.

The research objectives of this program are as follows:

1. To stimulate relevant, high-quality, and innovative transportation research at universities for the creation of new concepts, techniques, and knowledge;
2. To increase the effectiveness of universities in helping to solve local, state, and national transportation problems;
3. To encourage the use of modern tools of analysis, planning, and management, of new technology, and of professionally trained people by state and local transportation agencies;
4. To stimulate industry and state and local agency sponsorship of university-based transportation research; and
5. To assess the demand for professional manpower in transportation and to project future training requirements.

Broad-gauge transportation research not in conflict with that sponsored by the modal administrations is intended. It can be supported under 4 program elements:

1. Major research by interdisciplinary teams;
2. Project research, joint ventures with the local transportation community, both local government and industry;
3. Individual research by single faculty members and their students; and
4. University-based seminars to foster interaction between the university and the transportation community.

The earlier-noted readiness of the academic community to engage in transportation-related research was dramatically underscored by the response to this program. For the total funding of \$3 million in fiscal year 1973, 723 proposals were received. Contract awards were made in response to 49 of these proposals. Therefore, current probability of success is very low indeed—an obvious source of discouragement to prospective researchers.

Already the internal (to universities) impact of this program has been large. The number of people devoted to writing the 723 proposals is a somewhat unhappy testimony to this fact. Future impact on universities is uncertain, but it is likely to increase. This prediction is based on the following:

1. The program is positioned in the top transportation office, and so will command money and attention;
2. It stresses interdisciplinary approaches; and
3. University-industry-government working alliances are encouraged.

Some \$3.5 million was awarded on fiscal year 1974 funds. The present intent is to go to Congress for \$6 million for fiscal year 1975. Table 2 gives information on the 1973 program.

SUMMARY OBSERVATIONS ON CURRENT PROGRAMS

These brief reviews indicate that there are several fundamentally different approaches to transportation research. They can also be used to support observations on several university-related issues.

Freedom in Problem Definition

UMTA, HPR, and PUR offer considerable freedom to the researcher in defining the problem he or she wishes to address. The research community makes much of this freedom, as was noted in the section on the RANN program, on the premise that responding to a predefined problem statement is destructive of the creative environment that universities should offer. RANN and NCHRP do, in fact, work entirely from sharply defined problem statements, and there are those in the university community

Table 1. NCHRP projects at universities from fiscal year 1963 to 1973.

Research Area		Number of Projects	Number at Universities	Total Funding (millions of dollars)	University Funding (millions of dollars)
General	Specific				
Design	Pavements	25	15	2.16	0.97
Administration	Economics	12	7	1.09	0.46
Traffic	Operations and control	21	5	4.80	0.79
Materials and construction	General materials	15	9	1.26	0.77
Traffic	Illumination and visibility	12	7	1.70	1.26
Maintenance	Snow and ice control	12	3	1.14	0.34
Transportation planning	Traffic planning	9	1	0.80	0.10
Transportation planning	Urban transportation	14	6	1.74	0.76
Materials and construction	Bituminous materials	4	1	0.33	0.11
Materials and construction	Specifications, procedure, and practice	11	3	0.83	0.10
Administration	Law	18	3	0.28	0.07
Design	Bridges	15	7	2.40	0.72
Maintenance	Equipment	1	0	0.02	0
Maintenance	Maintenance of way and structures	3	1	0.50	0.10
Design	General design	7	3	1.13	0.29
Design	Roadside development	3	1	0.32	0.22
Traffic	Safety	3	0	0.37	0
Materials and construction	Concrete materials	2	2	0.40	0.40
Administration	Finance	6	0	0.38	0
Special projects	—	13	4	2.70	1.30
Soils and geology	Testing and instrumentation	3	1	0.13	0.03
Design	Vehicle barrier systems	2	0	0.15	0

Table 2. Research categories in contracts and proposals of Program of University Research.

Category	Frequency Distribution*	
	Contracts	Proposals
Type of research		
Basic	25.8	17.7
Applied	45.2	45.7
Exploratory development	11.3	14.9
Advanced development	3.2	5.7
Prototype DT&E	0	3.4
Preliminary OP dev and demo	6.5	4.9
R&D support	8.6	7.8
Mode of transport		
Air	0	8.2
Guideway/rail	7.9	10.8
Highway	11.1	22.1
Marine	3.2	3.2
Pipeline	1.6	0.9
Intermodal	20.6	13.3
Multimodal	44.4	31.1
Other	11.1	10.4
Research objective		
Improve capacity and service	25.0	30.1
Reduce costs	8.8	13.2
Protect environment and conserve energy	16.3	16.9
Improve safety	11.3	14.2
Improve future options	27.5	18.8
Improve R&D payoff	11.3	6.8

*These numbers represent the times (frequency) that these categories appear in the contracts rather than a distribution of the contracts among the categories. They have been normalized on a scale of 100, and the numbers are not whole numbers.

who find this quite acceptable. Indeed, the high level of involvement of universities in NCHRP and the wide recognition of this program as a productive one argue in favor of this approach. Finally, those programs with a high visibility before state legislators or the Congress find that careful attention to problem definition is necessary if the work is to be directed along lines that will generate continuing support.

Continuity and Adequacy of Funding

The HPR program has enjoyed the greatest continuity and perhaps the most adequate funding. NCHRP is similar on both counts. The other programs described here are newer ones, responsive to a high need awareness. One might suppose that as long as this need persists they will have adequate funding, but that they are unlikely to have the continuity or to become institutionalized to the degree of the earlier mentioned programs.

Institutionalization

It belabors the obvious to note that the oldest programs tend to be the most institutionalized. But this institutionalization is so significant that it deserves mention. It touches on aspects such as reviews for the granting of research by friends and acquaintances, reviews for publication in the same way, well-developed bureaucracies for handling paper work, and well-known expectations regarding the product. As has been noted, however, it is risky to pass judgment on the pervasive institutionalization accompanying highway research since it cannot really be separated out as a factor in the high productivity that this program has enjoyed.

Interdisciplinary Approach

The newer transportation research programs (UMTA, RANN, and PUR) emphasize the bringing together of various disciplines. This is essentially contrary to the traditional university organization. The resulting structural and intellectual barriers probably cause interdisciplinary research to be less cost-effective in terms of short-term objectives than that within a single discipline. Experience and a wider frame of reference for evaluation are working for positive change here.

Requirements for Response

NCHRP has the most stringent response requirements. Research packages are large, funding is tightly fixed, problem statements are very specific, contract requirements are exacting, and demands on the research team are high. Nevertheless, university researchers have accommodated to this program, and it has been a productive one. With the growing requirement for interdisciplinary activity and for attention to real-world problems and the great competition for funds, all of these elements are likely components of future research programs.

Real-World Interaction

PUR places the sharpest emphasis on real-world interaction and linkages. The UMTA program also encourages a degree of institutionalization so that universities can become involved with local government and industry. The university context is not well suited for such real-world interaction, but for those who survive the frustration of doing it there are the rewards of enriched teaching and more relevant research.

Prospect for Implementation

NCHRP has placed great emphasis on implementation. Indeed its annual report calls out examples of implementation in great detail, this being the evidence of cost-effectiveness. Implementation is important not only for the customer but also for the self-satisfaction of the researcher. It seems likely that broad, multimodal programs will cause implementation to be rather more difficult. PUR, for example, is so broad in scope that it may be difficult to trace a project from the secretary's office to where implementation occurs and to maintain communications along this channel so that there is a feedback loop.

CHANGING VALUES

The implication of changing societal conditions and values for the various functional areas of a society is a popular topic for professional futurists. The predicted implications for transportation, for example, of an energy shortage, of the new environmentalism, of coming economic conditions, and so forth range from utopian to Orwellian. Perhaps the only safe statement here is that society is departing at some unknown rate in a largely unknown direction from an approximate 50-year period of almost total automotive dominance and that certainly there will be repercussions in transportation research.

In a summer workshop in 1973 at M. I. T., Marvin Manheim listed changing societal values as being among the reasons why a systems analysis approach to transportation is needed; his point was that a fluid value system (together with rapidly changing technology and changing demand) calls for a swift, comprehensive, flexible analysis methodology. Certainly these same traits must characterize our approach² to future transportation research programs. Indeed our research must be so forward-looking that it contributes to an understanding of this very societal value system!

In a time of rapid change our instincts are to concentrate on preserving our projects and programs. This is, of course, the very antithesis of broad-gauge creative research. At the same time there must be some base that provides continuity, that essential minimum context.

BEYOND CURRENT PROGRAMS

Acknowledging that changing values presage major changes in transportation research, what are the trends that indicate the future in our area of concern?

Institutional change perhaps provides the most illuminating trend in this regard. Apart from the creation of the U.S. Department of Transportation, the most significant institutional change is the move from state highway departments to state departments of transportation. To illustrate the significance here, virtually all of the departments provide for multimodal transportation systems planning. However, arrangements for the funding of such planning are in embryo stages of development, for until recently only highway funding, HPR money, existed. Pennsylvania, for example, initiated a study focusing on rail transportation needs but touching on modal interface aspects. To support the study, ad hoc funding arrangements had to be worked out between the various modal administrations in federal and state government. The old institutional channels did not fit this new type of project. Parenthetically, perhaps an even more serious problem is that the old institutions will still be there after a successful bypass has been devised.

Evidence of new institutional arrangements also is provided by the developing responsibilities for transportation, in a rather direct fashion, of the Environmental Protection Agency. If, in fact, air quality requirements are rigidly enforced, then the options for transportation may come to be dictated by this constraint rather than by transportation needs per se. The critical research areas then will derive from EPA requirements rather than from traditional transportation needs. Undoubtedly, there will be confusion

before such a change can be translated into working arrangements for university research.

Another illustration can be drawn from the energy situation. If we take seriously the constraints on oil supply, then energy consumption, probably translated into cost, becomes the dominant criterion for transportation investment. Again research will be motivated primarily by this constraint and very likely will be administered in a new administrative framework.

Clearly, then, the institutionalization that has provided security for university researchers and has in many cases promoted productivity is breaking down. A research "ad-hocracy" will likely follow: programs established in response to specific societal needs, funded at the level necessary to produce the desired product, tightly controlled by agency monitors, changed or terminated when productivity lags or needs change. The UMTA reevaluation after a relatively short time perhaps illustrates this approach.

How should university researchers respond? First, I suggest a pragmatic acceptance of the trends noted above. Our pressing societal problems must be addressed by university and other researchers in a businesslike fashion, drawing on the wealth of basic knowledge that now exists. However, I also would urge a concentrated effort to preserve programs with freedom of inquiry, programs where evidence of creativity is one measure of success. This latter can be approached in several ways: through lobbying with stress on past accomplishments, but also through demonstration, with careful attention to productivity in all university research. Both of these should be pursued.