

nineteen seventies, with a resulting gradual increase in funding for "soft-side" projects.

The last area is that of rail. Again, there was a sharp decline in R&D spending in the nineteen seventies from \$70 to \$80 million to about \$30 million today. The budget of the Federal Railroad Administration, the primary funder of rail research, experienced sharp cutbacks during the Reagan administration. Private sources of funding increased over this period, but not enough to offset the decline in federal support. (Rail was the one mode for which I was able to obtain estimates of private funding for research, in this case compiled by the Association of American Railroads.) When you look at rail R&D as a percent of operating revenues, spending has dropped to about half the level of that it was in the mid-nineteen seventies. R&D spending now accounts for about 0.14 percent of rail operating revenues.

In the final minutes, I would like to compare R&D spending levels in the transportation sector with private industry and finally, venture some explanation for positive R&D performance in certain transportation sectors.

When we compare public and private R&D spending levels as a percent of operating revenues for each of the four transportation modes, the highest is air R&D at nearly two percent of airline operating revenues. Highway, transit, and rail are all well under one percent of their respective operating revenues.

The average R&D spending for all private industries with R&D budgets of over one million dollars is 3.5 percent of sales. There is quite a range. For high-technology industries (i.e., computers, instruments, etc.), spending is about seven percent of sales. Many manufacturing industries (i.e. steel, food and beverages, textiles, etc.) are low spenders -- here R&D spending averages about 1.1 percent of sales. In conclusion, I think it is evident that, at least in comparison to private industry, transportation R&D spending levels are woefully low; they compare with some of the lowest spenders in the private sector. Moreover, share of revenues that has been expended on transportation R&D as a percent of operating revenues has declined over the last decade, with the exception of R&D for highways, the only sector which has maintained R&D spending levels as a share of operating revenues. This good performance can be attributed to the percentage set-aside of highway funds for research, under which research budgets benefit from an increase

total allocations for the highway sector.

NEWDIRECTIONS FOR TRANSPORTATION
ADMINISTRATION RESEARCH, A
REPORT ON NCHRP 20-24

Richard R. Mudge, Apogee Research, Inc.

In response to concerns raised by the chief administrative officers (CAOs) of numerous state departments of transportation (DOTs), NCHRP Panel 20-24 was formed in late 1986 to explore the feasibility of a "top down" research program to help meet the management, administrative, and financial problems faced by CAOs. This effort was divided into two phases: an exploratory review and a more detailed research plan. The team of Apogee Research and John Clements was selected to conduct this research.

Our approach in the first stage of the NCHRP 20-24 project was to contact as many people and CAOs as possible. We had formal interviews with some 30-35 experts including 13 current chief administrative officers. (During the second stage, interviews were conducted with perhaps another half a dozen CAOs).

One problem we found is the tremendous turnover (particularly in recent years) among CAOs. Many of these people have been in the job a year or two or less -- they're brand new. There are fewer and fewer of the old hands around. But regardless of who we talked to, we found genuine interest in the project. Another clear finding was the importance of the form of communication; for example, only a limited number of CAOs come to TRB meetings. The form of communication by researchers is very important: it has to be in a form that CAOs can understand and be able to convert to direct use.

CAOs feel a clear need for targeted research; they have very specific problems to solve; they have to solve them in a very short time frame; and they have to be able to get research projects done quite quickly, and communicate the results effectively.

Not surprisingly we found that research needs vary quite widely among CAOs. Their backgrounds vary tremendously; for example, a number of CAOs were highway engineers and know the highway program very well (though they may have more limited knowledge of other modal areas), but they may be less involved in politics. On the other hand,

other CAOs come from a political background, may not know the program as well, and may or may not be good managers. Then there's another smaller group who typically come from business and consider themselves good managers, but who may be somewhat naive about politics or may have virtually no knowledge of the federal-aid highway program or the funding process for other transportation modes.

In the first phase of the research, we identified seven major research areas. There are no tremendous surprises; they are the types of problems that people talk about a lot. Our mandate was to put labels on them along with definitions so that we could focus our efforts on those that seemed to be most important.

While most of our effort was non-quantitative, we did use a questionnaire asking CAOs to rank problems in order of importance to them and their job, and then to note ones which they believed State DOTs were performing the best. One approach would be to focus research attention on those areas with the largest gap -- those areas which seem to be very important, but where performance is not as strong as it should be.

The area where there would seem to be the largest gap is one we called long-term policy development. This topic concerns long-term trends in society and the economy, their possible meaning for future transportation development, and how to design future transportation programs that will be in place to solve problems before they arise.

The second area was finance and resource development. In addition to identifying sources of funding, this area covers personnel resource development, in large part because there is currently a tremendous turnover problem with many highway engineers reaching retirement age. There was a real concern among many CAOs about their source of new middle and top managers. There was also a concern that they don't always know how to measure when an engineering department is doing a good job.

The third major area was implementation -- how do you ensure that a good job is done; what kind of organizational form works best; for example, what are the pros and cons of geographically dispersed decision making versus geographically concentrated? It includes very practical types of concerns.

The fourth major area was financial management. Given whatever resources you have, what is the most efficient way of allocating those resources among projects? What types of investment criteria make sense?

The fifth area was decision support -- what types of information systems or risk assessment systems are there in place to help you make both your day to day decisions as well as your long-term decisions?

The sixth area was general understanding of the industry -- what is the context of the world in which CAOs must make decisions, what is the trucking industry like, what are commuting patterns going to be like?

The final area was public and political interactions how do you explain to the public what your program is about, so they can understand what it is you're trying to do, and provide meaningful feedback?

After we prepared the first phase report, the panel met, commented on it, and concluded that the next phase of work should concentrate on three of the topics: resource development, decision support, and financial management. Those three areas were felt to offer the highest potential payoff.

Although we had found long-term policy development to be the biggest problem, the panel felt that finding answers to those three would also generate solutions to many long-term policy development problems. Further, given the limited resources available for the second phase of this work as well as the effort required to actually complete the research, it probably does make sense to focus on those three areas.

Based on personal interviews with CAOs and other transportation professionals, the first report found there was a clear need for an ongoing program of applied research that could meet the special problems faced by many CAOs. Rather than focusing on original research, however, most efforts under such a program would probably consist of syntheses of existing research, adaptation of work from other fields, case studies, and surveys of state practices. The interviews with CAOs found that effective communication of research results was vital and that different methods were required beyond the traditional formal written report.

At the panel's direction, the research program

developed in this report focuses on research topics within three broad problem areas:

- Resource Development;
- Decision Support; and
- Financial Management.

Within these three broad problem areas, seventeen separate research topics have been identified. Two generalities can be stated about these research topics.

First, although each could be completed individually, there clearly is a synergy among them, with implementation of one research topic often supporting one or more of the other proposed topics. Second, in contrast to the effort underway as part of SHRP, these topics do not appear to represent a backlog; rather they cover a set of ongoing problems that will continue to evolve over time. Both these findings appear to argue for establishing an ongoing applied research effort dedicated to helping solve the special problems faced by CAOs.

The seventeen research topics, in turn, have been broken into between three and ten separate projects each, for a total of some ninety projects. While differences exist depending on the individual topics, many of the research projects follow a five-step progression:

- Review or synthesis of current efforts and related research;
- Develop a general analytic framework;
- Demonstrate methods by analyzing a problem faced by a particular state or by developing case studies;
- Develop handbook or set of standards for applying the methods; and
- An update service to track and report on new advances.

SUMMARY OF PROPOSED RESEARCH TOPICS

Full details on each research topic are provided in the Appendix to the full report. A brief summary of these topics are described below.

RESOURCE DEVELOPMENT

The most basic resource of any DOT is its staff; in turn, this is supported by other resources such as

computer hardware, computer software, and research of all kinds. Research topics proposed in the area of resource development are designed to help CAOs evaluate the effectiveness of departmental resources, pinpoint barriers to greater effectiveness, and maximize the support contributed by all resources. Topics are grouped into two areas: Personnel Development and Performance.

Personnel Development

The transportation industry faces a continuing crisis in the availability of appropriately trained professionals.

At the entry level, fewer qualified professionals are entering the state DOT work force. Within middle management, increased rates of attrition and retirement are being felt.

Four research topics have been proposed that deal with the several dimensions of these problems:

- Recruitment and Training addresses the need to increase the flow of professionals into the transportation field in general and attract these entry-level professionals to state departments of transportation in particular.
- Middle Manager Training and Retention focuses on achieving better retention of those managers that might otherwise leave state departments of transportation and explores the potential for transfer and training of middle managers from other professional fields.
- Incentive Systems explores the role of different types of incentives in attracting high-quality personnel and encouraging high levels of performance. Information gained from this research can make a significant contribution to the preceding two topics as well.
- Civil Service describes the various systems in effect at the state level and analyzes positive and negative impacts of such systems on departmental flexibility, efficiency, horizontal equity, and personnel promotion. The focus would be on how to maximize productivity within the existing civil service rules and on how changes could be made.

Performance

- System Performance is motivated by the need for a consistent set of measures for different

aspects of DOT management. Because performance is often difficult to quantify it is often ignored. In addition to developing a system of management and administrative performance measures, this effort would initiate a national system to collect performance data across all state DOTs.

- Computer Performance is a special problem since there are limited standards for evaluating how and when to adapt past hardware and software investments to a rapid technological change. For example, how can tradeoffs be made between past investments and future investments?

DECISION SUPPORT

The CAOs of state transportation agencies routinely face important management, administrative and planning challenges. Yet they have only limited time to find, evaluate, and initiate effective solutions. The difficulty of meeting these challenges is compounded by the rapid turnover of CAO's in recent years and the diversity of their backgrounds. The research topics are designed to aid CAO's by supplying them with analytical tools to help make these important decisions; they are grouped into the following three areas: Departmental Organization, Management Support, and External Relations.

Departmental Organization

With increasing fiscal scrutiny of operations, transportation CAOs are forced to search for the most cost-effective organizational structures for their departments. The research topics proposed in this area address the following:

- Contracting Out focuses on the delegation of responsibilities to the private sector. The research is designed to formalize the process of contracting out, including provision of a comprehensive analytical framework for the decision on when and what to contract out, thus providing a more rational basis for CAOs' decisions.
- Centralization Versus Decentralization would provide guidelines for decisions that affect the concentration of responsibility within state DOTs. The proposed research would review case studies of decentralization, focus on determination of optimal conditions for decentralization, and provide guidelines for a

systematic economic evaluation of agency reorganization to aid CAOs in assessing these alternatives.

Management Support

Increasingly, CAO's of state departments of transportation serve for shorter terms and have come to office with limited prior experience in transportation. There is a pressing need for them to orient quickly to their new responsibilities. At the same time, the materials that they - as well as more experienced CAOs - must assimilate has become more extensive and sophisticated, adding greater urgency to the need for effective and timely support systems. Several research topics have been proposed to help provide this support:

- A Skills Inventory would offer a system to help CAO's evaluate their own unique strengths and relative weaknesses. This research would develop a task-based skills assessment and inventory for systematic self-evaluation. Part of this effort could also develop a guide to show CAOs how to use this information to remedy revealed shortcomings as, for example, through judicious personnel decisions and personal skill development. Further, types of technology transfer could be designed to strengthen CAOs personal command of subject areas identified as relatively weak. For example, curriculum design and establishment of a program of conferences, seminars, and mini-courses for new and incumbent CAOs; and creation of a compendium of available written and human resources that are particularly relevant to transportation CAOs.
- Senior Executive Service would design and establish a corps of experienced ex-CAOs to serve as mentors to new appointees to ease the transition and to provide informal support as needed thereafter. Research includes development of a classification and matching system to pair appointees with the Service members who can best serve them and creation of an organization to administer the Service.
- Communication for CAOs focuses on the delivery, rather than the content, of relevant information. This topic investigates the potential usefulness of less conventional communication modes in relaying information to CAO's already inundated with materials in traditional written form.

External Relations

The citizens of each state are the "customers" who use the transportation "product" or services generated by the DOT. Modern marketing techniques that create a two-way communication channel between customers and producers in the private sector can be used as well in the public sector to create and sustain transportation systems that are responsive to public wants and felt needs. Two aspects of external relations are proposed for research:

- Market Research focuses on the application to transportation of modern information gathering techniques to help CAOs assess public knowledge of and demand for different transportation components. The proposed research would review various market research techniques, evaluate their usefulness in transportation planning and consensus creation, develop information gathering instruments with a survey tied to the 2020 effort, and construct a guidebook for individual state application.
- Public Outreach focuses on market-directed dissemination of information related to transportation in general and individual projects in particular. This topic will investigate the role of outreach in building public consensus for transportation investment, resulting in a handbook to help state DOTs construct their own effective outreach programs.

FINANCIAL MANAGEMENT

Financial management encompasses "macro" level policy planning and "micro" level project selection and funding – both of which shape the structure of state transportation systems. The gap between funds available and funds needed for proposed projects must be addressed on two fronts: developing ways to increase available funds, and establishing more effective means of selecting among competing projects. CAOs must also make decisions that shape their states' transportation infrastructure far into the future – these macro-level decisions require analytical support based on a clear vision of long-term goals, bolstered by an evaluation of the likelihood of the various conditions. The following three research topics address these issues:

- Non-traditional Finance focuses on the recent rapid expansion of impact fees, exactions, tax increment financing districts, and other non-traditional financing. The proposed

research would explore how these techniques and the funds they raise could be incorporated into DOT plans and operations. Efforts would be made to develop techniques to measure the extent of these approaches, and suggest means to project future revenues.

- Economic Analysis presents both "micro" level and "macro" level techniques to encourage systematic analysis of investment decisions. The approach is the public sector analog of profitability and rates of return in the private sector. The micro-economic techniques explored deal with evaluation and setting priorities for individual projects as one factor in helping CAOs to determine which ones to undertake in a world of limited financial resources. The socio-economic effort would focus on the value of transportation as an integrated system, in effect to help CAOs choose the long-term investment programs that most effectively support the state's socio-economic objectives.
- Strategic Planning describes and evaluates techniques for dealing with the uncertainties involved in projection and long-term decision-making. This research topic will provide CAOs with guidelines and techniques to incorporate alternative scenarios in their planning efforts, recognizing that some alternatives are more likely than others.

INSTITUTIONAL OPTIONS

The mission of NCHRP Project 20-24 is to design a targeted program of research to be implemented over the next several years. An integral part of this effort is determining the institutional framework that would be most conducive to successful implementation of the program.

There are several institutional options which could be used to implement this research program. The choice of institution depends on the priority given to the specific program characteristics, and the institutional organizational framework that each implies. The options discussed in this report include:

- Stand alone agency -- similar to the SHRP model;
- Merge/Attach to Existing Institution -- for example, merge with NCHRP, AASHTO or a University; and

- **Combination.**

Due to the scale of the program and the tie with research, housing the research within TRB seems to be the most promising option. However, selecting research topics and identifying appropriate contractors should be streamlined. This would reduce the response time from identification of the problem to initiation of the research -- a priority in this program. The ongoing reporting aspects of these projects might require a few changes as well.

PROJECT PRIORITIES

With an estimated cost in excess of \$6 million, the scale of this program is clearly beyond the level of research funds that are readily available. While the selection of research priorities involves judgement, some research topics may address higher priority problems and may serve as building blocks for follow-on research. As mentioned above, the 20-24 Panel has decided to initiate the first half of the Market Research Program. In the personal opinions of the authors of this report, the following research topics appear to offer early promise: Senior Executive Service, System Performance, Middle Manager Training, and Contracting Out.

GAPS IN RESEARCH FUNDING; REASONS AND POSSIBLE REMEDIES

Ronald F. Kirby
Group 1 Council

As Chairman of Group One Council, I have been instrumental in pushing on with our deliberations on research needs, following my predecessor Bill Bulley, who initiated the Group One Council's interest in this area. It was under Bill Bulley that NCHRP Project 20-24 was generated. In my presentation I will try to give you a synthesis of a fairly lengthy discussion that we had at a meeting involving the Group One Council and a number of resource people in September of 1987. The meeting was prompted by a strong sense that research funding in transportation, particularly on the "soft" side, had been declining rather dramatically. We wanted to try to understand firstly whether that was true; secondly, what the reasons for it might be; and finally, what remedies there might be for this problem. At the time, we did not have the benefit of the excellent review prepared by Nan Humphrey -- we were deliberating in the absence of the kinds of numbers she assembled. Fortunately, I think our deliberations were based on assumptions that are consistent with her numbers.

In September we brought together a number of people on the buyer's side of transportation research, and some people on the seller's side, to give us their perspective on what was happening with transportation research spending. We then had a structured discussion with a facilitator to try to distill out of this information what really was happening and what might be done about it. The reason for Group One Council's interest in this subject is that the Council is designed to be an umbrella group over all of Group One -- and if you think about that, that means all modes. There are about 25 people on the Council, and they are carefully selected to represent all of the modes.

One of the first things you find when you come onto the Group One Council as a new person, as I did a few years ago, is how fragmented modal activities really are. When people from highways, transit, rail, air, and waterways get together, often they find that they don't know each other very well, if at all. We don't talk to each other very much -- and we don't generally look at things in a multi-modal way. To try to turn the multi-modal composition of the Group One Council to advantage, we decided at our September 1987 meeting to get input on research funding from representatives of all the modal areas, and to make some comparisons between what was going on in those areas. We wanted to look at different ways in which research was being funded, in the hope that we'd find some that were doing well that we could use as models to improve others that were not doing so well.

The presentations that we had from the buyers of research were from the National Cooperative Highway Research Program (NCHRP), the U.S. Corps of Engineers, the National Science Foundation, the Federal Highway Administration, a representative of a state DOT who spoke about state sponsored research, the Association of American Railroads, the Chairman of the Transit STRS Committee, and a representative from the Urban Mass Transportation Administration. Representing the sellers or providers of research, we had speakers from the Council of University Transportation Centers (CUTC), a university professor interested in freight research, and representatives of some of the Group One Committees in TRB. We had one person who reported on a joint committee meeting that had been held a few weeks earlier, in which a number of transit and highway committees got together to talk about the emerging suburban congestion problem.

I am not going to try to summarize in any depth what these people told us, but I do want to give you