Improving the Effectiveness of Transportation R&D Investments FINAL

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Millions of dollars are spent each year on transportation research. How can we be sure that these investments are effective and that the research findings are reflected in transportation decision-making? Here I briefly consider investments in Intelligent Transportation Systems, in University Transportation Centers, and in US DOT-led research, and recommend three strategies that could improve research and its utility: more emphasis on social science research to frame and complement technology-focused R&D; investing in long term and exploratory research as well as in short term, problem-solving studies, and framing research and investment in a strategic planning and evaluation context focused on outcomes rather than project categories.

A Bigger Role for Social Science Research: Evidence from Studies of the Implementation of Intelligent Transportation Systems

In a study conducted in 2003, researchers at the University of California investigated factors affecting ITS implementation as a "mainstream" transportation planning activity (Deakin et al., 2002; Deakin, 2006.) We conducted a detailed literature review, interviewed fifty-one leaders from a cross-section of California jurisdictions and agencies, surveyed 228 California transportation engineers, planners, and transit staff members, and had follow-up interviews with 52 of the staff members and 20 national transportation leaders with expertise in ITS.

ITS experts felt that ITS implementation has been slow, and attributed this to a lack of knowledge about ITS among elected officials and the public, as well as a lack of funding specifically for ITS. In contrast, our interviews with California leaders – elected officials and agency heads – revealed widespread familiarity with ITS concepts and applications (though many were irritated by ITS jargon and were unwilling to use it.) Policymakers cited freight applications, electronic toll tags, improved traffic signal systems, bus rapid transit projects, and traveler information signage as examples of ITS success. From the policymakers' perspective, ITS elements that are not proceeding well suffer from institutional and political problems (e.g., efforts to route additional traffic on local arterials when the freeway is congested) or market weaknesses (e.g., efforts to sell traffic information to third party providers.) Overall, most elected officials and senior policy staff members felt that ITS innovations are being implemented at a reasonable pace.

Elected officials were concerned, however, about a lack of good information on ITS benefits and costs, and some expressed concern that ITS evaluations have been less than arms-length. A number of leaders also commented that ITS proposals have focused too heavily on transportation system management benefits rather than traveler benefits. Some also argued that the private sector should be left to implement ITS applications such as traveler information systems.

Respondents suggested that the state DOT should lead by example, implementing ready-to-go technologies on its own facilities and within its own agency. Stronger partnerships with local government and other state agencies, developing mutually beneficial, multi-purpose applications, were recommended. Finally, respondents urged that future ITS work should pay more attention to legal and institutional issues and provide a clearer sense of "next steps."

Interviews with national experts identified additional issues. There was near-unanimous agreement that DOTs are having difficulty with ITS implementation because partnerships are needed to implement and partnerships

necessitate a change in agency culture, including less hierarchical decision-making. In the experts' view, separate ITS units and ITS implementation plans can foster strategic thinking about ITS technology development but may hinder ITS incorporation into ongoing plans, programs, and funding streams. Earmarked funding for ITS was seen as appropriate for demonstration projects, to test concepts and provide examples, and when ideas are accepted but resources are low; traffic signal timing, which produces valuable cumulative benefits but is low-visibility and typically a low priority for local governments, was given as a case where earmarked funds may be needed to induce action.

Based on these findings, we recommended a refocusing of applied ITS research across a wider range of applications, as well as greater attention to research on implementation, including market studies and work on strategies to foster consensus building and partnerships for ITS.

A follow-up study currently underway suggests that many findings of our earlier work still hold true (Deakin, Frick, and Skabardonis, forthcoming.) While efforts have been made to increase deployment of ITS, these efforts have continued to focus primarily on technology details rather than evaluating the broader questions of costs and benefits, markets and institutions that are also needed. Agencies have tried to address the latter issues and bring greater attention to implementation by requiring "technology transfer" elements in every project, but we find that this has been less successful than the agencies had hoped. One reason is that the assessments are often done as an add-on to a technology development or field test, often by the same staff members who developed the technology or test. But experts in science, engineering and technology are not necessarily expert in economics, policy design, planning, public support, and implementation, which are all social science fields of inquiry. We should not expect that our technical experts will excel at market studies, policy analyses, or social, economic, and environmental assessments any more than the marketing and public policy department of a technology firm would be expected to do engineering and technology development. Investments in social science research are what are needed, especially in the form of independent assessments conducted in consultation with technology developers. Such efforts could help us match technologies to markets, improve the research selection process, and speed up implementation of research findings when such implementation is warranted.

University Transportation Centers: Research and Human Resources

Since the late 1980s the federal government has devoted a portion of its funding for transportation to university transportation research centers. Originally the federal program funded ten centers, one per federal region, with center designation determined through a competitive process involving peer review of proposals. In the ensuing years, Congress has expanded the program several times, naming additional centers but also requiring that after an initial funding period, most centers must compete for continued designation. Currently there are sixty centers, with 20 selected through competitive reviews and 40 named in SAFETEA-LU. Centers fall under several classifications with differing funding levels. Most centers are required to secure a dollar-for-dollar "match" for federal funds, and state DOTs and other local transportation agencies are commonly called upon to provide this match. USDOT's Research and Innovative Technology Administration (RITA) manages the program with a small but highly effective staff.

All of the UTCs conduct research. The UTCs also support university transportation degree programs and offer continuing education, conferences, and symposia to help practitioners stay abreast of new methods and findings. However, the UTCs are a varied group, ranging from top-ranked research universities to smaller regional or local universities oriented principally toward education and training. The UTCs' emphases and work products likewise vary.

Most UTCs carry out a mixed portfolio of research projects, ranging from basic, exploratory research to highly applied projects. Each center has a strategic plan that outlines the areas in which it will concentrate. Most centers also refer researchers to the USDOT strategic plan and similar documents that identify research needs and project ideas. For most UTCs, however, the required "match" has a strong influence on the projects selected, since state and local agencies often will fund only those projects that they view as meeting their pressing, short term information and training needs.

California UTCs have been somewhat of an exception. California UTCs have had the benefit of a generous match guarantee since the start of the UTC program, with Caltrans staff participating in peer review of research proposals but not directing research selection. Most other centers have had less flexible arrangements and as a result do a higher share of short term, applied projects than the California UTCs.

California has had the ability to provide the UTCs this match and allow them this flexibility because of the size of its transportation program. However, with five UTCs now designated in the state and an increasingly constrained transportation budget, the UTCs have become a significant part of Caltrans' research expenditures and Caltrans is feeling the squeeze on its funding. Smaller states are even harder pressed for research funds and UTC match can eat up a large chunk of available funds. Under these circumstances, the states understandably want to see their funds used to meet their current need and are less interested in longer term, riskier research. Some are also concerned that the growth of the UTC program amounts to de facto "earmarking" of state research funds that the they would otherwise use at their own discretion.

The pressure for UTCs to show short term payoffs in ways that are relevant to current agency problems is substantial. Yet long term, researcher-initiated studies can pay off immensely. Since the start of the UTC program, California UTC researchers have carried out investigations on such topics as strategies for greenhouse gas reduction, new fuels and new vehicle technologies, measurement and control of particulate emissions from trucks, freight logistics, management of traffic to and from ports, congestion pricing, parking pricing, land use-transportation coordination, outcome-oriented performance measures, and collaborative strategic planning processes (to name just a few of the topics studied). Much of this work was initiated well before there were federal or state transportation policies or research programs on such matters. One result of this investment in long term, exploratory research – research that was NOT clearly tied to existing public policies and programs – is that the research itself has helped identify new ideas and directions. It has given California a strong evidentiary basis for action and has inspired new state legislation and new agency programs. As a result, California is now positioned to lead implementation efforts in key policy arenas that now are attracting national attention. The research might have been risky, but it has given us a distinct advantage in information and know-how.

At the same time, the UTC program has produced literally thousands of graduates in transportation, at least some of whom would not have entered the field had UTC-funded fellowships and research appointments not been available. Many of the graduates from early days are now in positions of leadership and are helping to reshape transportation policy and practice. This cadre of young transportation professionals is an important product of every UTC program and their accomplishments are a key measure of the program's productivity.

Indeed, a major way that UTCs disseminate research results – their own, and others' – is to train graduate students, who then enter the field armed with the latest methods and findings which they then introduce into their workplaces.

The consequences of the proposal to change the UTC match ratio from 50-50 to 80-20 will depend on the specifics of implementation. If the lowered match requirement is combined with a cap on federal funding for the UTC program at or near existing levels, and the number of UTCs stays the same or expands, both graduate student support and UTC research output is likely to decline. The UTC projects that do get funded are likely to be framed in longer term, bigger picture terms, and while riskier, more of these projects may be of lasting consequence. In other words, less state funding may mean less pressure for short term applications. However, there will of necessity be fewer projects, fewer graduate students supported, and as a result, a lower level of infusion of new knowledge into the profession. Not all UTCs will suffer, of course; the UTCs most successful at attracting funds from the private sector and foundations will refocus their efforts. Other UTCs will have to contract, and issues of public rather than private interest might receive less attention than they do today.

Of course, states could choose to continue a research program much as the one they are now funding through the UTCs, with consultants as well as universities able to compete for the available funds. Competing for these funds would allow UTCs to offset some of the reduced match "hit" on UTC funding levels.

If on the other hand Congress boosts the program funding to maintain or increase the funds available to the UTC program, while reducing non-federal match, a greater focus on national objectives and on longer-term innovation in research could be possible.

Congressional decisions on whether to designate more UTCs or endorse competition and peer review also will affect the quality and the scope of the UTC program. Research universities have concluded, based on the evidence, that competition and peer review are the best ways to produce quality results. However, in the UTC program it also is evident that earmarks have allowed some universities to develop transportation programs that have successfully competed for funds in later rounds. Building in an expectation of competition for all centers after an initial period of designated support appears to work reasonably well.

Finally, multiple year grants are important because they provide the predictability that enables graduate programs and research programs to mesh well. Sudden shifts in funding levels and expectations for match could cause significant disruptions to graduate programs, as could delays in reauthorization. Continuing the program as it stands for at least a year (rather than shorter periods that don't match grant cycles) is a preferable option to the difficult short-term continuations we experienced before SAFETEA-LU was enacted.

Coordination of Research Initiatives

Practitioners and policy makers often ask how we coordinate research programs funded variously by the USDOT, other federal agencies, the states, foundations and other nonprofits, and the private sector. The USDOT's Research and Innovative Technology Administration (RITA) has provided leadership in this regard. The USDOT's strategic plan provides a framework for priority-setting in research, and USDOT and RITA help insure that there is a basic level of information on DOT activities both by making information on the department's research initiatives available on the web and by organizing and by reporting on collaborations with other departments of the federal government (http://www.rita.dot.gov/about_rita/ .) On-line publication of research results and abstracts in journals and on university websites and academic/practitioner conferences such as the annual Transportation Research Board meeting are also important ways to share information.

However, there is more to be done. Compared to the EU and other economically advanced countries, the USDOT's strategic plan is narrowly framed; for example, there is no clear mention of global warming or many other environmental issues, and such matters as transportation's role in economic development, in social equity, and in quality of life are not given much attention. Further, the scope of the USDOT's collaborations with other federal agencies is quite limited and appears to be narrower in some cases than Congress apparently contemplated (e.g., in the Congressionally-requested Transportation Environmental Research Program, which was recommended as a collaboration with other agencies, states, and the private sector, but was instead instituted as a program within FHWA.) US research, development, and implementation practices also are narrower than those of other countries such as Canada, Australia, or the UK, where strong linkages have been forged among transportation, housing, and economic development planning, and among water, waste disposal, communications and transportation infrastructure investments.

A big worry for many public agencies is that research will be duplicative. However, a distinction needs to be made between intentional replication and unintentional duplication. Research is often replicated intentionally, or conducted with a series of test conditions, to determine whether the results are robust and generalizable, and not just a fluke or limited to a specific case. Such replication is highly desirable because it reduces risk and builds confidence in research findings. On the other hand, research is published in journals so that other researchers can discover and evaluate what has been found in previous studies, and avoid unintentional duplication. If the latter occurs, the researcher has not done his or her job well – it is this sort of uninformed duplication that should be avoided.

University researchers are evaluated by their peers not only on the quantity they produce but also on the intellectual content of the products, asking what's new and innovative, what new insights were generated, what

linkages were identified that were previously overlooked, what changed in research directions or in theory, method, policy, or practice as a result of the work. These are outcome measures.

In contrast, many transportation agencies evaluate the research they fund only on output measures (e.g., the main evaluation criteria are whether required products were produced on time and on budget, not whether the projects produced new knowledge, altered practice, or improved conditions.) The same is true, of course, for most on-the-ground transportation projects: they are evaluated on design compliance and whether they are on time or on budget much more often than they are graded on whether they actually improved services, the economy, or quality of life. Changing evaluation expectations from output-focused to outcome-focused could significantly improve the results for all of us, in both spheres of activity.

One of the problems with evaluating based on outcomes is that if negative outcomes automatically mean failure, embarrassment, and potential job loss, no one will want to admit to a negative outcome. Yet we know that most new products never reach market and only a fraction of those that do are true successes. The private sector knows this, and so does academia: ideas that are proven wrong and proposals that fail are nevertheless valuable products for researchers. "Failed" research efforts can lay the foundation for future research, push it in new directions, suggest alternative applications for the failed product, and highlight challenges to innovation. These are valuable lessons, not embarrassments. (Zhang and Sternberg, 2006.)

Creating an environment where risks can be taken, failures assessed fairly, and rewards given when due has been hard for the public sector. This may be a reason to rely more on private sector organizations and to give academics more independence, and more responsibility, for R&D. Risks and responsibilities are also reasons to promote competition and peer review; it shares the risk and responsibility for both research initiation and research evaluation among a number of experts.

Implications: Improving Technology Transfer and Incorporating Research Findings into Transportation Investment Policy

Our research speaks to the need to complement technological R&D with research and development in the fields of economics and finance, markets and consumers, law and institutions, planning and policy making. This is true with regard not only to the latest ITS technologies but more generally to all investments in transportation and other infrastructure.

A new USDOT strategic plan may be a way to organize these efforts. Work conducted last year as part of a study on how to respond more effectively to California's growth proposed the establishment of a new strategic planning process whose goals would be faster and more cost-effective delivery of infrastructure, better management of existing facilities and services, better value for money invested, greater accountability to customers, and the possibility of attracting private capital for infrastructure projects (Dowall and Reid, 2008.) The strategic planning process would be focused on outcome-oriented measures such as quality of service and how they are valued by customers rather than on inputs, e.g. how to allocate categories of funds. The process would involve creating a vision of the future and the investments needed to attain that future; evaluating a broad set of alternatives including both capital projects and "soft" investments such as regulation or pricing in deciding what infrastructure is needed; determining the best way to deliver needed projects – direct public or private provision, contracting, partnerships; and providing technical assistance to state agencies and local governments ranging from opportunities for bundling demand to information on best practices. Linkages modes (air, rail, highway…) and across fields (transportation, energy, housing, agricultural lands, environmental quality…) would be made explicit and tradeoffs examined. Priorities for investment would be identified.

Such a process, which is being pioneered in several Canadian provinces as well as in a few US states, could not only improve transportation investments but could help governments determine how to allocate scarce resources more effectively. State plans of similar scope are being developed and could greatly improve state and local priority setting, investment decision-making, and partnership opportunities.

References

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