The Uses of State DOT Research:

Customer Use of Completed Projects from NJDOT's Research Bureau

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16. Abstract

Based on case-study synthesis of ten projects completed between 1991-1998, this report explores factors that relate to how internal customers use the work completed for them by the New Jersey Department of Transportation's (NJDOT) Research Bureau. Factors examined include: researcher-customer relations, top management action, external influences (i.e., federal government and industry), and credibility and time dimensions of the research process itself.

Recommendations include:

1) Project follow-up should receive more attention with planning for follow-up scheduled during the work program development stage.

2) The work program mix should include policy research, allowing the Bureau to make recommendations in areas of special importance to agency executives.

3) The Research Bureau should consider increasing the flexibility of the solicitation process, particularly in relation to handling problem statements that come to light between annual solicitations.

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THE USES OF STATE DOT RESEARCH: CUSTOMER USE OF COMPLETED PROJECTS FROM NJDOT'S RESEARCH BUREAU

Hindy Lauer Schachter

INTRODUCTION

This report explores how internal customers use the work completed for them by the New Jersey Department of Transportation's (NJDOT) Research Bureau. By use is meant evidence that customers base some further activity or decision on research findings. A customer's refusal to buy a product or procure a new information system constitutes use if the decision is swayed at least in part by research work.

Organizations are increasingly coming to see internal and external customers as the focal point of quality services. (1) For transportation research this customer orientation means enhanced concern with use, with what happens to findings after reports are filed. A Transit Cooperative Research Program (TCRP) report asserts that research programs cannot prosper unless their work is picked up by customers. (2) A National Cooperative Highway Research Program (NCHRP) bulletin notes that project success requires use. (3) A Federal Highway Administration (FHWA) memorandum states that "research can only be effective if it finds its way to the road." (4) While few commentators argue that a successful research program has to show use for all its projects, some concern for what happens after project completion is now an important part of the transportation research agenda.

BACKGROUND

In organizations research use depends both on the credibility of the research itself and the social

context in which the findings are produced. Previous studies have shown that three factors often influence research use:

1. *Researcher-Customer Relations* - Prior studies of nonprofit and business organizations suggest that researcher-customer relationships affect research use; good communications and long-term, stable relations tend to increase the likelihood of implementing innovations. (5) Research use is more likely to occur when researchers and customers speak the same language and have the same assumptions about the project. Locating people near each other encourages informal, in-person interchange that can spark researcher-customer understanding. (6) Long term relations can help increase organizational memory, a factor in facilitating research use. (7) Effective communication between project directors and outside researchers is another element in successful research. (8)
2. *Top Management-Research Relations* - Outside of the researcher-customer nexus, the most important influence on research use comes from top managers who provide resources and who have power to propel or hinder implementation. (9) While top managers in a technological organization should value research because it can bring new materials and techniques to their agencies, few executives have a research background and therefore, many top managers may not be aware of all the benefits associated with successful research. (10) When top management values research, the organization is more likely to use it. In addition, personnel policy made by top management (including transfers and reductions-in-force) influences the stability of researcher-customer relations, an important variable affecting research use.
3. *Research Credibility and Timing* - Customers implement research on a need basis; they want findings that they can apply to real-world problems at a reasonable cost. The more

compatible innovations are with the existing system, the more likely people are to adopt them. Timeliness is very important; because an innovation has to meet a need delays can hinder project use. If the project arrives behind schedule, the need may no longer exist or the customer may have partially satisfied it in a less effective way. In some cases an innovation is worthwhile only if it is adopted at a specific time. (11)

METHODOLOGY

NJDOT's Research Bureau has managed over 100 projects in the last 10 years. The Bureau's primary goal is to use the scientific method to assist operations professionals to improve the effectiveness and reduce the costs associated with designing, constructing and operating transportation facilities, systems and vehicles. Research Bureau projects differ by type, customer and locus of research. Research can be authorized to prepare a technical concept review, evaluate new technologies, synthesize research literature on a given subject or for other purposes. The Bureau's internal customers can come from anywhere in NJDOT, e.g., environmental services, structural engineering, materials, operations support, traffic operations or planning. (It should be noted that internal customers are only the first in a succession of potential users of NJDOT research; project reports receive national distribution and results are available to other state agencies and the federal government.) Prior to 1995 most research was conducted in-house; more recent projects have been contracted out to universities or consulting firms.

This report is based on case-study synthesis of ten projects completed between 1991-1998. The sample contains a diverse mix of projects by purpose, customer and in-house/outside investigator dimensions. (A list of projects and people interviewed appears in "Projects and Interviews" in the Appendix.) For each case the official report and (where available) ancillary ma-

terial were read. Open-ended interviews were then conducted with project managers, customers and (where appropriate) outside principal investigators. The aim was to learn about the interactive processes occurring during the research, whether the customer used the findings and what were the reasons for use or its lack.

Interviews are a useful strategy for this project because they facilitate exploring the context out of which research findings emerge as well as aspects of the interactions between project managers and customers. They are a viable tactic for learning how the research process is administered and for singling out features that make research more or less able to meet potential users' needs. The interview method facilitates learning how insiders perceive NJDOT research. It maximizes one-on-one interaction, affording participants a chance to emphasize those aspects of the research context that they perceive to be most important in explaining use. With relatively open-ended sessions key actors talk about the issues they think are important. (12)

The interviews for this report explore the status of these three factors-- researcher-customer relations, top management-research relations and research credibility/time dimensions-- at NJDOT. The people interviewed spoke about their perception of the researcher-customer nexus and the overall organizational environment including the influence of top NJDOT management, the federal government and industry on research use. Factors the participants perceive as important were explored by noting which descriptive themes emerged in at least several conversations (e.g., whether many or few customers spoke about project manager communication as important to research use, whether many or few customers spoke about on-time performance or delays as important, etc.). The report concentrates on factors that the participants themselves deem important to research use. The strengths of NJDOT's process are examined along with those areas that can be further strengthened.

The remainder of this report contains seven sections. The first gives an overview of research use in the ten case-study projects. The second to fifth summarize themes from the interviews dealing with researcher-customer relations, top management action, external influences, and credibility and time aspects of the research, respectively. The sixth section analyzes the interview information and relates it to issues drawn from the management literature. The final section offers recommendations.

CASE-STUDY PROJECT USE

For this report use means that customers base future activities or decisions on research findings. This definition has three implications. First, it means that customers can use any project even a literature synthesis by taking the information and recommendations into account in further operations.

Second, the definition precludes easy reliance on putting projects into two categories of "used" and "not used." More reasonable is a threefold categorization of 1) significant use, where all or most recommendations are followed; 2) partial use, where some recommendations are followed and others are not; and 3) no use.

Third, the definition means that customer perception is the key variable in determining use. The maintenance management re-engineering project received a label of partial use, for example, even before Booz-Allen was rehired in September 1999 to develop and install a system because the customer believed that the report was useful for structuring debate and justifying a search for new maintenance-management software.

Another important variable in categorizing use is short- and long-term. Short-term use occurs when the agency follows the research recommendations for approximately one year or less

but then adopts other alternatives, possibly contradicting paths recommended by the research. Such shifts occur for political or technical reasons and some shifts are inevitable in any technological organization. Long-term use occurs when research findings influence a decision for a period over a year.

The table labeled "Utilization and Communication Patterns" in the Appendix shows that partial or short-term use is the typical project outcome at NJDOT. This is true across boundaries of customer function, project purpose (e.g., evaluation, synthesis or development) or whether the project is done in-house or by an outside consultant. Thus, for example, knowing whether a project was done in-house or by an outside consultant or knowing whether it was done for a customer in bridges or environmental services does not help much in predicting use.

Almost all Research Bureau projects have some impact on subsequent work or decision making; almost all are used by customers in some way. At the same time few sets of recommendations are followed in their entirety. In most cases the customer follows some recommendations and not others or the report has a short-term use and then the agency acts in a way that is clearly not consonant with the findings of the research.

The tendency for partial or short-term use across so many boundaries suggests two questions: What strengths of the NJDOT research process minimize producing reports that are not used at all? What areas of the process need additional strength to increase complete, long-term usefulness? The interview data on researcher-customer relations, top management, and other variables can help answer these questions.

RESEARCH TEAM - CUSTOMER RELATIONS

The following two subsections examine communication and stability patterns between re-

searchers and customers at NJDOT.

Communication Patterns

Good communication is a strength of NJDOT's researcher-customer relations. During the interviews for seven of 10 projects the customer explicitly praised communication patterns. Only in three projects were any negative comments made on this subject at all. In one of these projects both the manager and customer agree that although they started out with misperceptions about each other, they came to communicate well by the project's end. In a second project the customer pronounced initial coordination to be excellent but also wanted "more of a partnership" at the end. (The bulk of the problem here seems to have come from a change in project managers due to downsizing rather than poor communication skills by Research Bureau staff.)

Only one customer reported serious negative interactions. He disputed the researcher's techniques and perceived a lack of feedback by the project manager that he characterized by saying, "maybe you talk to them once or twice and then this thing appears on your desk." (This project ended by having short-term use, at least in part, because the customer persisted in trying to get permission to use devices not recommended by the research.)

Much more typical were two types of positive comments--praise for the project managers' technical skills and praise for their ability to work with customers. Examples of the first type of comment are one customer saying about the project managers, "They're very capable people," and another saying that his project manager "had an excellent background." Examples of the latter type of comment are a customer from environmental services who described the project managers as "good translators" and a customer from materials who said about a project manager "He's down to earth, a very good communicator."

In general project managers want to communicate and involve customers from the pro-

ject's start until the report is filed. At an early stage, customers get to review and sign off on work plans that are revised, if appropriate, based on customer comments.

During the conduct of the research project managers use many communication methods to keep customers informed including memoranda and meetings. For larger projects managers convene technical panels or advisory committees with customer members. When the research is completed by an outside investigator, project managers send chapters of the report to customers for their comments.

Project managers learn about customer needs through face-to-face communication. In a project evaluating de-icing materials, the project manager and customer agree that it was through intensive face-to-face communication that the research representative learned how important a "bare pavements" policy was to operating personnel in New Jersey.

Because NJDOT project managers and customers generally work in the same building they can take advantage of their proximity for long conversations when needed. The project manager of one successful project said "We met in hallways." Another said simply, "You try to get heads together."

In four projects NJDOT contracted the research to an outside source. In these cases research bureau managers become the liaisons between the outside investigators and NJDOT with much less communication between outside consultants and customers. In general, NJDOT project managers and outside investigators report good communication patterns. Investigators label project managers "pleasant" and "fine." The outside consultants on one team enjoyed having space to work in at NJDOT; they said that the close physical proximity enhanced their ability to interact with agency people.

Stable, Long-Term Relationships

Project managers and customers often do not have the long-term, stable relationships they would like. Where long-term, stable relations exist both project managers and customers applaud them. The project manager learns the customers' long term needs and can suggest additional research ideas to them. One customer argues that this service is very important, saying that his unit "has no time to sit and figure out research projects." In addition, one project manager explained the psychological benefit of a long-term relationship with a customer by saying that they trusted each other and so "he could be honest with me."

But organizational dynamics do not always facilitate long-term relationships. In several interviews both project managers and customers noted that many people were transferred or left NJDOT between start-up and completion. In the past seven years the Research Bureau has been reorganized five times; research program managers have changed at least six times. This lack of stability has hampered coordination and lengthened the time needed to conclude research. Sometimes results were out of date by the time they were written. Even one outside investigator noted that shifts in personnel made NJDOT a "slow" organization.

Lack of long-term relationships may be one reason participants do not always continue to inform each other about projects after reports are filed. In several interviews project managers did not know how customers used findings in the long run.

TOP MANAGEMENT

Interviews show the importance of NJDOT executive action. Nearly all project managers and customers mention top management actions as affecting project use while less than half the people interviewed mentioned the role of the federal government, industry or other state agencies

in affecting use of their work.

One positive theme that emerged in several interviews is the role of executive support as an asset, propelling a project to completion and use. On one successful project both the manager and the customer noted that an assistant commissioner was a proponent and this made a big difference! At other times project managers mentioned that a change in personnel at top manager levels led to variable amounts of support and hence different probabilities of use.

A more troubling theme that emerged in some interviews was the relationship between top management actions and the lack of long-term stable relationships at the project manager-customer level. As mentioned earlier several people talked about downsizing in the Research Bureau and concomitant shifts in personnel as one factor delaying projects beyond a point where findings could be used. Both project managers and customers talked about the need for long-term, stable relationships.

EXTERNAL INFLUENCES

As a public organization in a technological field NJDOT's research agenda should be affected by external influences such as the federal authorities and representatives of industry. The following subsections examine the role of each of these influences in turn.

Federal Government

Federal mandates set at least part of NJDOT's research agenda. For example, federal air and water laws lead state departments to research environmental issues such as runoff pollution or petroleum contaminants or to investigate the effectiveness of HOV lanes. When the federal government pays for innovations such as tilt barriers, it requires evaluations. Changes in federal mandates can propel or dampen the need to use state research.

Sometimes federal and state projects tackle different facets of a given research issue at the same time. The state report may recommend a course of action that can only be implemented if the federal project produces certain findings. For example, NJDOT's report on asphalt additives ends by recommending the use of new SHRP testing procedures. Since SHRP never developed all the tests, NJDOT clearly could not use this recommendation. In this case use of state work depended on federal action.

Industry

As vendors and objects of regulation industry has an interest in research use. Companies often spark research requests by touting technologies to NJDOT divisions. Administrators subsequently ask Research for objective evaluations.

As potential objects of regulation, companies through their trade associations may try to delay or negate use of research they find inconvenient. Representatives of construction firms, a politically powerful force in New Jersey, initially tried to undermine use of the findings in a project that upgraded definitions of quality levels in a construction item and reexamined the pay schedule allowed companies for non-acceptable work. The project manager and customer met with industry members many times and explained the benefits of the new system. When the companies saw potential benefits for themselves, they accepted the new payment plan. Thus good communication with industry can be a factor in accelerating use of Research Bureau work in some cases.

RESEARCH: CREDIBILITY AND TIME LAGS

Aspects of the research itself may affect use. Such aspects include research type and time lags in delivery and implementation.

What Kind of Research?

Several project managers and one customer argued that research use depends, at least in part, on enthusiasm for a given project. One project manager said that the organization has to make a realistic appraisal of success before it accepts a project. In his view, the Research Bureau should not get involved unless it is clear that the customer has a strong desire to use findings from the work. Another project manager noted, however, that it is easiest to get enthusiastic customers for projects that make small-scale changes; the more difficult task is getting enthusiasm for major changes. This insight accords with the organizational behavior literature finding that people are most likely to adopt innovations that are compatible with existing systems.

Time Lags

For political and technical reasons NJDOT exists in a landscape of constant change. The political environment shifts because ultimately NJDOT, as a state agency, is accountable to a governor and legislature who are held accountable to the public through voting. The technical landscape shifts through engineering advances and new product developments. For research to have maximum impact projects have to be completed as quickly as the nature of the problem allows.

One theme that emerged in interviews for over one-half the projects was the slow pace of research work. Many customers mentioned the time issue. Almost the first words one customer uttered during our interview were "It took too long to get the end result. You need quick responses. This is a now kind of world." In separate interviews, two different customers gave the opinion that the Research Bureau must be biting off more than it could chew because of time lags. Another customer said that if the results had come in sooner, his unit might have been able to advocate use in a more strenuous way. Even an outside principal investigator called the proc-

ess "slow and inefficient."

Time lags can emerge for valid scientific reasons. Unsuitable weather conditions or unforeseen equipment problems can force researchers to wait before collecting data. When information must be analyzed, haste can mean skimping on accuracy. It is possible that some respondents who criticized the slow Bureau work pace were not aware of the time frame needed to get scientifically valid results.

But some lags have organizational origins. In the interviews, the most frequently cited reason for delay was administrative action. Downsizing and shifts in research personnel slowed operations. Executive-level personnel changes led to long holds on implementing research. A Research Bureau member also reported that lags occur because of long and complicated execution procedures, e.g., the Bureau could not buy specialized equipment in a timely fashion due to the need for vendor waivers. In the fast paced world of state transportation agencies, these delays made projects less likely to be implemented.

ANALYSIS

The interviews suggest many issues that could be explored further. Discussions with project managers, customers and outside principal investigators show that many contextual factors--some within and others outside the control of researchers and customers--influence use. This section considers three areas that emerge from the interviews where the Research Bureau can at least partially influence outcomes. The questions asked are:

1. How can the Bureau build on its considerable strengths in communicating with customers to improve use?
2. How can the Bureau position itself to maximize the support of top NJDOT management?

3. To what extent can the Bureau develop a faster, more flexible delivery system without compromising its adherence to scientific methodologies?

Researcher-Customer Communication

With very few exceptions, researcher-customer communication is a significant strength of NJDOT's research process. Project managers are generally regarded as good translators and communicators during the life of a project. The only problematic stage occurs after report completion. Very little follow-up occurs in most situations.

The role of the Research Bureau at the project implementation stage can become a prickly issue. The Bureau cannot dictate how operating personnel use reports and some follow-up might be interpreted as an attempt to dictate. One project manager suggested in an interview that lack of follow-up was not necessarily a bad development because customers might resent too much interference from Research during implementation.

Yet successful change agents argue that innovation is not fostered by having researchers do a study, offer advice and move on. (13) The need is for follow-up of a kind that customers want and view as helpful--research experts on tap to assist, not on top to dictate. This means follow-up that is mutually agreed on by the project manager and customer at an early stage of proposal development. Follow-up should be built into projects through mutual consent at the start of the project's life cycle; it should be thought through from the project's inception.

Follow-up can involve Research Bureau personnel and outside consultants. If outside principal investigators do the research, their contracts can include a clause about interacting with customers after submitting their report. (14) Significant projects can have multiple impacts that are spread out over a period of years.

Top Management Support

The literature argues that the values of top management influence research use since agency executives set the organization's vision and priorities. The interview data show that many NJDOT projects do prosper or languish depending, in part, on support at the assistant commissioner level or higher. It is important for the Research Bureau to have top management positively disposed to the research function, aware of its benefits, and concerned with its needs. Since most agency executives do not come from a research background, they need to be educated as to the importance of the bureau's work.

One way to increase top management support is to explain the benefits of research findings to the operation of the department as a whole over the short and long run. Another way is to show NJDOT executives the importance of research to their own particular, policy agenda by adding policy analysis to its project mix. NJDOT executives would become direct customers of Research Bureau studies if the work program addressed policy.

The Bureau already commissions research on issues with intense policy content, e.g., petroleum contaminants, HOV lanes. Department members know that political imperatives have a role in deciding how the agency resolves questions in these arenas; both project managers and customers mentioned in interviews that decisions on the HOV lanes, for example, were predicated, at least in part, on public opinion and political concerns. One project manager said, "Political climate drives our direction."

The Research Bureau should take a broad view of the kinds of questions on which research can shed useful light. Its projects should describe and explain transportation policy, assess the impact of the social environment on policy content, analyze the impact of institutional arrangements and political processes on policy and evaluate the impact of policies on society in

both expected and unanticipated consequences. (15) Such research is best done by professionals possessing a set of generic techniques (e.g., in operations research or systems theory) along with knowledge of political institutions. If the Research Bureau spotlighted policy analysis in its program mix, it would have a direct link to aspects of issues that its own personnel see as crucial to top management decision making. A policy-oriented research agenda would increase the Bureau's usefulness as top management's problem solvers.

Faster Delivery Systems

To increase use the Research Bureau has to be able to move projects from proposal to completion at a faster rate to the extent this can be done without compromising the Bureau's adherence to scientific methodologies. A balance is needed between speed and effectiveness. Such a balance can be struck by shifts in administrative processes that do not decrease the scientific care devoted to projects.

The Bureau is already aware of the importance of resources for accelerating the time dimension and has mechanisms in place for shifting resources or requesting additional resources from operating units if a particular project is falling behind schedule. In an ideal world, the surest long-range organizational strategy for increasing the speed of Bureau work would be for top management to authorize additional resources and people for the Bureau.

Given the resources the Bureau actually has, however, some time gains may come from adopting a schedule with more flexibility than an annual research program allows. With an annual program some customers wait a considerable time between submitting problems and the start of research. A more flexible cycle might result in smaller waiting times and hence, faster delivery.

One fast and efficient way for potential customers to communicate with the Bureau might

be through a Research Bureau Web page. Many national professional organizations already seek solicitations for conference presentations through the Web and the Bureau could seek research suggestions in the same way. Completed research reports could be scanned into the page as well thus giving a wide audience--inside and outside NJDOT--access to Bureau work.

RECOMMENDATIONS

1. Project follow-up should receive more attention. Planning for follow-up should begin during the research work program development stage. The research staff commitment section on the work program should list the project manager efforts needed to ensure follow-up; outside principal investigator efforts should be written in the consultant commitment section.

   Research staff might consider hosting a one-day program each year at NJDOT where they discuss newly completed projects with interested members of the entire department. This session would alert units to the contributions research had made to other sections and might spark a discussion on project use from different perspectives. Outside investigators would also speak at these sessions.

2. The work program mix should include policy research, allowing the Bureau to make recommendations on issues of special importance to agency executives. This addition gives the Research Bureau another way of helping the organization as a whole while offering direct access to top management. The Bureau should consider forming liaisons with outside investigators who have expertise in public-administration and policy research and can help develop the Bureau's capacity in this area.

3. The Research Bureau should consider increasing the flexibility of the solicitation process.

Appropriate allocations should be made in the budget for processing and handling problem statements that come to light between annual solicitations. Use of a Research Web Page is recommended as an appropriate vehicle to increase communication flexibility.

REFERENCES

1. See, for example, "Cynthia Lengnick-Hall, "Customer Contributions to Quality: A Different View of the Customer-Oriented Firm," *Academy of Management Review*, 21, 3 (1996), 791-824.

2. Transit Cooperative Research Project J-1, *Final Report: Dissemination and Implementation of Research Findings*. Washington, D. C.: American Public Transit Association, June 1995.

3. National Cooperative Highway Research Program, *Know Your National Cooperative Highway Research Program*. Washington, D.C.: Transportation Research Board, n.d., pp. 10-11.

4. U.S. Department of Transportation, FHWA, Office of Research and Development, Administrative Memorandum of October 1990, quoted in Richard Weed, *Managing Quality: Time for a National Policy*. Trenton: New Jersey Department of Transportation, June 1996, p. 98.

5. See, for example, Allen Afuah, *Innovation Management*. Oxford: Oxford University Press, 1998; Thomas Allen, *Managing the Flow of Technology*. Cambridge, MA: MIT Press, 1984; Ralph Katz and Thomas Allen, "Organizational Issues in the Introduction of New Technologies," in R. Katz (ed.), *The Human Side of Managing Technological Innovation*. Oxford: Oxford University Press, 1997, pp. 384-397; John Kimberly and Michael Evanisko, "Organizational Innovation: The Influence of Individual, Organizational and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations," *Academy of Management Journal*, 24, 4 (December 1981), 689-713; and Paul Shrivastava and Ian Mitroff, "Enhancing Organizational Research Utilization: The Role of Decision Makers' Assumptions," *Academy of Management Review*, 9, 1, (1984), 18-26.

6. Allen, p. 14.

7. Andrew Hargadon and Robert Sutton, "Technology Brokering and Innovation in a Product Development Firm," *Administrative Science Quarterly*, 42 (December 1997), 716-749.

8. Texas Department of Transportation, *Addendum to Continuous Improvement Team Research Program Recommendations*. Austin Texas: Texas Department of Transportation, April 1995, p. 10-1.

9. See, for example, Richard Hall, *Organizations*, 7th ed. Upper Saddle River, New Jersey: Prentice Hall, 1999, p. 201.

10. H. Schneiderman, "Managing R&D: A Perspective from the Top," *Sloan Management Review*, 32 (1991), 53-58.

11. Hall, p. 199.

12. See James Spradley, *The Ethnographic Interview*. Fort Worth, Texas: Holt, Rinehart and Winston, 1979, and Anselm Strauss, *Qualitative Analysis for Social Scientists*. Cambridge: Cambridge University Press, 1987.

13. See the discussion on uses of criminal-justice research in Vera Institute of Justice, *Twenty-Five Year Report From the Vera Institute of Justice, 1961-1986*. New York: Vera Institute of Justice, October 1986, pp. 2-3.

14. The role of the researcher in implementation is part of the research contract at the Utah Department of Transportation. Apogee Research, *Strategic Direction for the NCHRP and Other AASHTO Research Activities: Final Report*. Washington, D.C.: Apogee Research, 1995.

15. For an introduction to the dimensions of policy analysis see Thomas Dye, *Understanding Public Policy*, Englewood Cliffs, New Jersey: Prentice Hall, 1975, p. 3.

APPENDIX

Projects and Interviews

Project	Interviews
Evaluation of the Tilt and Absorbing Noise Barriers on I-78 Sections 5M, 5BW, and 5BY in Union County, N.J., Report No. 92-002-7840, October 1991.	Mark Marsella, Project Manager Domenick Billera, Customer
Evaluation of Bridge Deck Cathodic Protection, Report No. 93-006-7520, March 1994.	Cary Younger, Project Manager Harry Capers, Customer Richard Gramlich, Customer
Guide Sign Placement and Highway Environments, Report No. 95-002-7370, August 1995.	Arthur Roberts, Project Manager Bill Anderson, Customer Norman Deitch, Customer
Development of Air Voids Specification for Bituminous Concrete, Report No. 96-003-7490, March 1996.	Richard Weed, Project Manager Henry Justus, Customer
Maintenance Management Re-engineering Study, Report No. 96-006-7170, April 1996.	Vincent Nichnadowicz, Project Manager Rodney Roberson, Customer John Walz, Customer Don Hoffeditz, Booz, Allen & Hamilton* William Thornhill, Booz, Allen & Hamilton*
Evaluation of Highway Runoff Pollution Control Devices, Report No. 96-007-7620, December 1996.	Mark Marsella, Project Manager Tony Sabiddussi, Customer Mike Kaminsky, Customer Taha Marbata, New Jersey Institute of Technology
I-80 HOV Lane Evaluation Study, Report No. 97-004-7290, June 1997.	Mark Marsella, Project Manager at Report Publication Time Bill Mullowney, Early Project Manager* Jim Pirovar, Customer Al Kotchi, Parsons Brinckerhoff*
Asphalt Additives and Rut Resistant Pavements, Report Nos., 97-002-1730 and 97-002-7440, July 1997.	Nick Vitillo, Project Manager Henry Justus, Customer
Evaluation of Materials, Equipment and Procedures for Chemical Use in Anti-Icing, Report No. 96-001-7100, September 1997.	Cary Younger, Project Manager John Raniero, Customer
Conceptual Feasibility Study for Centralized Treatment of Petroleum Contaminated Soil, Report No. 97-007-7060, June 1998	Mark Marsella, Project Manager Bob Lane, Customer Joe Sullivan, New Jersey General Services Administration (formerly), Outsider Customer Bill Librizzi, New Jersey Institute of Technology

*Telephone interviews

Utilization & Communication Patterns

Project	Utilization	Communication Patterns
Evaluation of the Tilt and Absorbing Noise Barriers on I-78 Sections 5M, 5BW, and 5BY in Union County, N.J., Report No. 92-002-7840, October 1991	Short term: Report was a factor in keeping NJDOT from using barrier for about a year. Barrier now used based on customer advocacy and other research.	Customer and project manager disagreed.
Evaluation of Bridge Deck Cathodic Protection, Report No. 93-006-7520, March 1994	Short term: Use after research precluded because of lack of money for maintenance.	Project manager and customer cooperated.
Guide Sign Placement and Highway Environments, Report No. 95-002-7370, August 1995	Partial: Recommendation to trim trees used; to raise signs blocked by bridge parapets not used; 3D models not used at this time but report was a factor in subsequent use of this methodology.	Project manager and customer cooperated.
Development of Air Voids Specification for Bituminous Concrete, Report No. 96-003-7490, March 1996	Used: Research changed acceptance specification and pay schedule.	Project manager and customer cooperated. Industry originally disagreed but came to accept the innovation.
Maintenance Management Re-engineering Study, Report No. 96-006-7170, April 1996	Partial: Customer says research report sparked debate, but the department now intends to enhance off-the-shelf systems rather than to develop one de novo as the report suggests.	Project manager, customer, and outside principal investigators cooperated.
Evaluation of Highway Runoff Pollution Control Devices, Report No. 96-007-7620, December 1996	Used: Customer used this report as literature search section in Best Practices Manual.	Project manager, customer, and outside principal investigators cooperated.
I-80 HOV Lane Evaluation Study, Report No. 97-004-7290, June 1997	Short term: Research was one factor keeping this HOV in operation for a short term. HOV was later disbanded.	Project manager, customer, and outside principal investigator cooperated. Many shifts in project manager. Some shifts in communication.
Asphalt Additives and Rut Resistant Pavements, Reports Nos. 97-002-1730 and 97-002-7440, July 1997	Not used: Gave important information on special asphalt pavement products but these products were no longer in use by the time the report was published.	Project manager and customer cooperated.
Evaluation of Materials, Equipment, and Procedures for Chemical Use in Anti-Icing, Report No. 96-001-7100, September 1997	Partial: Non chloride materials not used at this time because federal regulations do not require it.	Project manager and customer cooperated at end.
Conceptual Feasibility Study for Centralized Treatment of Petroleum Contaminated Soil, Report No. 97-007-7060, June 1998	Not used: Report urged centralized treatment plant but none was used.	Project manager and customer cooperated. Outside principal investigator cooperated but was late with report.