Evaluation of TravInfo™ Field Operational Test

Youngbin Yim

Mark A. Miller

University of California at Berkeley
Institute of Transportation Studies

California PATH Program

April 25, 2000

TRAVINFO™ FIELD OPERATIONAL TEST EVALUATORS

The evaluators, who are members of various institutions, are listed below.

Elizabeth Deakin, University of California Transportation Center, Director

Randolph Hall, University of Southern California Transportation Center, Director

Asad Khattak, **Linda Stalker**, University of North Carolina, Chapel Hill

Ronald Koo, Harvard University

Dimitri Loukakos, California PATH Program, Institute of Transportation Studies, University of California, Berkeley

Mark Miller, California PATH Program, Institute of Transportation Studies, University of California, Berkeley, Deputy Evaluation Project Manager

Brian Peiffle, California PATH Program, Institute of Transportation Studies, University of California, Berkeley

Robert Tam, California PATH Program, Institute of Transportation Studies, University of California, Berkeley

Alex Skabardonis, California PATH Program, Institute of Transportation Studies University of California at Berkeley

Stein Weissenberger, University of California Lawrence Livermore Laboratory

Jean-Luc Ygance, French National Transportation Research Institute (INRETS)

Youngbin Yim, California PATH Program, Institute of Transportation Studies, University of California, Berkeley, Evaluation Project Manager

ACKNOWLEDGEMENTS

The TravInfo™ evaluation was performed by a team of researchers, professionals, and students from several campuses under the management of the California Partners for Advanced Transit and Highways (PATH) Program of the Institute of Transportation Studies at the University of California, Berkeley from July 1993 to June 1999. It was funded by the Federal Highway Administration (FHWA) and the California Department of Transportation (Caltrans). Although the final report was prepared by the authors, credit should also go to those evaluators who contributed individual components, showing dedication and commitment throughout. The evaluators produced over 50 working papers, most of which were presented at annual meetings of the Transportation Research Board, Intelligent Transportation Society of America, World Congress of Intelligent Transport Systems, Society of Engineering Association, Society of Automotive Engineers, Regional Science Association, and the Association of Transportation Research. Most were published in conference proceedings and professional journals and as working papers for the California PATH Program.

The conclusions drawn in this report are the authors' alone and do not reflect the views of the other evaluators who assisted in the creation of individual components.

Early in the evaluation process, an Evaluation Oversight Team comprised of representatives from public agencies, academic institutions, and private organizations was formed. The team members spent many hours and much effort advising the authors and the other evaluators in monthly meetings and reviews of interim evaluation deliverables. Their contribution to the evaluation is significant; the authors wish to acknowledge all members of the team for their support and guidance.

The authors would also like to acknowledge the TravInfo™ project partners, including the members of the Management Board, Steering Committee, and Advisory Committee; the consultants to the Management Board and evaluators; and the Traveler Information Center supervisors and operators for making themselves available for interviews and providing data to the evaluators.

The authors also wish to acknowledge the support and advice they received from the research and professional communities as well as the PATH administration and the PATH technical support group that made the evaluation study possible.

Copies of PATH working papers can be obtained online by going to the following Web site address and clicking on the desired document. It will also be necessary to have Adobe Acrobat Reader 3.0 or greater installed.

http://www.path.berkeley.edu/PATH/Publications/PATH/index.html

Documents may also be obtained by contacting the primary authors, Youngbin Yim and Mark Miller, at the main PATH telephone number (510-231-9494) or by contacting the PATH Publications office (510-231-5601).

The authors would like to give special recognition to the following individuals and organizations.

The Evaluation Oversight Team Members and Supporters
The authors would like to acknowledge members and supporters of the Evaluation Oversight Team for their contributions during the evaluation.

Federal Highway Administration (Funding Agency) - Frank Cechini, Mark Kehrli, Jeff Lindley, Jackie Landsman (formerly of the Federal Highway Administration)

Federal Highway Administration's Review Team - Mitre Corporation, Booz-Allen-Hamilton, Jet Propulsion Laboratory

Caltrans Office of New Technology and Research (Funding Agency) - Pat Conroy (formerly of Caltrans), Elaine Houmani, Cliff Loveland, Bill Tournay, and Shara Lynn Kelsey (formerly of Caltrans)

Metropolitan Transportation Commission (TravInfo™ Management Board, Lead Agency) -Melanie Crotty (TravInfo™ Project Manager), Michael Berman, Jeff Georgevich, Joel Markowitz, Emily VanWagner, and Ann Flemer

Caltrans District 4 (Management Board) - Judy Chen, Jim McCrank, and Douglas Sibley

California Highway Patrol (Management Board) - Mary Ann Marubashi

SRI, Inc. (Technical Advisor to the TravInfo™ project team) - Roy Stehle and Richard Tucker

Metro Networks – Joan Ravier, Dave Henderson (formerly of Metro Networks), Sheila Tucker, Al Rogers, and Bill Carrico

California PATH Program - Joy Dahlgren and Stein Weissenberger (formerly of PATH)

TRW, Inc.

ETAK, Inc. - Larry Sweeney and Craig Lynar

Fastline - Steven Wollenberg, Joel Schwartz

DaimlerChrysler

Academic Community
The authors acknowledge the following professors who provided valuable advice on the evaluation process and inspiration to the evaluators.

University of California at Berkeley - Elizabeth Deakin, William Garrison, Adib Kanafani, Alex Skabardonis, Pravin Varaiya

University of California at Los Angeles - David Wilson

University of California at Davis and Kyoto University, Japan - Riyuchi Kitamura

University of Southern California - Randolph Hall

Claremont Graduate Institute - Tom Horan

University of Monash, Australia - Geoffrey Rose

Consultants to Evaluators
The authors would like to acknowledge those consultants who provided invaluable assistance to the evaluators. GLS Research administered all traveler surveys using the Computer Aided Telephone Interview method; the PMR Group investigated business plans of advanced traveler information systems; Corry Technical Support processed large amounts of evaluation data; and Octel Communications Corporation (subsequently Lucent Technologies) developed the software tool the evaluators used to track usage of the TravInfo™ Traveler Advisory Telephone System.

Administrative and Technical Support
The evaluation of the TravInfo™ Field Operational Test required administrative and technical support. The authors thank Professors Karl Hedrick and Pravin Varaiya, current and former Directors of the California PATH Program, respectively, Steven Shladover, Deputy Director of the California PATH Program, and Pat Conroy, Advanced Transportation Management and Information Systems Group Manager, who supported the evaluation project. Special thanks to Phyllis Orrick and Betsy Wing of the Publications Division of the Institute of Transportation Studies at the University of California at Berkeley who provided invaluable support to the authors in preparing the Final Report.

ABSTRACT

TravInfo™ is a regional traveler information system in the San Francisco Bay Area. It was a Field Operational Test (FOT) over a two-year period from September 1996 to September 1998 with funding from the Federal Highway Administration and the California Department of Transportation (Caltrans). The California PATH Program at the University of California, Berkeley conducted an evaluation of the field test. TravInfo™'s goal was to broadly disseminate accurate, comprehensive, timely, and reliable information on traffic conditions and multi-modal travel options to the public in the Bay Area. Organizationally, it was structured around a commitment to a collaborative partnership between and among public and private participants. Operationally, the system was built on an open-architecture concept to make its regional database easily accessible to all parties interested in disseminating traveler information. TravInfo™'s operational core, the regional Traveler Information Center (TIC), collected and processed information for dissemination directly to the public and to information service providers. It was primarily a manually run operation and so depended heavily on the performance and workload of its staff.

The TravInfo™ evaluation focused on three areas: institutional, technology, and traveler response. The evaluation of the field test was performed using various data sources from field observations, focus group discussions, traveler surveys, and field measurements. The most significant attribute of TravInfo™ was its engendering of public- and private-party partnerships. As a result of TravInfo™, new ideas emerged, new approaches developed, and new partners were solicited, which is in keeping with TravInfo™'s key objective of developing and implementing a regional traveler information system. Traffic system operators learned how to run their systems better, and the private sector gained a better understanding of consumers' purchasing habits and the importance of marketing for its products. The partners learned the value of making firm commitments to collaborative partnerships.

The major challenges of TravInfo™ include setting ambitious goals unattainable within the limited time for the field test, underestimating the time required to develop mutual understanding and trust among parties with varying objectives, underestimating consumer market uncertainty for commercialization of traveler information products and services, having inadequate information about how to put a consumer value on the information being provided, defining appropriate roles for the parties involved, and appreciating the importance of having enough time and funds to market the product and convince people to use it.

TravInfo™ implemented a prototype regional transportation information system to benefit the traveling public and ultimately the Bay Area transportation system. It tested a unique concept of open architecture and collaborative public-private partnership to broadly disseminate traveler information and foster a commercial market for privately offered advanced traveler information services. Despite many challenges, the field test was completed, and TravInfo™ entered a transitional phase to full deployment as an

integral part of the Bay Area transportation infrastructure. The lessons learned from the field test will be of value to the sponsoring agencies and the TravInfo™ partners as well as those public agencies that are interested in implementing similar systems.

Key Words: advanced traveler information systems, field operational test, evaluation, TravInfo™

EXECUTIVE SUMMARY

TravInfo™ is a regional traveler information system in the San Francisco Bay Area. It was a Field Operational Test over a two-year period from September 1996 to September 1998 with funding from the Federal Highway Administration and the California Department of Transportation (Caltrans). The PATH Program in the Institute of Transportation Studies at the University of California, Berkeley conducted an evaluation of the field test, the results of which are documented in this report.

TravInfo™'s goal is to broadly disseminate accurate, comprehensive, timely, and reliable information on traffic conditions and multi-modal travel options to the public in the Bay Area. TravInfo™ differed from other Field Operational Tests at that time in two respects. On an organizational level, it was structured around a commitment to a collaborative partnership between and among public and private participants. Operationally, the system was built on an open-architecture concept in order to make its regional database easily accessible to all parties interested in disseminating traveler information; notably, private information service providers who could then develop commercially marketable traffic information services using TravInfo™'s data. This approach could enable TravInfo™ to reach a broader audience, and thus more travelers would make informed travel decisions, ultimately leading to improved performance of the Bay Area transportation system overall.

The operational core of TravInfo™ is the regional Traveler Information Center, which was created for the Field Operational Test. The center collects and processes traffic information for dissemination directly to the public through the Traveler Advisory Telephone System and to information service providers over TravInfo™'s Landline Data Server for their product testing. During the field test, three private information service providers deployed traffic Web sites in the Bay Area using TravInfo™'s data, and a few dozen others retrieved TravInfo™ data to test a wide range of advanced traveler information products.

The Field Operational Test attempted to measure how well TravInfo™ performed in four major areas: building a regional traveler information system with the collaboration of public and private parties; providing improved travel information to the public; stimulating the creation of a commercial market for advanced traveler information products; and ultimately enhancing the entire Bay Area transportation system. The field test did not evaluate the fourth area for three reasons: the traffic data were insufficiently accurate and reliable to permit any system-wide changes to be measured accurately; there was difficulty in developing a measurement technique sensitive enough to assess TravInfo™'s impact on network performance; and commercial products were not deployed widely enough to have an easily discernible presence and effect

The evaluation of the field test was performed using various data sources from field observations, focus group discussions, a series of telephone surveys with travelers, in-

person interviews with project partners and Traveler Information Center staff, and field measurements. An Evaluation Oversight Team was formed from representatives of public agencies, practitioners, and the academic community to provide advice to the evaluators and serve as a communications link between the evaluators and the project partners.

Institutional Evaluation

TravInfo™'s organizational structure was unique because of the high degree of openness in the public-private partnership. TravInfo™ meetings were conducted as open forums to encourage the entrepreneurial participation of members of the traveler information industry as well as active participation of local public agencies. The ultimate responsibility for TravInfo™, however, lay with the public sector, in the form of the Management Board, whose members came from three Bay Area regional agencies, the Metropolitan Transportation Commission, Caltrans District 4, and the California Highway Patrol's Golden Gate Division. The Metropolitan Transportation Commission served as the lead agency and managed the project during the Field Operational Test. The private sector participated through the Advisory Committee, which was open to all interested parties. During the field test, it evolved into the Information Service Providers Forum. In addition, the Board appointed a 15-member Steering Committee from members of the Advisory Committee to advise it.

The TravInfo™ organization underwent few fundamental changes. The Management Board, Steering Committee, and Advisory Committee/Information Service Provider Forum essentially maintained their roles, though they evolved as the project moved from design to operation. The majority of the initial participants stayed with the project until the field test was completed. The project team had strong leadership from both the public and private partners.

The TravInfo™ organization was effective in appropriately utilizing public- and private-sector talent. By placing the Metropolitan Transportation Commission, which is the Metropolitan Planning Organization for the nine-county Bay Area, in a leadership role, the project recognized the importance of consensus building. TravInfo™ also benefited from having many talented individuals participate.

Perhaps the most significant attribute of the TravInfo™ field test was the creation of partnerships among public and private parties. The project helped foster constructive relationships among the three principal public agencies, and the benefits carried over into other joint ventures. Many of TravInfo™'s private participants went on to form alliances with one another, and their positive experience with TravInfo™ led them to take part in other Field Operational Tests and Model Deployment Initiatives around the U.S.

As was the case with other federally supported Field Operational Tests of this type, the TravInfo partners encountered many institutional challenges. Among them were: different expectations for the project among the partners, which took a long time to reconcile, delays caused by contracting problems with the third-party design of the TravInfo system,

working with an inefficient system while continuing to attempt to meet the goal of the TravInfo Field Operational Test, and heavy reliance on Caltrans' Traffic Operations System, which was never developed on time due to a state executive order temporarily prohibiting sole-source contracts, including the one Caltrans had, for computer-related work.

Technology Evaluation

The Traveler Information Center is operated by a private contractor, with the Metropolitan Transportation Commission overseeing the entire management of the center. It disseminates traveler information in two ways: directly to individual travelers through the interactive Traveler Advisory Telephone System (TATS), a landline telephone system that can be reached by dialing 817-1717 (TTY: 817-1718) from all Bay Area area codes, and to information service providers who have registered to participate in the TravInfo™ project and who tap into the center's database through a modem or telnet connection to TravInfo™'s Landline Data Server.

TATS provides regularly updated information on current traffic conditions, carpooling, highway construction reports, bicycle programs, San Francisco International Airport ground transportation, and a direct connection to the region's more than two dozen public transit and paratransit operators. During emergencies and special events, information is added.

The center operates 24 hours a day, seven days a week. There are three weekday shifts, with the busier morning and afternoon shifts each staffed by four operators and one supervisor and the overnight shift staffed by one operator. During weekends, there are rotating shifts with two operators on duty during the day and one overnight. Two sources of data were fed automatically into the TravInfo™ database: they were data from the inductive loop sensors of Caltrans' Traffic Operations System and data from the Freeway Service Patrol. However, these sources did not provide sufficient geographic data coverage or accuracy, because many of the loop sensors were not performing properly, and the Freeway Service Patrol system's vehicle probes did not produce sufficient coverage and could not produce accurate freeway travel times. As a result, the most significant source of data soon became incident reports of the Computer-Aided Dispatch system from the California Highway Patrol, which require significant interpretation, data entry into the Traveler Information Center's system, and follow-up by the operators. Although the software, overall, allows operators to perform efficiently, the interface has shortcomings and could have been designed to better support them at their tasks.

Because of the manual nature of the TravInfo™ system, the operators' response time is critical to how well the center meets its goal of timely, comprehensive, and reliable dissemination of traveler information. During the field test, it took an average of 10 to 11 minutes to process an incident from the Highway Patrol's Computer-Aided Dispatch system and enter it into the Traveler Advisory Telephone System. Approximately 20% of the total number of incoming Computer-Aided Dispatch incidents were entered.

Operators' job performance and their workloads were the two primary factors influencing the number of incidents they entered into the system and the time required to do so. Numerous operator work activities affect operators' response times, though it was difficult to isolate these activities and quantify their individual contributions to operators' response times. Nevertheless, examining them helps provide a fuller context within which response times can be assessed. These activities included attempts to verify an incident, disruptions caused by operators' shift changes, calls into the phone advisory system for quality-control purposes, updates of an incident already entered into the system, and searches for redundant listings or listings of incidents that do not delay traffic flow. Other factors such as the number and type of incidents reported by the California Highway Patrol, the operator's level of experience, the rate at which incidents arrived, and system software and hardware problems played only a minor role in influencing response times.

The physical environment of the Traveler Information Center proved to be acceptable, and operator performance was not directly related to working conditions. Overall, competent staff was employed at the center, and management oversight measures were taken to monitor performance. Moreover, the center's staff worked to resolve problems and developed good working relationships with outside contractors.

Relying on operators to perform TravInfo™ tasks proved time-consuming, especially in the transfer of incident data from the Computer-Aided Dispatch system's terminal to the center's system, and from the center's system to the telephone advisory system. Automating the data entry process, which was part of the system's original specifications, could speed operators' response times and increase the number of incidents they could process, although it is likely that operators would still need to intervene in the interpretation of some incident reports.

By the end of the field test, over 50 information service providers registered with TravInfo™. Of that group, 90% were in the private sector. They ranged from local Bay Area firms to large international corporations. Approximately 30 of the private firms retrieved TravInfo™ data intermittently; three were continuous users throughout the field test. The firms joined the TravInfo™ project because they were interested in deploying traveler information through wireless services, including cellular phones, FM subcarriers and paging; through in-vehicle navigation devices; through portable and hand-held personal computers; through Web pages and Internet-based personalized profiling and alerting services; through interactive broadcast and cable TV; through telephone-based information services; and through kiosks.

The TravInfo™ field test was effective in eliciting participation from information service providers and resolving issues concerning the public sector's potential competition with the private sector. However, providers remained unconvinced of the business opportunities for advanced traveler information services in the current marketplace. An often-expressed belief was that advanced traveler information would not be commercialized for at least the next three to four years, especially as long as travelers can obtain information for free from other sources such as radio and television. However,

some providers believed that personalized traveler information bundled with other real-time information services could find a market niche among long-distance commuters and high-mileage drivers.

They also believed that TravInfo™'s centralized regional database offers advantages to both the public and private partners, because it helps prevent duplication of data collection and expedites the exchange of data among a large number of public agencies. It also offers an open and level playing field for commercial developers and simplifies the private sector's access to public data. Despite those considerable advantages, in the final analysis, providers found that TravInfo™'s data did not cover a substantial enough portion of the Bay Area's transportation system for them to use it to actively develop and test their products. Many providers expressed the desire to wait until adequate data became available before investing in the industry. In addition, some providers were also interested in rolling out products nationally and without tailoring them to specific local markets.

Traveler Response Evaluation

Commercial radio reports were the primary source of traffic and transit information in the Bay Area. One-third of Bay Area households listened to radio traffic reports on a regular basis, and an additional one-third listened occasionally when a traffic problem was expected. The remaining one-third did not listen to traffic reports at all. Since radio traffic reports cover freeways primarily, and about half of the commuters use freeways, the majority of the listeners were freeway travelers. According to the household survey conducted in 1998, the impact of radio or television reports on the entire traveling population including non-listeners is approximately 12%. People modified their travel behavior, mostly by leaving earlier or taking alternate routes. Very few people chose public transit such as bus, rail, or carpool, because they perceived it to be inconvenient and more time-consuming than driving alone, even with congestion.

The surveys also showed that the vast majority of Bay Area households were not aware of the TravInfo™ Traveler Advisory Telephone service or traffic Web sites. Of the 9% of Bay Area households that were aware of TravInfo™, very few had actually tried it because the respondents did not remember the telephone number. This was reflected in the monthly call volumes, which ranged between 50,000 and 65,000. The volumes remained consistent during the field test except on two occasions, the BART (Bay Area Rapid Transit) strike in September 1997 and the floods in February 1998, when volumes rose significantly, but temporarily. Although the precise number of Web site visitors was not available, the providers estimated that monthly visitors numbered approximately 15,000 toward the end of the field test without having an organized ad campaign.

Among those who did use the TravInfo™ telephone service or Web sites, their satisfaction level was consistently high; they rated the quality of the information to be far superior to radio or television reports and perceived it to be useful in their trip planning. Because of this, over 80% were repeat users.

Initially, fewer than 1% of the TravInfo™ callers asked to be rerouted to the transit menu after learning about bad traffic conditions from the traffic menu. However, the second survey, conducted after the field test, showed that 5% of the callers were rerouted to the transit menu, a significant increase, and 90% of them switched to transit. The field measurement of call volumes confirmed this increase. While this is a significant increase in call rerouting and modal shift, generalizations cannot be made using these figures because the sample size of this group in both surveys is fairly small, and the traffic call volume is relatively smaller than the transit call volume. Some inferences can be drawn, but they need to be tested and verified. The increase in call re-routing requests may be due to the fact that repeat users of the traffic menu became gradually aware of the convenience of getting to the transit menu to learn about the availability of transit for their trip, and once they obtained transit information they were willing to try it. Although transit and traffic information services deal with distinctly different markets, the majority of the callers liked the easy access to all travel-related information via a single telephone number.

TravInfo™ was able to capture those who never listened to radio or television reports; it also led people to substitute TravInfo™ telephone advice or Web sites for radio or television reports and to seek out more information. One-third of phone callers and one-third of Web site visitors switched to TravInfo™ from radio or television reports; most of those who switched were long-distance commuters and high mileage drivers. Many of the new consumers of the TravInfo™ telephone service were cellular phone users: 31% of calls came from cellular phones in the beginning of the field test, and this number increased to 41.8% after it ended.

Although TravInfo™'s short-term effect on the overall transportation system appears to have been marginal, TravInfo™ was able to influence travel behavior far more effectively than radio or television traffic broadcasts. Twenty-five percent of those who obtained relevant information from radio or television changed their travel behavior, while nearly twice as many of the TravInfo™ callers , 45%, and more than three times as many of the Web site visitors, 81%, reported to have altered their trips after obtaining information specifically on their routes.

Many investors believed that in-vehicle computers would have the potential to capture a large number of subscribers for traveler information. As the technology takes off, firms will continue to expand in the areas of product testing, marketing, and distribution. The commitment of the TravInfo™ partners can contribute to an improved traffic management system over time, as well as the dissemination of timely and accurate information to travelers through the telephone advisory service and even personalized information through information service providers' products. Only when TravInfo™ is widely deployed can its ultimate benefits to users, information service providers, and the overall transportation network be accurately measured and understood.

Lessons Learned

From the institutional point of view, it was necessary to adjust the public and private partners' differing expectations for TravInfo™ in order to work toward the common goal of disseminating accurate, reliable, timely, and multi-modal information to Bay Area travelers. The public partners expected to make TravInfo™ available for better congestion management, while the private partners expected to test and market products that would make a profit. It took a long time to reconcile their differing objectives. In addition, the field test's goals were too ambitious and unrealistic to achieve within the allotted time. Although TravInfo™'s organization was effective, the consensus-based partnership caused TravInfo™ to be slow at making critical decisions. While productive at some levels, the project approach during the field test was not flexible enough to quickly respond to obstacles that arose unexpectedly, such as the delays in the development of Caltrans' Traffic Operations System due to the state executive order and the consultant's delivery of a system not fully compliant with design specifications. In the planning phase, the TravInfo™ project relied on the best-case scenario for both system design and implementation. It did not consider worst-case scenarios to develop possible alternative courses of action. Such risk assessment strategies and contingency planning are vital to moderate the potentially negative consequences of unforeseen events. However, the project team was wise to respond to the situation by retaining an expert who could advise it on all facets of technical and management issues.

The TravInfo™ system is not as efficient as originally envisioned because of its heavier-than-expected dependence on the manual performance of jobs by the Traveler Information Center operators. That in turn makes it necessary to employ significant measures to ensure the quality of operators' performance. TravInfo™ needs an automated system that is flexible enough to keep up with rapidly advancing technologies, which will likely require its system components to be enhanced and upgraded. As the system becomes more automated, the organizational structure, which was top-heavy during the field test, can be streamlined since there would be less need to supervise operators and conduct such heavy quality-control monitoring.

The sustainability of TravInfo™ beyond the field test was critical to the private partners, because their products rely on the availability of the public data that TravInfo™ supplies. Public support after the field test was necessary to encourage organized consumer research, which is crucial to deploying TravInfo™ through private-sector products and services. At the same time, TravInfo™'s public partners need to be better informed about the private sector's consumer research findings in order to continue their collaboration and supply data in a form and amount that is usable by private parties.

Both the public and private partners learned that effective marketing was essential for the TravInfo™ project. A more substantial advertising budget was necessary to promote public awareness of TravInfo™. Marketing consultants were retained to assist the TravInfo™ project team in designing a marketing plan, using advertisements on commercial radio, billboards, and other media. The TravInfo™ telephone service was

advertised over a consecutive three-month period early in the field test. The partners, however, found that the one-time ad campaign was not effective in increasing the call volume of the TravInfo™ telephone service. To promote public awareness of the TravInfo™ service, it was necessary to have a comprehensive and organized marketing plan with expert guidance for an aggressive, consistent ad campaign. Information service providers also recognized that an organized marketing campaign for their Web sites, in some cases, would have induced more people to use their services. As a result, TravInfo™'s potential was not fully realized. The high level of user-satisfaction with the TravInfo™ telephone system and participating traffic Web sites implies that people would use TravInfo™'s services if they were aware of them and had a chance to try them. The vast majority of traffic information seekers who used the TravInfo™ telephone system and Web sites were repeat users. As public awareness of TravInfo™ improves through better marketing, more people should come to understand the benefits of calling TravInfo™ or visiting traffic Web sites.

Perhaps the greatest value of the TravInfo™ field test comes from sharing the experiences from it with others. Since it was the first to test the concepts of open architecture and open partnership, it has a wealth of findings. The partners gained knowledge of building successful partnerships through, among other things, better understanding of different points of view and objectives, and improved communication. In addition, many TravInfo™ private partners were actively involved in tests and model deployments of advanced information systems in other parts of the country, which brought invaluable experience to the TravInfo™ project. At the same time, their role in TravInfo™ gave them national recognition. At this juncture, new partners could bring a different perspective to TravInfo™.

Regular meetings with the Evaluation Oversight Team were valuable. The evaluation plan was a living document and underwent changes over time. As the project evolved, revisions were necessary and were made, rather than maintaining strict adherence to the original approach. The evaluation plan needed to be flexible enough to adapt to the evolving nature of a field test. For a proper assessment of the TravInfo™ project's performance, adequate data coverage on large portions of the transportation network is necessary. In addition, there is a need for basic and applied research on how realistic evaluation studies might be conducted, including the assessment of the long-term impact of traveler information on travel behavior and its consequential effects on the overall transportation system.

Recommendations

The TravInfo™ evaluation's recommendations, numbered 1 and 2 apply to field tests of other systems and similar projects in other regions, and recommendations 3 through 10 apply to TravInfo™ as it extends its operation beyond the field test phase.

1. Allow more time for start-up tasks and pre-planning including administrative procedures and task management plans.

2. Develop a risk-management plan early in the planning process to deal with unforeseen challenges and to ensure consultants' compliance with project specifications.

3. Continue to have the three public agencies that were responsible for the field test collaboratively manage and operate the TravInfo™ system, thereby allowing seamless transition from the field test to system implementation. Such a regional partnership will provide a strong organizational foundation and incentives to other public agencies and the information industry to participate in the deployment of TravInfo™.

4. Continue to seek public funding to support TravInfo™ operations as a public service while providing support to information service providers for development, testing, and deployment of their value-added products or services.

5. Conduct organized consumer research for a better understanding of the Bay Area market, and implement aggressive marketing strategies to increase public awareness of TravInfo™ and its privately offered products.

6. Improve the quality and geographic coverage of traffic data, and continue to support research on and development of surveillance technologies.

7. Develop a comprehensive outreach program for public and private parties to actively participate in deployment of a regional advanced traveler information system.

8. Encourage debate and discussion of topics of interest to information service providers, including the need for sustained public-sector support of private-sector commitments to invest in development of commercial applications, offering databases in ways that encourage market growth at the appropriate level, be it regional or national, monitoring system changes with an eye to ensuring the regional system's compatibility with national architecture for database interfaces, and setting up a clear and mutually acceptable division of roles between the public and private sectors.

9. Improve the TravInfo™ operating system to the level of efficiency and automation that was originally intended, and investigate the feasibility of redesigning the interface that operators work with to enter and process incident data.

10. Investigate new strategies to improve the quality and timeliness of data dissemination in the Traveler Information Center, and if the system is to be manually operated in the future, carry out further assessment of operator response time to identify the significance of operator performance and operator workload so that appropriate remedies can be pursued.

Conclusions

The TravInfo™ field test provided a strong regional stewardship for an infant program and in the process pioneered a unique, open public-private partnership dedicated to a regional system built on the same philosophical commitment to openness through its open architecture. The experience benefited the Bay Area as a whole, both through an improved transportation system and the presence of a new, institutional collaboration. The private sector benefited from having a venue in which to test advanced information products.

TravInfo™'s primary successes lay in developing a network of public and private professionals who collaborated on advanced traveler information system projects in a variety of settings and providing a platform for different organizations to create networks and form partnerships. These networks and partnerships are the most significant and unique outcome of the field test and promise to result in many innovative traveler information services and products beyond the telephone or Web site services.

The long-term benefits of TravInfo™ will be of more value to the partners than the short-term benefits of the field test. New ideas have emerged, new approaches developed, and new partners solicited, which is in keeping with TravInfo™'s key objective of developing and implementing a regional traveler information system. Through the field test, traffic system operators learned how to run their systems better, and information service providers gained a better understanding of consumers' purchasing habits and the importance of marketing for their products. Beyond the economics of the information system, the partners learned the value of making firm commitments to collaborative partnerships.

Finally, the major challenges of the TravInfo™ Field Operational Test were notably similar to those of other Field Operational Tests. Among them were setting ambitious project goals that were unattainable within the limited time reserved for the field test; underestimating the extensive time required to develop mutual understanding and trust among parties with varying objectives; underestimating the uncertainty of the consumer market for commercialization of traveler information products and services; having inadequate information about how to put a consumer value on the information being provided; defining appropriate roles for the parties involved; and appreciating the importance of having enough time and funds to market the product and convince people to use it.

In sum, the TravInfo™ Field Operational Test implemented a prototype regional transportation information system to benefit the traveling public and ultimately the Bay Area transportation system. It tested a unique concept of open architecture and collaborative public-private partnership to broadly disseminate traveler information and foster a commercial market for privately offered advanced traveler information services. Despite many challenges, the field test was completed, and at its conclusion TravInfo™ entered a transitional phase to full deployment as an integral part of the Bay Area transportation infrastructure. The lessons learned from the field test will be of value to the

sponsoring agencies and the TravInfo™ partners as well as those public agencies that are interested in implementing similar systems.

TABLE OF CONTENTS

Chapter 1
INTRODUCTION

TravInfo™ is a regional traveler information system in the San Francisco Bay Area. Its goal is to broadly disseminate accurate, comprehensive, timely, and reliable information about traffic and multi-modal travel options to the public. The TravInfo™ Field Operational Test officially ran from September 1996 to September 1998 to provide benefits to the public and the Bay Area transportation system. At its conclusion, TravInfo™ entered a transitional phase to full deployment as an integral part of the Bay Area transportation infrastructure (1).

TravInfo™ differed from other traveler information systems being tested at that time in two respects (2). On an organizational level, it was structured around a commitment to vigorous, collaborative partnerships among public and private participants[1]. Operationally, the system was created using a unique concept of "open" architecture, which makes its database easily accessible to all information service providers. They could tap into TravInfo™ data and create commercially marketable travel information services; hence, they could reach a broader audience than public agencies typically have the means to do.

A fundamental premise of the TravInfo™ project was that stimulating the private sector to invest in and develop advanced traveler information systems would lead to their wider use by the traveling public through a variety of devices, including personal computers, cellular phones, personal digital assistants, digital watches, and in-vehicle navigation devices. It was hoped that as more travelers used the data to select appropriate modes, routes, and departure times, the overall Bay Area transportation system would become more efficient. The test location encompassed nine counties with a population of approximately six and half million people and a diverse, multi-modal transportation network traveled by single-occupancy vehicles, high-occupancy vehicles such as vanpools and buses, other motorized vehicles and bicycles, as well as light rail, rapid rail, commuter rail, cable cars, and ferries.

As part of the TravInfo™ Field Operational Test, a regional Traveler Information Center was created. Since September 1996, the center has been disseminating traveler information to the public through the Traveler Advisory Telephone System and to information service providers through the Landline Data Server. During the Field Operational Test, three information vendors rely exclusively on TravInfo™ to disseminate traveler information through traffic Web sites. TravInfo™ received public funding for an additional five years beyond the end of the field test from the Transportation Equity Act for the 21st Century along with local matches.

The TravInfo™ Field Operational Test was concerned with how well TravInfo™ performed in four major areas: building a regional traveler information system with collaboration between and among public and private partners; providing improved travel

information to the public; stimulating the creation of a commercial market for advanced traveler information products; and ultimately enhancing the entire Bay Area transportation system.

Accordingly, this evaluation was intended to examine the effectiveness of the institutional relationships among the public- and private-sector partners; the level of maturity of the technologies needed to execute TravInfo™'s goal of disseminating accurate, timely, and reliable traveler information in a useful format; travelers' receptiveness to and the market demand for different kinds of advanced information-based products; and TravInfo™'s influence on the Bay Area transportation system (3, 4). The last element could not be evaluated because travel-time data on major freeways were not available, and commercial products were not widely deployed at the time of the field test.

The evaluation was conducted by the California PATH Program in the Institute of Transportation Studies at the University of California, Berkeley and funded by the Federal Highway Administration (FHWA) and the California Department of Transportation (Caltrans), whose Office of New Technology and Research provided a matching grant. Its primary goal was to ascertain the usefulness of an advanced traveler information system of this type and to document the history of TravInfo™ in a way that could be shared with other state and local transportation agencies. Although the evaluation was done independently of the TravInfo™ project, the evaluators did provide interim findings of the evaluation to allow the project partners to make mid-course modifications and corrections as appropriate.

Evaluators used field observations, focus group discussions, in-person interviews, and mail-back surveys to assess the effectiveness of the institutional side of the TravInfo™ project. To evaluate the technological aspects, they examined the workings of the Traveler Information Center, which was the key data exchange point between the public- and private-sector participants. Evaluators took field measurements and interviewed operations staff on the public side and talked to the private vendors that distributed the center's data to the traveling public. Bay Area households and selected groups of travelers were surveyed to understand the extent to which traffic or public transit information influences their travel behavior. User surveys were conducted to measure travelers' receptiveness to and interest in TravInfo™'s information services.

An Evaluation Oversight Team was formed early in the process to serve as a liaison between the PATH evaluators and the TravInfo™ project partners and to receive monthly reports on the progress of the evaluation. The oversight group was comprised of representatives from public agencies and transportation practitioners and academics from various institutions. It was chaired by a representative of the Federal Highway Administration and convened once a month.

This is the first of eight chapters. Chapter 2 provides general background. The evaluation of the institutional relationships is presented in Chapter 3, followed by the technology evaluation in Chapter 4 and the evaluation of how travelers responded to TravInfo™ in

Chapter 5. These three evaluations are synthesized in Chapter 6, which examines the lessons learned. Recommendations based on these lessons are offered in Chapter 7, and, finally, conclusions are drawn in Chapter 8.

Chapter 2
BACKGROUND

TravInfo™ was conceived in 1992 during a period of large-scale, federally funded field tests of advanced traveler information systems that communicated to travelers exclusively through intelligent navigation products.[2] The major projects at the time shared the feature that federal funds would be used to finance the distribution and testing of in-vehicle navigation products within a "closed" system. Within these systems, traffic surveillance data would only be broadcast to the devices provided by the project.

While a closed architecture offered considerable advantages from the standpoint of a product test, it was also clear that the public sector could not possibly sustain the costs of distributing navigation products. Instead, a philosophy that traveler information might be disseminated through an open-architecture system arose; hence, any company could sell products that tapped into a real-time transportation database through a standardized interface. The assumption was that the open-architecture system would stimulate growth in the traveler information industry, and that a proliferation of traveler information products would result in improved transportation conditions (e.g., reduced congestion and air pollution).

TravInfo™ was conceived by a group of individuals from public and private organizations in the Bay Area. With active support from the region's Metropolitan Planning Organization (MPO), public agencies involved in deploying intelligent transportation systems throughout California and members of the burgeoning intelligent transportation system industry (especially those that worked with map databases), the group saw the opportunity to stimulate the industry and sought to realize the potential benefits of an open-architecture system. Among the original participants were the Metropolitan Transportation Commission (the MPO), the California Department of Transportation (Caltrans), the California Highway Patrol, the University of California PATH Program, ETAK, SRI, Inc., and local government public works departments.

TravInfo™ was initially to serve as the integrator of information, which would come from diverse data sources (primarily public agencies), and be made available to various entities (primarily private) for dissemination. The data could be retrieved by three different means: travelers could use a "baseline" automated telephone information system; information service providers could tap data from a landline data server; and service providers and the public could collect information from a wireless data broadcast system. (The data broadcast system was never developed - See Chapter 3: Institutional Evaluation.) TravInfo™ itself would not create the information products that tapped into the database; that would be the responsibility of the private partners. Likewise, TravInfo™ would not be responsible for data collection; that would be carried out by various public and private participants.

The essential contribution of TravInfo™ was to centralize and "fuse" data sources and to provide standardized access. Public agency participants viewed this as advantageous

since they would not need to provide data to large numbers of information service providers - they would only have to provide it to TravInfo™. Private participants also viewed this as advantageous since they would not have to go to multiple sources to obtain data; furthermore, interfaces would be improved and standardized. The wireless data broadcast system could also free them from the cost of developing their own wireless systems, allowing them to specialize in products rather than communication. There was also some hope that a project of this sort might lead to national interoperability, further stimulating a consumer market for advanced traveler information. Finally, compared to the other field test projects of the time, TravInfo™ as proposed was to be lean and cost-efficient on the strength of a highly automated system, and would not require huge public subsidies for development of end-user products.

TravInfo™'s goals were to implement a system to collect, integrate, and broadly disseminate timely and accurate traveler information throughout the Bay Area; stimulate and support the deployment of a variety of advanced traveler information systems by creating a competitive market with products covering a range of prices and capabilities; evaluate the effects of TravInfo™ on a broad array of issues, including entrepreneurial response to improved travel information, changes in individual travel behavior, and the impact on the transportation system's overall performance; and test the value and effectiveness of a public-private partnership.

The baseline system was planned to include integrated geographic references; traffic operations information and public transit information databases, with data coming from the California Highway Patrol, Caltrans and other local agencies; an interactive traveler advisory telephone system; a system for broadcasting real-time traveler information on a regional basis by FM radio sideband or similar techniques; and, to the greatest extent practical and feasible, data integration methods that automated and lightened operator burden.

TravInfo™ Organization and Management Philosophy

The organizational structure of the Field Operational Test was unique, because of the high degree of openness that was practiced by the public-private partnership. TravInfo™ meetings were conducted as open forums as part of the philosophical commitment to casting as wide a net as possible in order to encourage entrepreneurial activity in the advanced traveler information system industry.

The ultimate responsibility for TravInfo™, however, lay with the public sector, in the form of the Management Board, whose members came from the three regional transportation agencies, the Metropolitan Transportation Commission, Caltrans District 4, and the California Highway Patrol's Golden Gate Division. The Metropolitan Transportation Commission was the lead agency.

The private sector participated through the Advisory Committee, which the Board set up and opened to all interested parties, and the Advisory Committee's 15-member Steering

Committee, the majority of whose Board-appointed members came from the private sector. The Advisory Committee and its Steering Committee had no direct authority to set policy but were active advisers to the Board. By the start of the field test, the Advisory Committee had evolved into the Information Service Providers Forum, which was still guided by the Steering Committee.

The Management Board set policy for all TravInfo™ field test activities, reviewing and approving procedures for how the test was conducted, registering information service providers, and giving them access to the databases. In addition, the Board investigated alternative methods for collecting data and installed additional traffic surveillance devices. It also devised the plan for deploying TravInfo™ and coordinated public agencies' policies around advanced traveler information systems. The Board retained consultants to develop and market the TravInfo™ Traveler Advisory Telephone System and to operate the Traveler Information Center. It also retained an expert to provide technical advice to the project team.

Day-to-day supervision of TravInfo™ fell to a full-time project manager, who operated under the policy direction of the Board. During the field test, the Board oversaw the operation of the TravInfo™ Traveler Information Center and the phone advisory system, while the project manager supervised consultants and directed the installation and operation of TravInfo™ overall, acting as liaison to the Advisory Committee and making progress reports to the Board.

The Management Board met monthly until the end of the field test. The Steering Committee met monthly until the TravInfo™ Traveler Information Center began operation in September 1996, when it scaled back to every two or three months for the duration of the field test. The Advisory Committee/Information Service Provider Forum met every three months.

Chapter 3
INSTITUTIONAL EVALUATION

One objective of TravInfo™ 's field test was to evaluate the open public-private partnership that faced the challenging goal of implementing the first major regional advanced traveler information system whose data would be accessible to and usable by all public or private participants. Achieving that objective rested heavily on the success of the collaboration of the public and private participants, which makes the evaluation of their relationship central to the measurement of TravInfo™'s performance (5, 6, 7).

During the six years from TravInfo™'s inception in 1992 to the completion of the field test in 1998, the institutional character of TravInfo™ went through several distinct phases that are detailed in the discussion that follows.

October 1992 - September 1994:
Division of Responsibilities between Public and Private Sectors

In 1992, TravInfo™ was selected as a federally funded field operational test. The Management Board, made up of representatives from the three regional transportation agencies — the Metropolitan Transportation Commission, Caltrans' District 4, and the California Highway Patrol's Golden Gate Division — began meeting at the end of that year. Initially, the Board focused on signing its cooperative agreement with the Federal Highway Administration. Central concerns were organizing the project team from the public-sector participants and setting up the Advisory Committee in which the private sector, along with public agencies not necessarily represented on the Management Board, would have a voice. It began meeting in April of 1993. In June, the cooperative agreement between Caltrans and the Metropolitan Transportation Commission was signed to disburse federal funds to the metropolitan planning organization through the state agency.

At first, the Advisory Committee was viewed as a self-organizing body, which would have a strong role in defining its mission and selecting its leaders. Under this premise, the first Advisory Committee meeting was attended by over 200 people representing a wide range of private companies and public agencies. Because the sheer number of participants made its operation unwieldy, the Advisory Committee soon centered on its Steering Committee, whose 15 members were appointed by the Management Board. The Steering Committee in turn set up a series of working groups to better focus members' efforts.

In the summer of 1993, the Board retained a private consultant to design a regional traveler information system to be operated from the Traveler Information Center, through which data would be disseminated to the public and information service providers. Around the same time, the Steering Committee delegated tasks to various working groups, whose assignments included developing an outreach program for private-sector participants, assessing the state of advanced traveler information system technologies, and working closely with the consultant on the design of the traveler information system. The

working groups reported back to the Steering Committee with their recommendations to the Management Board. It stepped in to resolve some technical issues that were raised around the design of the system.

The December 1993 meeting of the Steering Committee marked a turning point in the institutional relations between the public and private participants. The private partners expressed the concern that TravInfo™ might take business away from them, rather than give them more opportunities. Their concern was that private services would be squeezed out if TravInfo™ pre-processed data to the point where private companies could add little value and then made the data widely available through means such as the wireless data broadcasting system, direct modem links to individuals and a personalized automated phone reporting system. As a result, the Management Board excluded the wireless system from the TravInfo™ design and agreed not to provide any transportation data directly to the public, other than through the 817-1717 telephone system. This agreement was an essential feature of the TravInfo™ field test that was intended to allow the private-sector participants to develop products without fear of public-sector competition (5).

October 1994 - April 1995:
Issues about the Usability of the Traffic Surveillance Data

TravInfo™'s original plan was to integrate traffic surveillance data from Caltrans' Traffic Operations System into the Traveler Information Center's database. The Traffic Operations System's data generated from inductive loop detectors were to be the major data source for TravInfo™. Under development since 1990, the Traffic Operations System was expected to be fully operational and able to support TravInfo™ by the end of 1994. In October of that year, in response to problems with a computer system at the Department of Motor Vehicles, a California state executive order was issued to temporarily prohibit sole-source contracts for computer-system development throughout state government, which put a halt to further development of the Traffic Operations System (6).

The executive order marked a major turning point for TravInfo™. Its most immediate effect was to delay the TravInfo™ schedule considerably. Over the longer term, the order forced the Board to work with an already deployed system of inductive loop detectors covering 250 miles of freeway versus the 500 originally envisioned. To wait for the full-scale surveillance system to be deployed would have pushed the start of the field test beyond a date acceptable to the Federal Highway Administration. Caltrans agreed to transfer to the Metropolitan Transportation Commission the funds that were to have been used to build the full-scale Traffic Operations System. The Commission, as TravInfo™'s lead agency, agreed to develop an Interim Freeway Surveillance System, as the reduced Traffic Operations System was known, which it would eventually turn over to Caltrans for maintenance and operation. (This was done in early 1996.)

The interim system processed inductive loop data from field devices and put them in a format that could be entered into the TravInfo™ database. Additional data included

incident data from the California Highway Patrol's Computer-Aided Dispatch system and the Freeway Service Patrol's probe vehicles. The project partners envisioned that the full-scale Traffic Operations System would also incorporate information from closed-circuit television cameras, ramp meters, and Caltrans' regional transportation management center, making it a comprehensive traffic management and information tool.

May 1995 - August 1996:
Contract Compliance

By May 1995, the contractual issues of the Traffic Operations System had been resolved, as had most of the major system-design issues. The focus was on completing the system design and starting operation for field testing. The system-design consultant delivered a detailed scope of work and a schedule and budget that anticipated the start of formal operation to be in August. For a variety of reasons, including unwarrantedly optimistic estimates by the consultant and delays with the Traffic Operations System, by July, the consultant's expenditures had far exceeded the estimated internal budget. Consequently, the consultant found that designing traveler information systems was not a business opportunity over the near term and scaled back work on the project. These events were a major setback.

The system-design consultant continued to develop software for the TravInfo™ system. In the meantime, in January 1996, the Board retained a private firm to operate the Traveler Information Center. In April 1996, acceptance testing began, before a formal test plan was approved. During testing, the Board realized that the consultant's system did not meet project specifications. Instead of the system being automated, it was dependent primarily on manual operation. Despite evidence of significant problems with the system, the consultant requested on-the-spot acceptance. The Board resisted, which led to protracted negotiations between the two sides. In August, a year later than anticipated, the Board granted conditional acceptance for the system, though acceptance testing continued for three months after start of the field test in September 1996. Another issue was the ownership of the intellectual property rights to the TravInfo™ software, which was resolved with an amendment to the original contract formalizing the intellectual property agreement; it gave the Board all rights for the use and improvement of the system and granted ownership to the consultant who designed it.

These setbacks placed the project 28 months behind the proposed date when baseline operation of the TravInfo™ Traveler Information Center was to have begun. Design and implementation lasted 35 months, 19 months longer than originally proposed to the Federal Highway Administration.

During this period, contracts for operating the Traveler Information Center and marketing TravInfo™ were executed, and the Traveler Advisory Telephone System was completed. The Steering Committee became less active, but still maintained a strong presence. The Management Board kept the Steering Committee fully apprised of contractual issues, though negotiations were done by Board staff. At this time, the Board also set up

registration requirements for participating service providers, who were to furnish information about product development and testing in exchange for access to the database.

September 1996 - September 1998: TravInfo™ Operation and the Field Operational Test

The delay associated with trying to develop a full-scale Traffic Operations System spurred two significant shifts in the TravInfo™ partnership. First, the Management Board became more prominent in setting project direction. Until then, the Steering Committee's advice significantly influenced the Board's decisions, but the problems with the Traffic Operations System were clearly beyond the scope of the Steering Committee. Second, it caused a strategic shift in TravInfo™'s role, from merely integrating data from existing sources to actually collecting data, a role that TravInfo™ continues to play.

The TravInfo™ field test officially began operation in September 1996 and ended in September 1998. In the early phase of the TravInfo™ field test, the dominant issues were determining whether a second site would be created to test interoperability, resolving contractual issues with the Traveler Information Center system-design consultant to get access to source code to enable the system to be maintained, and enhancing the traffic surveillance system. The Board decided not to build the second test site. The original system design consultant continued to provide maintenance of the Traveler Information Center system by making a software engineer available as a TravInfo™ in-house consultant to maintain and improve it. The Management Board continued to work on enhancing the traffic surveillance system.

After accepting the TravInfo™ system from the design consultant, the Board discovered that the data generated from the Interim Surveillance System's loop detectors were not reliable because of multiple technical problems associated with the hardware, software, communications network, and wiring. That in turn compromised the ability of the Traveler Information Center to make full reports of traffic conditions. In addition, technical problems as well as contractual issues kept the Traveler Information Center's database from having an automated link to the Highway Patrol's Computer-Aided Dispatch data, a major source of traffic information since the Traffic Operations System was not fully functioning. In addition, the advertising campaign for the Traveler Advisory Telephone System, a primary mechanism for making the public aware of TravInfo™, proved to be severely under-funded and, thus, ineffective.

In September 1997, the loop detector problems were assigned to a working group consisting of Caltrans, the Metropolitan Transportation Commission, the Traveler Information Center's operations consultant, and some Steering Committee members. Although the group worked diligently for many months, no significant improvement was made. In an attempt to fill the gaps in surveillance data caused by these shortcomings, the Board retained a consultant to install 20 microwave radar surveillance units at locations critical to TravInfo™. They were equipped with wireless modems to send data to the

Traveler Information Center. The Board also hoped to convert existing call boxes into "smart" ones that could also feed data to the Traveler Information Center. However the microwave radar devices were incompatible with the interim surveillance system and suffered from malfunctioning power supplies that required redesign and reinstallation.

These operational problems consumed much of the attention of the Management Board and Steering Committee. Other areas they addressed were improving various aspects of the surveillance system and the performance of the Traveler Information Center and exploring TravInfo™'s interoperability with other public projects with an eye to its eventual full deployment.

From early 1998 to June of that year, a working group met regularly to develop a deployment plan. It was adopted by both the Board and the Steering Committee in July 1998, with a recommendation by the Board that TravInfo™ continue to operate after the end of the field test as a "public good." Both the Board and Steering Committee recognized the valuable service TravInfo™ has provided to the public.

In September, the Board and Steering Committee adopted a statement of principles to guide TravInfo™'s operation beyond the field test. An Executive Board, with the same voting members as the Management Board, was created to address broader policy questions, while the lead agency, the Metropolitan Transportation Commission, would focus on administrative details. The Steering Committee would be reorganized composed of those private and public institutions that were interested in participating in the deployment phase of the TravInfo™ project.

Recognizing that TravInfo™'s data were not comprehensive or accurate enough to be useful to most commercial information providers, the Board recommended that TravInfo™ be operated as a public service on an "as is" basis for another nine to 18 months, continuing to disseminate data and participating in the development of a statewide asset management plan. The Board decided to apply for public funding through the region's mainstream mechanisms rather than seek either dedicated federal intelligent transportation system funding or private-sector contributions.

The Board would use those nine months to develop a strategic plan and resolve key issues about TravInfo™'s future. It hoped to determine what data should be available about key congested corridors and how TravInfo™'s operating system could be made to produce output that was more attractive to information service providers. Although the commercial market for advanced traveler information systems had not matured as expected, the Board decided to continue to provide public support to foster a regional market and pursue other ways TravInfo™'s travel information could be disseminated through such devices and products. The Board would also develop performance measures to evaluate the deployed TravInfo™ system.

On October 1, 1998, TravInfo™ ended its operational test phase and began its transition to full deployment as an integral part of the Bay Area transportation infrastructure. As

part of this process, the Management Board became the Executive Board. The TravInfo™ system will continue to be operated by the three principal public agencies. The Steering Committee will be composed of private-sector participants who are interested in joining the project team.

Observations

1. *The TravInfo™ organization maintained remarkable continuity among participating institutions and individuals.*
   From inception to completion of the Field Operational Test, the roles of the original governing bodies, the Management Board, Steering Committee, and Advisory Committee/Information Service Providers Forum, remained essentially the same, though they evolved as the project moved from design to operation. The project had remarkable continuity within the Metropolitan Transportation Commission, the leadership and members of the Steering Committee, the project manager, the technical adviser, Caltrans, the California Highway Patrol, and the PATH evaluation team.

2. *The project team maintained an open forum.*
   Steering Committee meetings were structured so that members and non-members participated equally. They were scheduled regularly, complete with agendas for important issues. Contracts were discussed openly, even when some attendees had a direct financial stake.

3. *The project team had strong leadership and the full commitment of the partners.*
   Strong leadership was shown in the public and private sectors and was a major development to come out of TravInfo™ and explains how the project was carried into full and stable deployment. The TravInfo™ project manager, the Steering Committee chair, and Board staff were all fully committed. The Federal Highway Administration and Caltrans' Office of New Technology and Research were highly supportive.

4. *The TravInfo™ project had to overcome many unexpected obstacles.*
   It is not unusual for a field test to encounter unforeseen obstacles, but TravInfo™ was plagued with them every step of the way. The Traffic Operations System, a core component that was being developed independently of TravInfo™, was expected to be fully functional by the time TravInfo™ began operation. However, it was delayed considerably by the state executive order temporarily prohibiting the execution of contracts of its type. Other unforeseen developments were the design consultant's inability to deliver the Traveler Information Center system in as highly automated a version as called for in the specifications, an ineffective marketing campaign for the Traveler Advisory Telephone System, lack of reliable traffic surveillance data from existing loop detectors, and contractors' inability to deliver work on time. All these unexpected shortfalls required the additional expenditures of time and money by the project team (5, 6).

5. *The TravInfo™ organization put public and private-sector talent to effective use.*

By placing the Metropolitan Transportation Commission, the region's Metropolitan Planning Organization, in a leadership role, TravInfo™ made consensus-building an important feature. It also benefited from having many talented people participate in the design and deployment of the system.

Accomplishments: Institutional

1. *TravInfo™ went beyond its field test phase to full operation as an integral part of the permanent Bay Area transportation infrastructure.*
   Unlike other projects of this type, TravInfo™ survived past its field test. In the process of drawing up and executing the TravInfo™ deployment plan, the project team provided strong regional stewardship for an infant program. As TravInfo™ moved into deployment, the team laid out a strategy to improve the Bay Area transportation system through a more efficient and reliable surveillance infrastructure, broader dissemination of accurate and timely traveler information, and more extensive data coverage for private information service providers.

2. *TravInfo™ gave different organizations a platform on which to network and form partnerships among public and private participants and nurture a young industry.*
   By focusing on delivering an operable advanced traveler information system, TravInfo™ stimulated development of related concepts and products in the public and private sectors. Although many products had not reached full commercialization by the end of the field test, TravInfo™ provided invaluable market information to guide future product development (8).

3. *The TravInfo™ Field Operational Test was built on a collaborative partnership.*
   The true sense of partnership that TravInfo™ engendered among members of the Steering Committee and Management Board was clearly its most unique and significant accomplishment in the public-private arena. Likewise, the project helped nurture constructive relationships during the field test among the three principal public-agency participants, the Metropolitan Transportation Commission, Caltrans, and the California Highway Patrol. The benefits carried over into other joint ventures, such as the joint operation of the Freeway Service Patrol by the Metropolitan Transportation Commission and the California Highway Patrol, and the Metropolitan Transportation Commission's work with Caltrans to enhance the regional freeway surveillance systems.

   TravInfo™'s emphasis on open access for its partners helped create considerable interest from private firms. In spite of the shortage of reliable data generated during the field test, *The Contra Costa Times*, Etak, and a division of Maxwell (later bought by Smart Routes) all deployed traffic Web sites based on TravInfo™ data. Bay Area television stations KTVU and KPIX hoped to use TravInfo™'s closed-circuit television images for their traffic Web pages. During the Field Operational Test, these and other service providers (among them, DaimlerChrysler, Fastline, and Digital DJ) were in various stages of developing and testing advanced traveler information

products such as cellular telephones, personal digital assistants, and in-vehicle navigation devices using TravInfo™ data.

Furthermore, many of TravInfo™'s private participants went on to form alliances with one another, and their positive experience with TravInfo™ led them to take part in other field tests and model deployments of advanced traveler information systems, among them AZTech (the Phoenix Model Deployment Initiative), SmartTrek (the Seattle Model Deployment Initiative), and RAPID (a test of FM-subcarrier delivery of traveler information in Phoenix).

One alliance born out of TravInfo™ is a partnership between Etak and Metro Networks. It is set to roll out a nationwide, commercial advanced traveler information system that will reach approximately 75 cities by the year 2000. Both parties say it is a direct result of their experiences with the TravInfo™ field test. They even used the TravInfo™ database to try out Etak's Traffic Workstation, which processed and distributed TravInfo™ data through the FM subcarrier network of Differential Corrections Inc., another TravInfo™ participant. Wireless data from Differential Corrections were made available to other TravInfo™ partners, including Clarion, which in turn modified its in-vehicle navigation device and used the TravInfo™ database to test its technical viability in the U.S. and Japan.

4. *The partners took the time to define the roles for public and private participants.*
Although building a consensus among them took considerable time and effort, the TravInfo™ partners were able to define the public and private sector's roles for the field test. They agreed that members should focus on what each does best. That is, the public sector should collect and integrate large amounts of data into a single database, which would be easily accessible to the private sector. It in turn was to disseminate the data by selling directly to end-users or to other information service providers, who might bundle TravInfo™ data with other products.

Challenges: Institutional

1. *A project of this nature was new to partners.*
When TravInfo™ was being designed and developed in 1994 and 1995, there was no other regional advanced traveler information system of comparable scope to learn from. The Boston SmarTraveler project, which began operation in 1995, did not have any evaluation results yet. Two others that were underway in California, the Yosemite Advanced Traveler Information system and TransCal, either had not been implemented or did not have completed reports. Therefore, the partners could only guess at the elements involved, among them the challenges of partnerships, consultants' contracts, the maturity of information technology, and the depth of the advanced traveler information market.

2. *The partners had different expectations.*
The public and private partners approached TravInfo™ with different motivations and

expectations. The public side generally hoped to disseminate accurate and timely traveler information as widely as possible to help the public by improving the traffic management system. Their expectations about how easily that would be accomplished might have varied. The private partners hoped primarily to use the TravInfo™ database to create value-added information services that they could sell at a profit. Although the partners agreed for the duration of the field test that the public sector should collect and fuse data, which the private sector would then disseminate, the final division of duties has not been precisely defined.

3. *The partners had not anticipated contracting problems.*
   Two major contracting problems were not foreseen and caused significant delays. The state executive order temporarily prohibiting sole-source government contracts threw development of the Traffic Operations System into disarray. The challenge was then to push the project forward so the Management Board could meet its contractual obligation to the Federal Highway Administration. The system-design consultant's unexpected delays in its deliverables and its decision to scale back its involvement in the TravInfo™ project before completing its contract was the second major setback that could not have been anticipated. These events also hampered the information service providers' product development and testing.

4. *TravInfo™'s challenge was working with an inefficient system in an environment of rapidly advancing technologies.*
   The TravInfo™ system was out of date the moment it was completed, because the technology was changing at such a rapid rate. Compounding the problem, the TravInfo™ software was based on a system used in the military — the most economical and practical option at the start of the system's design — which was not easily modified. As a result, developing the TravInfo™ software took more time and effort than anticipated, and it turned out to be less effective than expected. The major challenge was operating an inefficient system as effectively as possible to accomplish the goals that had been set out.

5. *The partners relied heavily on the Traffic Operations System, which could not be developed in time.*
   Under the new, expanded Traffic Operations System, the TravInfo™ partners expected to have surveillance data which would provide speed and congestion data on at least 250 miles of the planned 500-mile freeway surveillance system in the Bay Area. That amount of data coverage was considered sufficient to support the TravInfo™ field test. When the new system did not materialize, and TravInfo™ was forced to operate with a small fraction of that coverage, the project's basic goals were compromised.

6. *Local governments and transit agencies had limited participation in the TravInfo™ field test.*
   Active participation by local public agencies would have greatly helped TravInfo™ achieve its goal of improving transportation coordination across agencies, modes, and

geographic boundaries. However, few local government and public transit agencies participated in TravInfo™'s development. It was not due to lack of interest. In the case of local governments, it was largely because they have limited resources and a heavy daily workload of local projects. That restricts the amount of time they can spare for projects concerned with regional transportation issues. On several occasions, representatives of local governments who participated in the project did so on their own time. Local agencies pointed out that, to increase their active participation, they should have additional resources devoted to regional intelligent transportation system projects. In response, the federal government is planning to support active participation of local agencies by having highway funds be used for this purpose.

Transit agencies had a different reason: they were concerned about protecting their own brand-equity, particularly when it came to signing on to TravInfo™'s 817-1717 traveler advisory phone line. All allowed their customers to obtain information through TravInfo™'s number, but only one of the 26 transit agencies in the Bay Area, Alameda-Contra Costa Transit (AC Transit), used the TravInfo™ number as its only access number during the field test. Near the end of the field test, AC Transit also adopted its own telephone service number in addition to the 817-1717 number. Another major challenge was to persuade local public works departments to integrate their databases with those of TravInfo™.

7. *Freight companies did not fully participate in the partnership.*
   Most freight companies have been using two-way communication devices to increase the efficiency of their delivery systems. TravInfo™ could have greatly benefited from freight companies' data sources, especially with the Traffic Operations System's limitations, but none was willing to share what it considered proprietary information with TravInfo™. They perceived their participation in TravInfo™ to be an expenditure that might not yield any tangible benefits to their businesses and might potentially result in their losing a competitive edge.

8. *Intellectual property rights to the TravInfo™ system were a major concern of the partners.*
   The TravInfo™ system was designed by a consultant who resisted transferring the intellectual property rights to the TravInfo™ system to the Management Board. Although many intelligent transportation system projects have had to address intellectual property rights issues, there were no national standards for contracting agencies or design consultants to follow. Negotiations between the Management Board and the consultant resolved the TravInfo™ intellectual property issue by granting ownership of the software to the system developer, who in turn licensed it to the Metropolitan Transportation Commission to use it and make any modifications that it desired. Modifications that are considered "derivative works" revert to the software developer; those that are considered new belong to the Metropolitan Transportation Commission.

9. *More intra-agency support from the three managing agencies was needed.*

All three public agencies serving the Management Board needed better buy-in from their public relations offices, instead of forcing TravInfo™ to run its own advertising campaign and address public relations issues. This could have made a significant difference in the visibility and awareness of TravInfo™.

Chapter 4
TECHNOLOGY ELEMENT EVALUATION

The technology element of the TravInfo™ evaluation examined the performance of the Traveler Information Center (9, 10, 11, 12, 13, 14) and information service providers' traveler information services and products (15, 16, 17). The Traveler Information Center study assessed the state of TravInfo™'s technology in terms of its ability to collect, integrate, and broadly disseminate accurate, timely, and reliable traveler information throughout the Bay Area. The Information Service Providers Study assessed the extent to which the providers developed and tested products that tapped the TravInfo™ database.

The evaluation of the Information Service Providers was performed in two waves, in 1995, a year before TravInfo™ began operations, and during the summer of 1998, near the conclusion of the TravInfo™ field test. The first was intended to document the state of the information service provider industry before TravInfo™ started, and the second to capture how the industry actually responded to TravInfo™. Originally, it was also to include an examination of actual products deployed that used the TravInfo™ database, but the absence of any such products at the time of the field test, except for three Web sites,[3] precluded that evaluation. As a result, the study was limited to interviews with various information service providers and field measurements of TravInfo™ data retrieved by service providers during the field test.

This chapter addresses the Traveler Information Center first, followed by the Information Service Providers.

Traveler Information Center: Service Features and Operational Characteristics

The regional Traveler Information Center was the key component of the TravInfo™ field test. It is a publicly operated, centralized database that collects, processes, and disseminates traveler information throughout the nine-county Bay Area region.

Its sources are the California Highway Patrol's Computer-Aided Dispatch system and the Freeway Service Patrol[4], both of which supply data about incidents on freeways, airborne reports from the private contractor that runs the Traveler Information Center and its Web-based service, closed-circuit television cameras, callers from cellular phones, Caltrans (for road work updates and inductive loop sensors from the Traffic Operations System), beat calls to other sources (bridges, transit service providers, police stations, and county offices of public information), and the Transportation Management Center. In general, local agency data are not yet integrated into the Traveler Information Center's database, with the exceptions of some cities in Santa Clara County as well as the Santa Clara County Transportation Management Center. Other cities are expected to eventually integrate their data into the system in a process that has continued since the conclusion of the field test.

The public has access to Traveler Information Center data through the interactive Traveler Advisory Telephone System, which is a landline telephone network that can be reached by dialing 817-1717. Information service providers that registered to participate in the field test can tap into the center's database through a modem or telnet connection to TravInfo™'s landline data server.

The telephone advisory line provides public transit[5], paratransit, and park-and-ride lot information; information on current traffic conditions (slowdowns, roadwork, incidents); carpooling, vanpooling, and commuter check information[6]; highway construction updates; and parking, bicycle, and airport ground transportation information. It also makes available a public comment line. It uses a touch-tone keypad, menu-driven interface, and an interface for travelers using a Teletype Terminal for the Deaf (TDD).

Of particular note is the information TravInfo™ provides during emergencies, roadway construction, and special events. During two travel-related emergency periods, the especially heavy rains of the winter of 1998, when severe flooding occurred, and the Bay Area Rapid Transit (BART) strike in September 1997, TravInfo™ disseminated travel warnings and advised on alternative travel options. When major highway projects were scheduled, such as the demolition of the Central Freeway in San Francisco, TravInfo™ advised motorists on street closures and alternate routes around the massive demolition zone. During the end-of-year holiday season, TravInfo™ reported airport parking information and traffic conditions around the three Bay Area international airports. During the summer, when ozone levels exceeded acceptable levels, TravInfo™ carried Spare-the-Air messages, sponsored by the Bay Area Air Quality Management District's clean air campaign. TravInfo™ advised callers of alternative modes of transportation, such as transit, to reduce emissions and improve air quality.

Current traffic updates and information on parking and bicycles are tailored to five sub-regions - the East Bay, South Bay, San Francisco, North Bay and Solano County, and the Peninsula - and the Bay Area's bridges. At the start of the field test, TravInfo™ was configured to the Bay Area's four area codes so that callers anywhere in the region could dial TravInfo™ with the same seven digits, without entering an area code. During the field test, two of the four codes split, and callers in regions defined by the new area codes temporarily had to dial the area code before the TravInfo™ access number, until TravInfo™ was able to institute corrective measures due to regularity constraints of the California Public Utilities Commission.

The Metropolitan Transportation Commission has retained a private contractor to run the TravInfo™ Traveler Information Center, bringing its experience as a traffic-reporting business to the project. In TravInfo™'s early development phase, it was expected that the Traveler Information Center's operation would be considerably more automated than it ultimately turned out to be. Because of that, the performance of the operators and the interface between operators and the Traveler Information Center system played a more significant role in the center's operational effectiveness than anticipated. In recognition of

that shift, the study examined in greater depth than originally intended the tasks and responsibilities of the operators, how quickly they executed them and the degree to which the working environment, including the computer interface that was employed, supported them.

Operator Tasks and Responsibilities

The Traveler Information Center operates 24 hours a day, 7 days a week. There are three weekday shifts (5 a.m. to 1 p.m., 1 p.m. to 9 p.m. and 9 p.m. to 5 a.m.) with the busier morning and afternoon shifts each staffed by four operators and one supervisor and the overnight shift staffed by one operator. During weekends, there are rotating shifts with generally two operators on duty during the day and one overnight (9).

Operators must process information from all the sources listed above except for data from Caltrans' Traffic Operations System inductive loop sensors and the Freeway Service Patrol, which are automatically fed into the center without operator interpretation or processing. But because the loop sensors were not deployed as extensively as anticipated, coupled with their ongoing accuracy and communications-related problems, the most significant data source soon became the Computer-Aided Dispatch incident reports from the Highway Patrol, which required significant interpretation and follow-up by the operators.

After acquiring and integrating data from all these sources, the operators update the center's master database and then update the message on the telephone advisory line[7] for public dissemination. Operators can then also make changes in existing incident reports or events announcements as updates are received, and the new data are routed to the server that supplies the information service providers.

During the shifts that have rush hours, 5 a.m. to 1 p.m. and 1 p.m. to 9 p.m., three operators are assigned to specific geographic regions. A fourth covers traffic slowdowns and roadwork for the whole Bay Area. Slowdown information, i.e., recurring congestion, is covered mainly during rush hours while mostly roadwork data are entered the remainder of the time. During the overnight shift, the operator covers mainly incidents and enters roadwork data.

The Computer-Aided Dispatch data present the greatest potential bottleneck in the flow of information because they must be manually entered into the Traveler Information Center's system even though the source is an automated feed. Approximately seventy-five percent of each operator's time (except for the person in the slowdown position) is spent on this data, which represent about ninety percent of what arrives at the three geographic workstations. During inclement weather or particularly busy periods, a backlog may develop, requiring the operator to select only the more salient incidents.

Traveler Information Center-Operator Interface

The Traveler Information Center's performance depends in part on how the Traveler Information Center system supports the operators in performing their jobs. Operators communicate with many people and work with a great deal of equipment and supplies in the course of performing their daily tasks.

Operators work at both the Traveler Information Center computer and the California Highway Patrol Computer-Aided Dispatch terminal located at each operator's workstation; they monitor closed-circuit television screens and use a telephone, a voice-processing system, a printer and a fax. They fill out (paper) operator activity tracking forms; communicate with other operators, Traveler Information Center supervisors and management, maintenance crew, and, to some extent, Traveler Information Center visitors; and take reports from the cellular reporter network.

The primary operator interface is with the Traveler Information Center computers and the center's databases. The Traveler Information Center-operator interface structure is a proprietary software product of the system developer running on a Sun Workstation with a Solaris operating system supporting a Sybase database and the X-Windows/Motif graphical user interface. Each window consists of a frame, a toolbar of pull-down menu items, a resizing corner, a closure button, a full screen button, and an optional scroll bar. The Traveler Information Center-operator interface design utilizes a combination of three dialog styles, i.e., means of interaction, between the operator and the system: menus, fill-in forms and direct manipulation. A menu provides a list of options from which an operator makes selections. A fill-in form is an electronic version of a paper fill-in form, i.e., structured and formatted with fields in which an operator enters data. In direct manipulation, operators perform actions directly on visible objects instead of specifying actions indirectly through language. These interfaces are sometimes called "point-and-select" interfaces and include a pointing device such as a mouse and often use graphics to display objects and actions. The operator interface evaluation was conducted through examination of the interface by the evaluators and operator interviews (11).

Physical Working Environment

Operator, and hence Traveler Information Center, performance depended also in part on the physical working environment as it could have contributed to or hindered the operators' ability to work efficiently and effectively. For most of the field test, operators worked in a single room in individually enclosed workstations separated by height-adjustable partitions. Three months before the field test ended, the operations moved to a new location, which was smaller but allowed in natural light. Key considerations for both are the characteristics of the ambient air, noise, and light, and the attributes of the computer screens and keyboards and work surfaces and furniture (11).

Operator Response Time

One of TravInfo™'s primary goals has been to provide timely traveler information, but there is no unambiguous and generally accepted meaning of "timely" in this context. The System Requirements Document (18) stated that on average no more than one minute should elapse between the receipt of information about a freeway incident and its being posted on the server and the telephone advisory line. That, however, does not take into account the time between the incident's happening and the center first being aware of it.[8] Thus, "timely" does not necessarily mean "instantaneously." Moreover, with the California Highway Patrol Computer-Aided Dispatch system being the primary Traveler Information Center data source, and its data needing to be manually entered, which creates a potentially serious bottleneck in Traveler Information Center information flow, to enter, process and disseminate such data would very likely require longer than one minute (13).

The operator's response time is critical to how well the center meets this ambiguous goal. However, with no baseline value for what a "timely" response is, the timeliness of operators' responses could not be comparatively assessed. Factors that could influence them, however, were identified, and the added time associated with these factors calculated. Based on those findings, recommendations were made for altering certain factors in order to reduce times.

Two one-week[9] analyses approximately six months apart were conducted during the final nine months of the field test. Response times were examined between 5 a.m. and 8 p.m. for each day of these two weeks. Response time was defined as the time between an incident first being posted on the California Highway Patrol's Computer-Aided Dispatch system and it being entered into the phone system and available to the public.

There are some notable intermediate times, like the moments between an incident being posted and an operator being aware of its posting and the gap between an operator's initial awareness of a posting and its verification. The time between the first appearance of an incident record in the California Highway Patrol's Computer-Aided Dispatch system and operator awareness of it depends mainly on the operator's workload and attentiveness. Operators are instructed to confirm an incident before entering it into the database, and while they make attempts to do this, actual verification does not always occur before an entry is made in the interest of remaining timely, according to operators. Operators use several means to confirm an incident, including an on-site California Highway Patrol officer report, an airborne record, a web-service report, multiple Computer-Aided Dispatch entries for the same incident, and operators' experience about incidents occurring at certain locations during certain time periods.

The time between the first appearance of an incident record in the California Highway Patrol's Computer-Aided Dispatch system and incident verification (if it actually occurs) is a time in which operators are engaged in making incident verification attempts for that particular incident, as well as other activities related to other incidents and other Traveler

Information Center operational matters. The time between incident verification (again, if it occurs) and entering the processed incident into the Traveler Information Center is related more to the specific incident under examination.

The following factors could potentially influence operator response times: the number of incidents to be processed; the rate at which incidents arrive, the type of incident (e.g., traffic hazard, accident with major injuries), the time of day, the location where the incident is processed (i.e., the specific geographic workstation), the length of the operator's experience working at the Traveler Information Center, the time and nature of the California Highway Patrol's Computer-Aided Dispatch system problems (documented by operators), the time and nature of the Traveler Information Center's system problems (documented by operators), operators' work-break periods, and weather conditions.

Findings

Traveler Information Center-Operator Interface

Although the software, overall, allows operators to perform their tasks relatively efficiently, the interface could have been designed to better support them at their tasks. Its shortcomings included fill-in forms whose organization and layout did not always consider operator tasks; menus on the two most important and commonly used windows that were poorly ordered, filled with rarely used items and not ordered by frequency of use or by categories to assist the operator for timely retrieval of needed information[10], forms that failed to group related items or contained ambiguous terms; attributes within certain fields that were not mutually exclusive; and inconsistent organization in different windows. The operators have adapted to these design shortcomings, but there could be time delays resulting from them (11).

Physical Working Environment

Operators found it quite acceptable and suggested only minor changes to potentially increase their productivity and performance: improve air circulation, moderate occasional temperature extremes, and redesign work areas to reduce the need for operators to move to gain access to supplies and equipment.

Response Time

Average response times in both evaluation periods for processing the Computer-Aided Dispatch data ranged between 10 and 11 minutes. The range of the average number of operator-processed incident records entered into the database was two to five records per hour, with approximately 20%[11] of the total incoming Computer-Aided Dispatch incidents being entered. Factors such as the number and type of incidents and the speed with which they arrived, an operator's level of experience, computer problems, break periods, and weather had only a minor influence. There were consistent and statistically significant differences in response times by operator, which were a function of the quality of the operator's performance and the level of operator workload (13).

Numerous operator work activities also affect operator response times and help provide the fuller context within which response times were assessed to help explain these findings. These activities include attempts to verify an incident prior to entering it in the Traveler Information Center; disruptions during shift changes and handoff of workstation control between operators; operator call-checking exercises into the telephone advisory system at the start of each shift; processing incidents that ultimately are not entered into the Traveler Information Center for California Highway Patrol-related reasons; updating an incident that has already been entered into the Traveler Information Center; searching for needed information for some incidents; and searching for multiple Computer-Aided Dispatch listings and those incidents not affecting traffic. These activities, however, are difficult to isolate and individually quantify.

Accomplishments: Traveler Information Center

1. *Overall, good hiring decisions were made.*
   The effectiveness of Traveler Information Center operations depends to a large degree on its staff because of the manual nature of Traveler Information Center operations. While there were operator performance issues during the early part of the field test due to inadequate quality-control measures, these measures were implemented near the end of the field test. Subsequently, continuous enhancements have been made to these quality-control measures, including additional supervision during non-peak hours, e.g., weekends. Overall, good hiring decisions were made, competent staff was employed, and management oversight was implemented.

2. *Staff showed initiative, flexibility and teamwork.*
   Operations staff exhibited teamwork and resourcefulness among themselves, as well as cooperation with and responsiveness to the Management Board during the field test. Staff showed flexibility and resourcefulness in integrating new data to augment Caltrans' Traffic Operation System loop data after they were found wanting and developing additional data-entry tools (e.g., macros for use on the California Highway Patrol's Computer-Aided Dispatch terminal). They also rose to the occasion in maintaining the center during emergencies such as floods and the BART system strike.

3. *There was a good working relationship between staff and outside contractors.*
   Collaboration of staff with other project contractors contributed to a more efficient operation, as did both teams' commitment to solving problems as they occurred.

Challenges: Traveler Information Center

1. *Shortcomings in traffic data impeded performance.*
   Because of the inadequate data coverage from the Traffic Operation System's loop network, the Traveler Information Center performed under significant constraints. It required TravInfo™ to rely on other sources such as closed circuit television and cellular calls, which resulted in an increase in operator work load and in considerably

less scope of coverage for the Traveler Information Center, and prevented TravInfo™ from providing highway speed and congestion information to the public and to private-sector partners reliably and accurately.

2. *The greater-than-expected reliance on human operators made the database less timely and complete.*
   Relying on operators to perform data-entry and dissemination tasks proved time-consuming and labor-intensive, especially in the transfer of incidents from the California Highway Patrol's Computer-Aided Dispatch system's terminal to the Traveler Information Center's system and from the Traveler Information Center's system to the telephone advisory system. Although it is very likely that operators would still need to intervene in the selection of incidents, automating the entry process could speed operators' responses and increase the number of incidents they could process. However, the operators' intervention is still crucial to the execution of many essential functions such as carrying out general system maintenance, circumventing design shortcomings and verifying and tracking data.

3. *The design of the computer interface provided insufficient support for operators to perform their jobs.*
   Although the team that designed the interface stated that it incorporated operators' needs from similar, earlier systems, the operators in the Traveler Information Center still had to make adaptations to compensate for design shortcomings. Overall, the resulting Traveler Information Center-operator interface provided insufficient support to the operations staff in the performance of their jobs. That likely contributed to longer response times.

Information Service Providers:
Their Technologies and Business Strategies

To tap into the TravInfo™ database, information service providers, public agencies, or research organizations had to register with TravInfo™. By the end of the field test, registered participants reached over 50 (15). Of that group, 90% were in the private sector. They ranged from small local Bay Area firms to large international corporations.

Approximately 30 of the private firms retrieved TravInfo™ data intermittently. Etak, DaimlerChrysler, and Maxwell were continuous users throughout the field test, and *The Contra Costa Times* began retrieving data approximately six months after operations began and has continued to do so. Etak, Maxwell, and *The Contra Costa Times* deployed Internet Web sites that provide traffic information using TravInfo™ data either exclusively or partly and get access to the TravInfo™ database every day, 24 hours a day, every two to three minutes at times, and often continuously. Etak downloaded approximately 90% of the TravInfo™ data, with the other three firms downloading approximately 8 to 9%. In addition, two public agencies developed kiosk systems that will include TravInfo™ data, e.g., Contra Costa County's TRANSPAC and the City of Alameda. DaimlerChrysler, Fastline, Digital DJ, Etak, and others are in various stages of

developing other products. For example, Fastline is about to deploy its service via a personal digital assistant using the TravInfo™ database exclusively, and Etak has developed an information service via cellular phone.

These companies were interested in developing advanced traveler information system technologies through the use of:

- wireless services such as cellular phones, FM subcarriers, and paging;
- in-vehicle navigation devices, real-time traffic information systems, and roadside assistance programs;
- portable and hand-held PCs and personal digital assistants;
- personalized profiling paging and alerting services;
- Web pages, Internet-based personalized profiling and alerting services;
- interactive broadcast and cable TV;
- conventional cable TV;
- fleet-management systems;
- telephone-based information services;
- and kiosks.

Findings

The state of the industry before TravInfo™

While TravInfo™ was effective in stimulating business opportunities and resolving the issue of the public sector's potential competition with the private sector, providers indicated that they viewed the future with an uncertainty which would not be resolved until they knew more about TravInfo™'s data and operations. Furthermore, many of the participants took part primarily to test the market for advanced traveler information systems, rather than any single product or service. Thus, their continued participation depended on whether they thought the market was large enough (16).

The response to TravInfo™ by service providers

Twelve firms that had shown interest in using TravInfo™ data to test their traveler information systems were interviewed, and six provided information about their business plans. The remainder of this section summarizes the findings from these interviews. These firms were motivated to register as service providers for the TravInfo™ field test because they were interested in disseminating personalized, real-time traveler information; creating high-quality, digital road maps and technologically advanced supporting software; and integrating advanced technology solutions into a broad range of commercial components and systems. They said that they ultimately were interested in marketing their products nationally (17).

One type of product they are currently interested in is online traffic information - travel speed, incident reports, and highway construction updates - accessible via the Internet. Future possible products in the near-term (three to five years) include personalized, route-specific, and point-to-point, real-time traveler information disseminated directly to end-

users without a service charge, initially. Likely targets are commuters, commercial vehicle operators, and tourists.

The information service providers were divided over whether TravInfo™ had influenced their companies' plans. They stated that TravInfo™ only partially met their operational performance requirements because of its lack of complete, accurate, and reliable speed and congestion data. TravInfo™ also would benefit from a more powerful server to provide data more rapidly. Despite those qualifications, all expressed the need to continue support for TravInfo™, because it promises them the potential to expand various services.

At the time of the field test, a market for advanced traveler information systems did exist, though it certainly was in its early stages and did not generate revenue through the selling of information, which is the hope of some of the service providers interviewed. For a commercial market to develop, they stated, several conditions need to be satisfied: there must be a national traveler information infrastructure with a wide variety of standard and specialized formats; traveler information must be reliable, accurate, timely, comprehensive, and of obvious value relative to what is provided by traditionally free services; the cost of acquiring travel information from the Traveler Information Center must be nominal, since private companies must invest for several years just to explore the likelihood of a commercial market; and access to the data must be streamlined and in place to make it convenient for providers to distribute it.

The service providers expect the private sector to play a larger role in at least some aspects of advanced traveler information system development, though no single public or private firm or government agency can carry out all the tasks needed, most notably, data collection from different sources, fusion of data, and dissemination. Public- and private-sector entities are likely to collaborate in translating the data into standard and custom formats, with one consortium or a joint venture perhaps taking over all functions, using specialized service providers. Public-sector entities such as TravInfo™ would continue to produce data and probably fuse them for use by the private sector. However, the service providers expressed the concern that even these functions could become competitive with the private sector.

Accomplishments: Information Service Provider Perspective

1. *TravInfo™ pioneered the use of open architecture and interface standards concepts.* TravInfo™'s open-architecture system has encouraged a large number of private companies to register and participate, and it has gained wide acceptance among service providers nationwide. A by-product is the development of standardized interfaces to gain access to the system. Open architecture is more routinely taken for granted as a valuable component of the Bay Area's system.

2. *The centralized regional database offered advantages to both the public and private sectors.*
   The centralized regional database helped prevent duplication, expedited the exchange of data among a large number of public agencies, offered an open and level playing field for commercial developers of products and services, and simplified the private sector's access to public data.

Challenges: Information Service Provider Perspective

1. *The inadequacy of the Traffic Operations System data deterred providers from relying on TravInfo™.*
   The data supplied to make up for the inadequate Traffic Operations System traffic data were considerably more qualitative in nature than would be possible with accurately functioning Traffic Operations System data. Although Caltrans (which was responsible for the Traffic Operations System) made a concerted effort to improve the quality of existing loop detectors, and the Management Board initiated new projects to acquire additional data sources during the field test, the data provided by the Traffic Operations System were not able to sufficiently support TravInfo™ in coverage, accuracy, or reliability. As a result, many providers understandably decided to wait until adequate data become available over a substantial portion of the Bay Area freeway network before proceeding with development of products or services.[12]

2. *There is uncertainty in the advanced traveler information services consumer market.*
   During the field test, the TravInfo™ database was used by a limited number of information service providers. The primary reasons for this were the uncertainty associated with the advanced traveler information services market and insufficient and inadequate data available to service providers, e.g., speed and congestion data, through the Traffic Operations System.

   Private-sector participants believe that, over the short-term, the advanced traveler information service market is still uncertain, and it will not mature for at least the next three to four years, which is why they support sustained public funding for TravInfo™. One element contributing to that uncertainty is the fear that consumers will not be willing to pay for personalized traveler information as long as public entities offer information for free. This has been the key factor in many small firms' reluctance to invest in the industry.

3. *More marketing is needed to communicate advantages of the new products.*
   Like many of the Field Operational Tests throughout the country, TravInfo™ had limited outreach, public relations, advertising, and marketing. This resulted in a low level of consumer awareness of TravInfo™'s products and, more importantly, their added value in comparison to the travel information that has traditionally been broadcast free over radio and television. Over the two-year field test, Web sites were able to capture only a small segment of the Bay Area consumer market, and product testing was a substantially higher priority than product deployment and distribution.

Chapter 5
TRAVELER RESPONSE EVALUATION

The traveler response evaluation investigated the public access to and use of different types of traveler information, changes in travel behavior based on that information, and the demand for and effectiveness of different information-based products (18, 19, 20, 21, 22, 23, 24, 25, 26).

Commercial radio and television reports were the primary sources of traffic and transit information in the Bay Area. The morning peak hours received the greatest coverage, with only a few stations reporting traffic conditions during afternoon peak and off-peak hours. Also, reports ran no more than once every eight minutes, and only in half-minute segments, which is not timely enough for travelers to make informed decisions about their trips. Also, the area covered was limited to major freeways, and reporting was not consistent throughout the Bay Area (27) and, by necessity, lacking in detail. Although Bay Area travelers expressed general satisfaction with radio and television traffic reports, TravInfo™ has clear advantages, given those shortcomings. The primary one is that it can provide more current and accurate traveler information on demand, at any time.

To investigate the effects of traveler information from conventional media and the new information sources (i.e., the telephone advisory service and Web sites) that used the TravInfo™ database on travel behavior, a series of telephone surveys was conducted before, during, and after the field test. Four different types of survey design were employed to assess traveler responses to traffic or transit information. They were surveys of Bay Area households (referred to as the "Broad Area Study"), surveys of commuters who traveled on a case-study corridor south of San Francisco during a major incident (referred to as the "Target Study"), surveys of callers to TravInfo™'s Travel Advisory Telephone System's 817-1717 number (referred to as the "Travel Advisory Telephone System Caller Study"), and, finally, a survey of Internet traffic Web site users (referred to as "Information Service Providers Customer Study").

1.Broad Area Study

The Broad Area Study addressed issues of how travelers obtained traffic and transit information and how the information influenced travel behavior. Two waves of telephone surveys of Bay Area households were conducted, one prior to and one after the field test. The initial survey was conducted in November 1995, eight months before TravInfo™ began operations. Its purpose was to establish a baseline of traveler behavior of Bay Area households. The final survey was conducted in November 1998, shortly after the completion of the field test. Its purpose was to understand the extent to which TravInfo™ was able to penetrate the Bay Area market and to assess its impact on the entire Bay Area traveling population. The survey participants were selected by random digit dialing, and each survey obtained 1,000 completed telephone interviews (18, 19, 20).

2. Target Study
The purpose of the Target Study was to investigate the travel behavior on a 17-mile corridor of U.S. 101 south of San Francisco during the morning of a major incident. Four waves of surveys, two on northbound traffic lanes and two on southbound traffic lanes, were conducted during the field test. Survey participants were recruited from those whose primary commute route included the selected U.S. 101 freeway segment during morning peak hours from 6 to 10 a.m. A panel of 563 southbound and 526 northbound commuters was created using the license-plate survey method. Immediately following major incidents, telephone interviews were conducted. The sample size in each case ranged from 80 to 106 commuters (21, 22).

3. Traveler Advisory Telephone System (TATS) 817-1717 Caller Study
Two waves of TATS caller surveys were conducted, one in April 1997, eight months after TravInfo™ went on-line, and the other in March 1999, six months after the field test concluded.

The purpose of the TATS caller evaluation was to measure the effectiveness of TravInfo™'s Traveler Advisory Telephone System in helping callers make informed travel decisions. Incoming calls were randomly intercepted to obtain a representative sample of callers and created a pool of individuals who were willing to participate in follow-up telephone interviews. Within two days of an intercept, a follow-up survey was conducted. Each survey obtained 421 completed telephone interviews (23, 24, 25).

4. Information Service Providers Customer Study (survey of traffic Web site users)
A survey of traffic Web site users was conducted over a six-month period from September 1998 to March 1999. A written questionnaire was integrated into three different traffic Web sites that used the TravInfo™ database exclusively. The purpose of the Web site user survey was to investigate how many Internet users retrieved information and to what extent users modified their travel behavior based on the Web site's information (26).

In addition, six focus-group meetings were held during the field test to assess consumer preference for different types of traveler information sources (28).

Findings

One-third of Bay Area households listened to radio traffic reports on a regular basis, and an additional one-third listened occasionally when a traffic problem was expected. The remaining one-third did not listen to traffic reports at all. Since radio traffic reports cover freeways primarily, and about half of the commuters use freeways, the majority of the listeners were freeway travelers. The vast majority of Bay Area households was not aware of traveler information disseminated through the TravInfo™ Traveler Advisory Telephone Service or private participants' Web sites.

According to the household surveys, approximately 15% of the total travelers modified their trips during commute hours; 12% were influenced by traffic reports, primarily from radio or television, and either left earlier or changed their routes as a result, and 3% changed for other reasons. Very few people chose public transit because they perceived it to be inconvenient and more time-consuming than driving, even with congestion. Of those who obtained information relevant to their trips, only 25% actually modified their trips based on radio/television traffic reports.

The surveys of U.S. 101-corridor travelers indicated that only half of them obtained traffic information from any source, and over two-thirds did not change their travel behavior, although the majority encountered congestion. They stated that they could not count on the information being reliable or current, and most people did not believe that travel changes based on radio or television traffic reports would necessarily shorten their travel times. Commuters often found that traffic was cleared by the time they reached the incident site. They also believed that riding public transit took longer than driving through congestion.

These surveys also showed that the vast majority of Bay Area households were not aware of the TravInfo™ Traveler Advisory Telephone Service or traffic Web sites. In the second survey of 1,000 randomly selected households around the Bay Area, after the end of the field test, in November 1998, approximately 9% of the participants were aware of the TravInfo™ telephone service, but very few had actually tried it. Among those who did use the service, callers' satisfaction level was consistently high; they rated the perceived quality of the information to be far superior to radio/television traffic reports and believed it to be useful to their trip planning. Because of this, over 80% were repeat users. Most (82%) of those who were aware of the service did not remember the TravInfo™ telephone number.

This was reflected in the monthly call volumes to the traveler advisory telephone line. They ranged between approximately 50,000 and 65,000, with an average of 55,000 calls (or about 1,800 calls a day). Transit information requests accounted for 60% to 70% of the total volume, and calls requesting traffic information ranged from 10% to 20%. Based on those volumes, it was estimated that the telephone line had approximately 1,500 traffic information callers per month. Approximately 10% were for other transportation-related information such as bike trail and parking information. Alameda-Contra Costa Transit (AC Transit) accounted for 70% to 80% of the transit calls, because TravInfo™'s telephone number was its sole telephone information source during the field test. The other Bay Area transit agencies retained their own telephone numbers, though calls could be routed to their own operators from TravInfo™. The monthly call volumes were consistent during the field test, except during extraordinary occurrences like the BART strike in September 1997 and the heavy winter flooding in February 1998.

During the eight-day BART strike, daily call volumes reached a maximum of 8,500. These calls were primarily made by people seeking information about the availability of alternative transit services. During the heaviest winter flooding, a two-week period, 8,000

calls were made daily at the peak. Most of the people calling sought information about road or traffic conditions. During the BART strike, 70% of all calls concerned transit questions, and during the floods, 70% were traffic-related. The TravInfo™ telephone information service was mentioned and endorsed by both television and radio stations during the events. TravInfo™ was referred to as a transit hotline during the BART strike and as a traffic hotline during the flood period. (10, 14). Neither of these events had significant long-term effects on increasing call volumes. They returned to their pre-event levels within one to two weeks.

Although the precise number of Web site users was not available, the providers estimated that monthly visitors were approximately 15,000 during the field test, without having an organized ad campaign. Web site services are oriented primarily to traffic conditions in the Bay Area; very little transit information is disseminated. The providers forecast that the usage of Web site information will increase significantly as their services expand with more comprehensive and reliable real-time traffic information from TravInfo™ data. When that happens, they plan to generate revenues from third-party ads as radio and televisions stations are doing.

Traffic Web site users perceived the quality of Web site information to be far superior to radio/television traffic reports. Maps and verbal descriptions of freeway speeds and the locations of incidents were considered valuable for making travel decisions. Also, over 80% were repeat users. The focus group participants also preferred obtaining information over the phone or the Internet, despite the effort required on their part, to tuning in to radio or television reports. Because most found it more convenient to retrieve the information off the Internet at their workplace than getting information before leaving home, more people among the Internet users said they preferred doing it that way.

The caller and Internet-user surveys suggest that TravInfo™ was able to attract Bay Area travelers in three ways: it captured people who never listened to radio/television reports; it led people to substitute TravInfo™ telephone advice or Web sites for radio/television reports; and it led people to seek out more information.

The new consumers of the telephone service were primarily cellular telephone users. Until the TravInfo™ service became available, only 6% of cellular subscribers ever used their own cellular provider's traffic information source, according to the first Bay Area survey conducted in November 1995. The first survey of TravInfo™ callers, conducted in April 1997, showed 31% of them used cellular telephones. By March 1999, that was up to 41.8%, a 35% increase, achieved with very little marketing to customers of cellular providers. Approximately one-third of phone callers and one-third of Web site visitors switched to TravInfo™ from radio/television reports. Those who switched were long freeway commuters and high-mileage drivers. The average commute time for both groups was 45 minutes, versus the average commute time in the Bay Area of 28 minutes[13].

The surveys showed that TravInfo™'s phone line and traffic Web sites had more influence over travelers' decisions than radio/television reports. While 25% of those who

listen to radio traffic/television traffic reports changed their travel behavior, 35% of TravInfo™'s callers and 80% of the Web site visitors did so. All surveys showed that people obtained traffic information from any of the three sources more frequently from the workplace than at home, and they tended to either leave earlier or take an alternate route. Very few people decided to take public transit after obtaining traffic information.

Initially, fewer than 1% of the TravInfo™ callers were rerouted to the transit menu after using the traffic menu. The second caller survey conducted after the field test, however, showed that 5% of the calls were rerouted to transit menu, a significant increase. Of that group, 90% switched to transit. The field measurement of call volumes confirmed this increase. While this is a significant increase in call rerouting and modal shift, generalization cannot be made based on these figures because the sample size of this group in both surveys is fairly small, and the traffic call volume is relatively smaller than the transit call volume. However, some inferences can be made, though they need to be tested and verified. The increase in call rerouting requests may be due to the fact that repeat users of the traffic menu became gradually aware of the convenience of getting to the transit menu to learn about the transit availability for their trip, and once they obtained transit information they were willing to try it. Although transit and traffic information services deal with distinctly different markets, the majority of the callers liked the easy access to all travel-related information via a single telephone number.

Assuming that approximately one million of the Bay Area's three million commuters acquired traffic information, less than one percent of them used the TravInfo™ telephone services or Web sites run by participating service providers. Considering that low market penetration, TravInfo™ presumably had a negligible impact on the overall performance of the Bay Area transportation system during the field test. However, the surveys suggested that TravInfo™ was able to capture consumers who rarely relied on traffic reports, who sought better information in lieu of existing sources, and who desired more and better information to supplement their conventional sources.

The fact that most travelers in the Bay Area had not heard of TravInfo™ is probably the main reason for the low volume of calls. Most focus group participants said that they would have used the TravInfo™ telephone information service if they had known about it. Although the short-term impact of TravInfo™ on the overall transportation system appears to have been marginal, TravInfo™ was able to influence travel behavior far more effectively than radio/television broadcasts. The findings of the field test suggest that TravInfo™ could have an impact, if, overall, more people were aware of it, and its market penetration were to increase.

Over the long term, TravInfo™ could improve the management of the Bay Area transportation system by collecting timelier and more accurate information using various traffic surveillance methods that would be acted upon by a potentially large and receptive audience. In the near future, it can help by providing data for a variety of electronic devices that are soon to penetrate the consumer market. Some information service

providers estimate that the market will mature in the next three to four years, while others believe that it could take as long as two decades (8).

The greatest potential for growth is expected to lie in a dozen different media, including phone systems, pagers, kiosks, Web sites, cable TV, and in-vehicle devices. Internet-based traffic information services are expanding rapidly; most large urban regions in the U.S. have three to four traffic Web sites. Landline traveler advisory telephone systems have been deployed in several metropolitan regions and are likely to be available in the major cities in a few years. Wireless services from cellular telephone providers, FM subcarriers, and paging service providers offer traffic information to travelers and users of commercial vehicles such as taxis, limousines, freight vehicles, and buses.

The surveys also suggested that traveler information usage through new media is closely related to its compatibility with hardware that has already penetrated the market. People were less interested in purchasing new electronic products, such as personal digital assistant units, just to obtain traffic information. But they were willing to subscribe to information services that could be delivered over a device they already owned, such as a digital cellular telephone. The second survey of Bay Area households (Broad Area Study in 1998) showed that there was a more than tenfold increase in cellular subscription, from 3% to 4% in 1991 to 56.6% in 1998.

The vast majority of those who already had electronic devices such as personal computers or Palm Pilots indicated that they would subscribe to traffic information if the monthly fees were, on the average, $3. Of Bay Area households, 71.6% had a personal computer either at home or at work, 52% had access to the Internet, 76.4% subscribed to cable television, and 46% had a pager. This trend was similar in other regions in the U.S., including the Seattle metropolitan region.

The second Broad Area survey showed that only one percent had an in-vehicle navigator, yet some information service providers predicted that in-vehicle navigators would open promising markets for real-time traveler information in the near future. Several automobile manufacturers are offering in-vehicle navigators in the U.S., and they are available in the European and Asian markets. In Japan, four million vehicles were already equipped with in-vehicle navigators by 1998. The market is uncertain, but if it grows at the rate some anticipate, TravInfo™ will be useful to travelers in many more significant ways.

Many investors believe that in-vehicle computers have the potential to capture a large number of subscribers for traveler information. The attractive feature of in-vehicle computers is their ability to receive traffic information along with other information, including driving instructions, to download information from the Internet, to send and retrieve e-mail, and to transfer data from office computers.

As advanced traveler information service technology takes off, firms will continue to expand in the areas of research and development, product testing, technology marketing

and product distribution. The commitment of the TravInfo™ partners can contribute to an improved traffic management system over time, as well as the dissemination of timely and accurate information to travelers through the telephone advisory service and even personalized information through information service provider products and services. Only when TravInfo™ is widely deployed can its ultimate benefits to users, information service providers, and the overall transportation network be accurately measured and understood.

Accomplishments: Traveler Response

1. *The TravInfo™ project provided early insights into travel behavior.*
   Prior to the TravInfo™ field test, very few studies had investigated the effects of traveler information on travel behavior in the Bay Area as well as in other regions in the U.S. The TravInfo™ field test provided basic knowledge of how Bay Area travelers acquire travel information and the extent to which it influences travel behavior.

2. *The TravInfo™ project provided information about the market in the Bay Area for an advanced traveler information system.*
   The TravInfo™ surveys showed a latent demand for personalized information services that would allow users to retrieve information when needed, to the point where Bay Area travelers stated they would be willing to pay a $3 monthly subscription fee for one. However, personalized information should be superior to the information that can be obtained for free through radio or television or other Internet outlets and services. At the same time, the TravInfo™ project demonstrated the need to further research user needs for traveler information. Shortly after the field test ended, the TravInfo™ Executive Board retained a consultant to do so.

3. *TravInfo™ had greater influence on travel behavior than radio/television reports did.*
   This is primarily due to the fact that the quality of TravInfo™ information is perceived to be superior to that of radio or television information and thus more useful in making informed travel decisions. The benefits of TravInfo™ information were perceived to be savings in travel time and a reduction in stress.

Challenges: Traveler Response

1. *Sampling of TATS traffic callers and Internet users was difficult.*
   Because the majority (80%) of the traffic information line callers were repeat customers, the call intercept method did not work well. Many were intercepted repeatedly, which caused the study's sample size of traffic information seekers to shrink to one-third the size that was originally planned. The caller surveys obtained 218 traffic callers for the first wave study and 211 for the second wave study. A larger sample size (1,000 completed surveys of traffic callers per wave) would have resulted in greater statistical validity. Likewise, the sample size of 334 Web site visitors is fairly small to adequately represent the user population. Because the survey was

conducted under an uncontrolled environment, that is, incorporating a questionnaire into the Web sites, the degree of self-selection bias could not be determined. Although the demographic profiles of the Web site survey participants were fairly representative of Internet users in the Bay Area, it was difficult to estimate the overall characteristics of the traffic Web site user population.

2. *The TravInfo™ telephone information service was hindered by a limited marketing campaign,while Web services had relatively high usage despite little or more marketing support.*
   The Management Board did not have an adequate budget to advertise the telephone advisory service, and the public's lack of awareness of the service was a major barrier to its use. The information service providers also experienced very little organized publicity for their traffic Web site services; nonetheless, Web site usage was relatively high. This may be due to the fact that Web site users are more receptive to information technology than the general public is, plus these Web sites already had a pre-existing user base — an easy way to introduce users to a new service. The surveys showed that users of the traffic Web sites and the telephone service were mutually exclusive. Most Web site users were not aware of the TravInfo™ telephone service. Although very few Web site users ever tried to retrieve information from the telephone service, their opinion was that Web sites are more user-friendly and more convenient for retrieving information than the telephone. The survey participants said that their ability to visually comprehend the entire Bay Area's traffic conditions from a single map with an option of focusing on specific routes for detailed information is beneficial. The telephone service requires selecting menu options, and some people may not have the patience needed. However, the focus-group study produced somewhat different results. Most of the participants preferred to use the telephone service over the Web sites after trying them both. Further studies are needed to test and verify these hypotheses.

   With increased usage of traffic Web sites, the providers hope to eventually generate revenues from selling advertising slots on their Web pages, but this may take some time to materialize since the current market is too small to attract advertising.

3. *The TravInfo™ project was unable to greatly influence the travel behavior of the overall Bay Area population during the field test.*
   Because of the limited awareness of the TravInfo™ telephone service and Web sites, TravInfo™'s overall impact on Bay Area travel was minimal. Although the field test was aimed at evaluating advanced information technologies, TravInfo™'s challenge was its ability to influence travelers, to the greatest extent possible, so that they would make informed decisions. The TravInfo™ field test was not able to reach a wide enough audience or significantly influence its travel behavior.

4. *Information on consumers was not readily available.*

Like many field operational tests of advanced traveler information systems around the nation, TravInfo™ suffered from not having enough information about consumers. TravInfo™'s challenge was designing a telephone system that would attract a large number of travelers. Many assumptions were used in the design of the telephone system regarding the kinds of information that people might find useful and the menu structure that might allow users to easily reach desired information. Similarly, information service providers developed their products with many assumptions regarding map displays, text language, menu options, and information content.

5. *The long-term benefits of TravInfo™ to the traveling public were difficult to measure.* The ability to quantify the long-term benefits of information technology is important to project partners and sponsoring agencies. Public agencies do not have prototype models that would provide forecasting ability to accurately assess the long-term impact of traveler information technologies on travel behavior and transportation network performance. As a result, TravInfo™'s impacts were assessed qualitatively although quantitative measurements of both tangible and intangible benefits would be highly desirable for evaluating field tests.

Chapter 6
LESSONS LEARNED

The main lessons learned from the TravInfo™ field test are: how to build and maintain a successful public-private partnership; how to deal with technological, financial, and market uncertainties; how to manage delays of the project and planning/implementation issues; how to effectively include new ideas, new approaches, and new partners; and how to conduct an evaluation for a Field Operational Test.

How to Build and Maintain a Successful Public-Private Partnership

1. *It was necessary to lower the parties' expectations while working toward a common goal.*
   The public and private partners had different expectations from TravInfo™. The public partners expected to make TravInfo™ available for better congestion management, while the private partners expected to test and market products that would make a profit. It took a long time to reconcile their differing objectives.

   Within the public sector, each agency also had different expectations for the project's accomplishments. For example, the funding agencies expected the Board to adhere to the original project plan, although TravInfo™'s operational needs seemed to dictate changing directions in some ways. But the partners were able to overcome these differences and managed to hold the team together because of strong personal and organizational commitments to get the field test underway.

2. *The TravInfo™ organization was effective, but a consensus-based partnership was slow at making critical decisions.*
   The Steering Committee and Advisory Committee/Information Service Provider forum were valuable to the Management Board. By participating, their members added to the Board's base of knowledge and provided a forum for resolving issues outside Board meetings. The Steering Committee contributed large amounts of time and specialized expertise, and its Chair was an effective leader. The members of the Steering Committee spent time with individual working groups on the development of a common format for the TravInfo™ system. The TravInfo™ project manager and the Board staff were able to work effectively with TravInfo™'s complex organizational structure, which required strong leadership. All participants felt that the TravInfo™ organization was effective and did not suggest any major organizational changes.

   At the same time, a consensus-based partnership was slow to make critical decisions. In addition, organizing a large partnership for monthly meetings took considerable staff time and effort. As the project was deployed, it became clear that using an open forum for discussion might not be the most efficient method for advancing tasks. In some situations, using a small core of partners with a closed system might have been more efficient when designing and developing components such as TravInfo™'s

Traveler Information Center system. Nonetheless, keeping TravInfo™ as an open system was a good policy in that it invited many vendors to make contributions.

3. *Experts' advice was beneficial to the project team throughout the field test.*
Most public agencies do not have the necessary complement of in-house experts, and TravInfo™'s public partners were no exception. Unlike other participants in federally funded Field Operational Tests, the Board retained a technical advisor to the project team to oversee all phases of the TravInfo™ project. The Board and the project team felt strongly that they greatly benefited from this decision, especially because the advisor brought his necessary expertise to assist the project team from the agency point of view. Without that kind of help, agencies will not necessarily know what questions should be raised, or what technical issues should be addressed.

4. *The project goals were ambitious and unrealistic to achieve within the time allotted.*
Any new technology product requires sufficient time to be developed, tested, and marketed. In the case of advanced traveler information systems, perhaps product marketing takes much longer than the development and testing. The TravInfo™ project established goals not only to develop and test a baseline system, but also to deploy the system fully to have a significant impact on individual travel behavior and, ultimately, on the Bay Area transportation system.

   Likewise, the evaluation objectives were as ambitious as the project goals. The evaluators initially believed that the effectiveness of the TravInfo™ project could be measured based on the extent to which the TravInfo™ goals were achieved during the field test itself. In retrospect, these expectations were unrealistic. The purpose of the federal field test was to test one type of application in terms of its design, software capability, data sources, integration, and dissemination, primarily to learn what worked and what did not. The partners accepted the challenge to deploy the system so as to achieve a market penetration level high enough to influence travel behavior and transportation system performance. These expectations were virtually unattainable by the conclusion of the field test.

How to Deal with Technological Uncertainties

1. *A flexible system is needed to respond to rapidly changing technologies.*
While the original concept for TravInfo™ was open and flexible, TravInfo™'s final design was not. TravInfo™ will likely require enhancements, if not a complete replacement of its system, to keep up with advances in technology.

2. *Streamlining data collection would be effective.*
The TravInfo™ system is complex. A number of problems can occur at any link in the chain, due to unforeseen institutional and technical obstacles. Streamlining the entire process, from fieldwork data collection to receipt of information by end users, would help eliminate some of them. For example, when the project team tried to fill

some data coverage gaps with microwave radar devices, they encountered unanticipated difficulties in appending a new data stream onto the existing system.

3. *A more flexible approach to project implementation is necessary.*
   While productive at some levels, the project approach during the field test was not flexible enough to quickly respond to obstacles that arose during the project. The project team isolated individual problems within the system and tried either to fix them or to add new components to the system. At times, it was necessary to step back and reevaluate the system as a whole. For example, TravInfo™ was developed under the assumption that Traffic Operations System data would be available. With no control over the development, operation, or maintenance of that system, the Management Board, as a whole, could do little more than deal with individual problems as they arose, since responsibility for the Traffic Operations System was solely that of one public agency (a Board member). A clearly defined contingency plan and flexibility of public agencies' cooperative agreements might have circumvented those difficulties.

4. *Risk assessment and contingency planning policies are vital to moderating the potentially negative consequences of unforeseen events.*
   A vital lesson learned from the data shortcoming is that a risk assessment of data reliability and contingency planning needed to be made early in the field test. The larger issue, however, was the over-reliance on a separate project (leading to over-reliance on one data source) over which TravInfo™ had no control (14).

   Another lesson was learned from attempting to accomplish the tasks set out in the original field test plan with the inefficient system design of the Traveler Information Center. The operator-dependent, manual system was not able to deliver the service as efficiently as the partners had anticipated if the automated system they expected had been in place. A contingency plan for dealing with a system which does not perform as specified would help the partners take necessary action, either allow enough time and resources to redesign the system or purchase a system that is more responsive to TravInfo™'s needs.

5. *The design of a computer-user interface should reflect who the users are and incorporate their needs and assigned tasks into the design.*
   The software interface should be designed either by directly involving intended users, in this case Traveler Information Center operators, in the design process, or by developing and utilizing a profile of user characteristics and tasks to be executed. Such a profile would normally include attributes such as level of education and experience with computer systems. The system designer tried to do this; however, there was no existing operation to work from, and the designer utilized a proxy to substitute for actual operators. Additional benefits could have been derived had there been a prototype interface.

6. *The way the Traveler Information Center's organization is structured, while necessary during the field test, could benefit from appropriate streamlining measures.* The four-tier hierarchy of program manager, operations manager, supervisors, and operators was perhaps necessary and appropriate in the context of the field test, because TravInfo™ was newly deployed and depended greatly on the human/manual element in its operations. This structure was, however, somewhat top-heavy. As the system becomes more stable, and enhancements and improvements are made (e.g., to the Telephone Advisory Traveler Service's tracking system and the interface between the California Highway Patrol's Computer-Aided Dispatch system and the Traveler Information Center), and the level of automation increases, this organizational structure could be streamlined or reorganized, potentially resulting in operational benefits (12).

7. *Operator quality control measures need to be given priority during the early stages of a project and be maintained throughout its lifetime.*
   While it is important to hire able staff and initially train them, as was the case with Traveler Information Center operators, it is essential to have regular and frequent training updates and to supervise operators closely. Such attention was not always possible during the field test, because supervisors were over-extended at times. Another important lesson is that operator performance reviews should be instituted early on in the project, which was not the case with TravInfo™. Implementing strong operator quality control measures was given lower priority than other operational matters such as completing acceptance testing of the system and addressing both internal and external Traveler Information Center problems. Aggressive operator quality control measures were initially viewed as more of a longer term issue compared to more basic problems in data collection that needed immediate attention.

8. *Two-way communication among staff is an important ingredient in maintaining high morale.*
   Maintaining regular two-way communication among all levels of Traveler Information Center staff is important to help insure an appropriate level of involvement from staff members. This is especially important and useful in the solicitation of input from operators, since they work most closely with the data and know the system best from the perspective of day-to-day operations. While some operators would be glad to concentrate their efforts on the minutiae of their individual jobs, others take a more macro-level view and desire and can possibly benefit from a more global perspective. This was especially relevant during the latter half of the field test before there were assurances of TravInfo™'s continuation, and some operators expressed concerns over the continuation of their jobs (12).

How to Deal with Financial Uncertainties

1. *Sustained financial support of TravInfo™ operations from the public sector is critical to the private sector's success.*
   Because TravInfo™'s private partners rely on the continued availability of TravInfo™'s public data source to offer their products and develop new ones, they view it as extremely important for the TravInfo™ system to operate as a public service without interruption. The Board responded with a plan to provide public funding for an additional five years beyond the field test to help reduce information service providers' uncertainties involved in product development, as well as guarantee seamless operation of the TravInfo™ Traveler Information Center. Timelines set by federal and regional funding practices, however, prevented anything longer. The Board intends to seek additional public funding through regional mechanisms to secure continuing support of TravInfo™ in recognition of the need for public support for the nascent market in advanced traveler information services.

2. *The market for advanced traveler information was not mature enough to enable private-sector partners to share the costs with the public sector.*
   The TravInfo™ partners hoped that the private partners would be able to transfer some of their revenues from value-added information products built with TravInfo™'s data back into the operation by paying TravInfo™ for access to it. However, the market for their products has not matured enough to produce significant revenues, which has postponed the process of recovering some of the public money that has supported TravInfo™. Another issue was whether publicly collected data could be sold to information service providers for their profit. This issue has been brought up in statewide discussions, but is not resolved as yet.

How to Deal with Market Uncertainties

1. *The TravInfo™ field test was the tool for organized consumer research for public-private partners.*
   Through the TravInfo™ field test, the partners learned that the market for advanced traveler information was uncertain. The idea of TravInfo™ was to allow both the public and private sectors to conduct organized market research and product testing. From the evaluation studies of the TravInfo™ field test, the partners were able to obtain consumer information about the extent to which Bay Area travelers obtain traffic information and change their travel behavior based on that information. However, the evaluation of the field test was not able to cover all facets of consumer research on potential advanced traveler information system products or services. The studies suggested that value-added traveler information might attract a certain segment of the Bay Area population, especially those who have long commutes or are high-mileage drivers. Thus, information service providers might target those who are time-sensitive and find market niches for that targeted population, while public agencies might provide information services targeted to broader audiences with services such as the TravInfo™ telephone advisory service. These studies were,

nonetheless, limited in their application to the TravInfo™ telephone information service and privately offered traffic Web sites.

2. *Sharing information about privately conducted consumer research with the public partners would be helpful for the public sector to support privately offered information services.*
   Private-sector research on consumer response to its products or services would help TravInfo™ meet its needs. Extensive market research on consumer behavior for product development and testing would provide information on the marketability of individual products. In some cases, however, small firms cannot afford to conduct market studies and thus they are reluctant to develop new products. Several information service providers said that they lost their initial enthusiasm for developing privately offered traveler information services because of this lack of consumer knowledge.

   It is highly desirable to share consumer information between the public and private partners. Sharing information on privately conducted consumer research would benefit both public and private parties, especially when dealing with market uncertainty. Over the past several years, market research on advanced traveler information technologies has been performed by a large number of private firms in the U.S., as well as in Asian and European countries. However, very few information service providers were willing to share their findings with the TravInfo™ partners. With a better understanding of information service providers' data needs, the TravInfo™ public partners could gauge their efforts in terms of the type of information and the level of data coverage that would best support commercial advanced traveler information system products or services. Private-sector concerns over the loss of exclusive control of proprietary information and the potential loss of a competitive edge, however, would have to be addressed to convince the private sector to share such information. The private partners' information about their potential customers and their needs would help the TravInfo™ public partners to determine the level of TravInfo™ data coverage that would adequately support information service providers' commercial products.

3. *Marketing was critically important to the TravInfo™ deployment.*
   Both the public and private partners learned that effective marketing was essential for the TravInfo™ project. A more substantial advertising budget was necessary to promote public awareness of TravInfo™. Early in the process, the marketing working group, comprised of Steering and Advisory Committee members, developed a TravInfo™ marketing plan. Later, marketing consultants were retained to assist the TravInfo™ project team in designing a marketing plan, using advertisements on commercial radio, billboards, and other media. The partners, however, found that the plan was not effective in promoting TravInfo™. This was reflected in the call volume of the TravInfo™ telephone service during the field test. In order to increase public awareness of the TravInfo™ service, it was necessary to have a comprehensive and organized marketing plan with expert guidance. TravInfo™'s information service

providers also recognized that an organized marketing plan for their Web sites, in some cases, would have induced more people to use their services. According to the Web site providers, public exposure to their sites was only through interviews with reporters and articles written about them in conjunction with the TravInfo™ project; they did not have any organized advertising campaign. Correspondingly, the surveys of Web site visitors showed that a majority of them learned about traffic Web sites through a search engine or word-of-mouth. As a result, TravInfo™'s potential was not fully realized. The high level of user satisfaction with the TravInfo™ telephone system and participating traffic Web sites implies that people would use TravInfo™'s services if they were aware of them and had a chance to try them. The vast majority of traffic information seekers who used the TravInfo™ telephone system and Web sites were repeat users. As public awareness of TravInfo™ improves through better marketing, more people should come to understand the benefits of calling TravInfo™ or visiting traffic Web sites.

How to Manage Schedule Delays and Planning/Implementation Issues

1. *Alternative courses of action would help deal with planning and implementation issues.*
   In the planning phase, worst-case scenarios could have been developed and possible alternative courses of action could have been identified. During the planning phase of TravInfo™, the best-case scenario was used. It was expected that the Caltrans Traffic Operations System would progress on schedule, and that system contractors would adhere to contract schedules and deliverables.

   One alternative that was explored, during the system design phase, was to extend the field test schedule until a data coverage plan was fully developed and implemented, so that more detailed and timely information on traffic delays and local traffic conditions could be offered to end users. At the same time, information service providers could have assessed a market for commercialized information products. However, this approach was not feasible because the Board had a contractual obligation to the funding agencies to complete the field test within a reasonable time frame. Nonetheless, the TravInfo™ partners believed that they acted rightly in proceeding with the project, supporting the nation's pioneering effort in traveler information technology testing. Even though the TravInfo™ system was not as effective as had been anticipated, the partners believed that attempting to make it work was better than abandoning it altogether.

2. *Early consideration of potential risks associated with contractors could be beneficial.*
   The TravInfo™ organization wisely relied on outside assistance in developing the system and in resolving technical issues. This process, however, required third-party relationships. TravInfo™ contracted out various segments of the project. When dealing with many contractors, issues need to be resolved and agreement between parties has to be reached. Furthermore, unforeseen events can affect contractors' performance or their ability to meet their schedules. Flexibility built into the contract

would have helped the project team cope with contractual problems for dealing with schedule delays and the quality of deliverables. A contingency plan could have established risk-sharing mechanisms or insurance policies, such as "performance bond" between the contracting agencies and the contractors. Streamlining contractual procedures also would allow more timely execution of contracts.

How to Effectively Include New Ideas, Approaches, and Partners

1. *Collaboration among public agencies would be necessary to generate new ideas and new approaches for enhancement and promotion of TravInfo™.*
   A successful operation of a regional transportation system depends on a partnership involving regional and local public agencies working together to get useful information to the traveling public in order to achieve the common goal of improving the overall transportation system. Not only is there strength in numbers through this approach, but it is likely to generate new ideas and approaches to old problems.

   The TravInfo™ field test provides a good illustration of the benefits of such work. The three regional transportation agencies, the Metropolitan Transportation Commission, Caltrans, and the California Highway Patrol, thwarted by recurring shortcomings in the Bay Area's traffic surveillance system, collaborated on ways to improve it. The Metropolitan Transportation Commission developed new ideas about how the surveillance system could be improved, while Caltrans offered its experience in and expertise of how new surveillance technologies could be developed to enhance the existing system. In addition, Caltrans' funds were secured to upgrade and correct the existing loop detector systems to support TravInfo™.

   Unity of public support for the regional traveler information system is as important as the deployment by private partners of commercial products and services. If public agencies deploy these technologies unilaterally, it will only confuse travelers. This is evidenced in the case of Bay Area transit services, which are still working on implementation of a coordinated regional strategy.

   During the field test, all transit agencies allowed their information services to be routed through TravInfo™'s Telephone Advisory Traveler Service, 817-1717, but they also retained their own telephone numbers. This occurred despite surveys showing that Bay Area travelers found it convenient and helpful to be able to obtain all travel-related information through the single 817-1717 number. An exception was AC Transit, which made 817-1717 the sole traveler information source for its patrons. However, at the end of the field test, the agency added its own telephone number to TravInfo™'s.

2. *New ideas and approaches could be developed by sharing experience with others.*
   Perhaps the greatest value of the TravInfo™ field test comes from sharing the experiences from it with others. Since it was the first to test the concepts of open architecture and open partnership, it has a wealth of new findings. The partners gained

knowledge of building successful partnerships through, among other things, better understanding of different points of view and improved communication.

The project also generated new ways to organize the partners behind the Bay Area's regional transportation system. For instance, the Metropolitan Transportation Commission devised a new role for itself when it took on the responsibility of overseeing the management of the Traveler Information Center. As it worked closely with Caltrans and the California Highway Patrol, it generated a new institutional perspective on the Bay Area surface transportation system. Its challenge was to have the TravInfo™ system benefit travelers as well as Caltrans' traffic management system. Beyond making TravInfo™ economically feasible to be used by information service providers, the Board worked from the premise that TravInfo™ was to provide a public good.

3. *Active involvement with Field Operational Tests or Model Deployment Initiatives projects in other regions, to the greatest extent possible, would bring experience to the TravInfo™ project.*
   While many TravInfo™ private partners were actively involved in tests and model deployments of advanced information systems in other parts of the country, their role in TravInfo™'s unique open-architecture, open-partnership structure gave them national recognition. And although some regional systems implemented elsewhere could be more effective and easier to operate than TravInfo™, it provided a richer array of lessons applicable to private vendors in situations around the nation. At the same time, the TravInfo™ public partners led the way on architecture standards and other technology issues. Moreover, lessons learned from other projects would generate new ideas and new approaches for more effective use of resources and further enhancement of the TravInfo™ system.

4. *New partners could contribute to TravInfo™ with a different perspective about the project.*
   Continuity in representatives of the partner agencies and enterprises was important to the progress of the project; however, periodically bringing in new participants could provide new perspectives on project approaches. Despite outreach efforts dating back to early in the process, the TravInfo™ project team experienced the reluctance of potential partners, such as freight companies and transit agencies, to join the partnership because they had difficulty seeing the benefits of participation. As they become aware of the benefits of TravInfo™, it should be easier to convince new members to join.

How to Conduct an Evaluation for a Field Operational Test

1. *The evaluation plan was a "living" document and would undergo changes over time.*
   As the project evolved, revisions to the original evaluation plan were necessary. For instance, it was hoped to evaluate how much travel time and fuel were saved because of TravInfo™ and how much the air quality was improved as a result. But the lack of

travel-time data made it infeasible to make an accurate assessment of TravInfo™'s benefit to the Bay Area's transportation system on the basis of those criteria.

It was also hoped to measure changes in the performance of the Bay Area transportation network, using yardsticks such as traffic throughput, average speed, average travel time, variability of travel time, traffic delay, and vehicle emissions. It also would have incorporated traffic information on congested links and overall network speeds and traffic levels before and after TravInfo™'s implementation. When it was found that the needed data would not be readily available, this component of the evaluation was removed.

2. *Further research on the long- term impact on travel behavior is necessary.* Most studies of traveler behavior require at least five years, but the TravInfo™ field test only lasted two. Additional time would be necessary to assess consumers' reactions as they evolve — to determine if they learn to use the information and how they adapt to it, how they make their travel decisions and how those decisions are influenced by TravInfo™ and how their travel behavior evolves over a relatively long period of time.

3. *Regular meetings with the Evaluation Oversight Team were valuable.* The monthly meetings with the oversight team were useful to the evaluators; communication flowed both ways. Comments from members of the oversight team on interim evaluation reports provided invaluable insights into all facets of the project's progress and the complexity of public-to-public, public-to-private and private-to-private partnerships, with the added benefit of coming from an insider's perspective.

Chapter 7
RECOMMENDATIONS

These recommendations are based on the findings from the evaluation of all three components covered in this report. Recommendations 1-2 apply to field tests of other systems and similar projects in other regions, and recommendations 3-10 apply to TravInfo™ as it extends its operation beyond the field test phase.

1. *Allow more time for start-up tasks and pre-planning in future field tests.*
   TravInfo™ had an aggressive, optimistic schedule for the completion of comprehensive contract procedures and lacked a data coverage plan very early in the process. It did not allow sufficient time for the pre-planning work, including administrative start-up tasks and project planning associated with meeting those objectives and producing the documentation that any new undertaking requires.

2. *Develop a risk-management plan early in the planning process to deal with unforeseen challenges and to ensure consultants' compliance with project specifications.*
   As was common in many field tests, TravInfo™ had to cope with numerous unforeseen obstacles. It is highly desirable to develop a risk-management plan early in the planning process to deal with unexpected challenges and remove unanticipated obstacles. In the pre-planning phase, legal and institutional mechanisms could be identified to give agencies more leverage in seeing that contractors' and consultants' work complies with project specifications. In particular, software products that do not comply with design specifications have been a common problem for public agencies. In response, the Federal Highway Administration is currently developing national guidelines to assist both public agencies and contractors for intelligent transportation system projects.

3. *Continue the collaborative management and operation of TravInfo™ by the three regional agencies, the Metropolitan Transportation Commission (MTC), Caltrans, and the California Highway Patrol, with MTC continuing its lead role.*
   The open partnership established by the TravInfo™ partners as they pioneered this open-architecture approach to regional advanced traveler information systems is essential to the future success of the project. This institutional approach benefited the Bay Area as a whole tremendously, as well. If the partners continue to collaborate to improve the region's entire transportation system by enhancing TravInfo™, the long-term effect could be significant. The field test demonstrated that the three regional transportation agencies could complement, support, and learn from each other. The Metropolitan Transportation Commission should continue to manage TravInfo™, with Caltrans contributing its expertise in data collection and traffic operations systems, and the California Highway Patrol adding its expertise in incident management and freeway surveillance. Furthermore, continued strong leadership by the three regional transportation agencies could encourage other public agencies and private firms to join in the effort to deploy TravInfo™ on a regional level.

4. *Continue to seek public funding to support TravInfo™ operations while providing a continued data stream to information service providers for development, testing, and deployment of their value-added products or services.*
   The Management Board's decision to continue to operate TravInfo™ as a public good was wise for three important reasons. First, a broad dissemination of timely, accurate and reliable information will influence travel decisions, which will, in turn, enhance the Bay Area transportation system at large. Second, TravInfo™ will continue to improve the traffic surveillance system. Finally, it will help create a commercially viable market for advanced traveler information systems in the region.

   Making a longer-term commitment to operate TravInfo™ would make it more attractive to service providers and give them a continued incentive to make an extended commitment to using it. Even over the relatively short duration of the field test, service providers have been influenced by TravInfo™'s database in designing their products. However, for the service providers to offer long-term commitments to their customers, they need a long-term commitment from TravInfo™. TravInfo™ could also make itself more attractive to service providers by making its data available for national databases, demonstrating to providers that there are compelling products and conducting research confirming the existence of greater consumer demand.

5. *Conduct organized consumer research for a better understanding of the Bay Area market, and implement aggressive marketing strategies to increase public awareness of TravInfo™ and its privately offered products.*
   Successful deployment of information products requires suppliers to understand what their potential consumers consider to be the benefits of their new products and how their products could meet consumers' needs and desires. The TravInfo™ field test had a role in pointing out the importance of consumer research and generating information about Bay Area consumers' needs for such products to some extent, but the work was limited to research of travelers' behavior for the project evaluation. Consumer research should be a joint effort between public and private parties, since the research findings will inform how TravInfo™ can be enhanced to satisfy the needs of both individual travelers and information service providers.

   Public awareness of TravInfo™ is vitally important, and only a sustained and highly visible marketing campaign will bring any significant outcome, as advocated by many marketing experts (29). A good place to start would be coordinated inter- and intra-agency efforts to promote the Traveler Advisory Telephone System's 817-1717 telephone number.

6. *Improve the quality and geographic coverage of traffic data and continue to support research on and development of surveillance technologies.*
   The inferior quality of data generated from inductive loop detectors is not unique to the Bay Area freeway network, though Caltrans District 4 had greater problems than

other regions. Elsewhere, especially in European countries, reliable traffic information is being generated from loop detectors, but the average performance of other regions in the U.S. was found to be relatively low in comparison. Caltrans and the Metropolitan Transportation Commission have been actively seeking assistance from consultants and research institutions to improve the current system and are supporting further research on different surveillance technologies to augment the basic loop detector system. By applying a multiple-technology system to the Bay Area network, it would be more fully instrumented and better able to produce accurate, comprehensive, reliable, and timely traffic information.

7. *Develop a comprehensive outreach program for public and private parties to actively participate in deployment of a regional advanced traveler information system.*
   Local agencies and public transit authorities must be convinced that TravInfo™'s benefits — improved service for their constituencies and more efficient operations — extend across transportation modes and geographic and governmental lines. An example is the single, region-wide telephone number for travel-related information that TravInfo™ offered during the field test. Likewise, private parties should be educated about the benefits of joining the TravInfo™ project. Routing deliveries, for instance, could be made more efficient by avoiding traffic congestion. A comprehensive outreach program is needed to achieve this level of participation, with support from the public relations offices of the three partners.

8. *Encourage continued debate and discussion of topics of interest to service providers at the appropriate level.*
   TravInfo™, as one of the early initiators of a regional advanced traveler information system, should foster continued discussions in regional and national forums, e.g., ITS America, of potentially contentious issues affecting both private service providers and their public partners to facilitate their eventual resolution. In interviews, participants and observers raised the following issues:

   - *Sustained public-sector support is needed to encourage commercial applications.*
     In the view of the service providers, since there is an overriding public benefit to maintaining operation of the TravInfo™ Traveler Information Center, it should be funded with public money on a permanent basis. They also feel that such support is critical so that the public will not be deprived of the benefit of the enormous public investment in the national intelligent transportation system infrastructure. Along the same lines, the public sector should provide seed money to the information service provider market until it can become more self-sustaining and until public awareness of its products reaches critical mass. Charging service providers too much to support the overhead of maintaining the central database would stifle the market's growth.

   - *Databases should be connected in ways to encourage market growth.*

Service providers were divided over how databases should be structured. Some favored TravInfo™'s centralized regional approach since it helps prevent duplication, expedites the exchange of data between a large number of public agencies and offers a level playing field for commercial developers. Others, however, support the use of regional databases linked through a nationwide system of hubs so that firms can market information across regions. This approach could reduce the risk of regional databases being too fragmented.

- *National interface standards are needed.*
  Service providers felt that, to encourage commercial applications, public agencies across the nation should agree on common standards, as opposed to the current practice of having many formats and protocols.

- *The division of roles between the public and private sectors should be clear.*
  Some private-sector representatives advocated that the public sector limit its role strictly to gathering and fusing dynamic data into a cohesive real-time database, with no exclusive access to any one information service provider. Beyond that, the private sector should be left on its own.

9. *Improve the TravInfo™ operating system to the level of efficiency and automation that was originally intended and investigate the feasibility of redesigning the interface that operators work with to enter and process data.*
   The TravInfo™ operating system needs several enhancements to make it more productive and efficient. Although planned for the field test, they could not be completed. At a minimum, the interfaces between the California Highway Patrol's Computer-Aided Dispatch system and TravInfo™ and between TravInfo™ and the voice-processing system of the Traveler Advisory Telephone System need to be automated more. Although operator involvement needs to be retained to allow for more subtle interpretation of data, automating more of the routine tasks would substantially speed the flow of information through the Traveler Information Center and improve response times. Two other immediate, necessary steps are improving the reliability of TravInfo™'s operating system and coordinating with information service providers over standards for how TravInfo™ data are formatted and the modes by which they will be delivered.

   Although some improvements have been made to the interface since a system administrator was assigned fulltime to the Traveler Information Center (which did not happen until more than halfway through the field test), the system has largely been running on an "as is" basis. Some modifications have been made to the existing Traveler Information Center interface design to improve its functioning. They include the removal of rarely used items on commonly used windows and the alphabetical ordering of items to better support the operator in retrieving information. Because the center's performance depends so heavily on how well it supports the operators in performing their jobs, the project team should consider a more thorough revamping

that would give careful consideration to the needs and duties of the operators and a review of what has worked and what has not on similar systems. However, it should only be undertaken after a thorough determination of the costs and benefits of such a revision.

10. *Investigate new strategies to improve the quality and timeliness of data dissemination in the Traveler Information Center and carry out further assessment of operator response time to identify the significance of operator performance and operator workload so that appropriate remedies can be pursued.*
Since TravInfo™ is only as useful as the data that flow out of its Traveler Information Center, the operators there should be continuously trained in the most efficient methods available to help maintain familiarity with operational changes and to ensure the highest level of performance possible. The project team should also consider supplementing announced reviews of operators' performance with spot checks.

    The project team should conduct another analysis of the Traveler Information Center's response time, to see if stringent operator quality control measures put in place in September 1998 have had any significant effect on the speed and degree to which the Highway Patrol's Computer-Aided Dispatch incident data are entered into the Traveler Information Center database. The previous two response time analyses performed in January and June 1998 could serve as the basis for comparison. If only minor improvement is shown, then the project team should consider hiring more operators, as then operator workload and not operator performance would be the most influential factor. This analysis would also be valuable to measure potential gains from automating more aspects of the data input process.

Chapter 8
CONCLUSIONS

The premise behind TravInfo™ was that, over the long term, the public-private partnership would encourage the growth of technologies for collecting and disseminating data for advanced traveler information systems that would eventually encompass real-time information about modal options and routes. As the project moved out of the field testing phase and into full deployment in October 1998, TravInfo™'s mission shifted from being a testing-ground for these theories to being an integral part of the Bay Area transportation infrastructure.

At the conclusion of the TravInfo™ Field Operational Test, the project's overall goal was to focus on providing traveler information to the public at large. Several new principles are being adopted. The Executive Board, the Management Board during the field test, is to focus on TravInfo™ as a public service, operating the system "as is," with some improvements, until the Board retains a system manager to stabilize the TravInfo™ system and make more extensive improvements. During this time it will scale back its outreach to private-sector projects, but continue to provide data access to information providers. It will seek support from regional funding mechanisms to continue to collect, integrate, and broadly disseminate traveler information to the traveling public at large.

The commercial market for advanced traveler information products and services remains uncertain. Nevertheless, the Board will continue to support efforts to create one. Recognizing that the current database is too limited and unreliable to be marketable by most information service providers, the Board is to develop performance measures to evaluate how well the newly stabilized system works and determine where it can be strengthened.

The TravInfo™ field test provided a strong regional stewardship for an infant program and in the process pioneered a unique, open public-private partnership dedicated to a regional system built on the same philosophical commitment to openness through its open architecture. The experience benefited the Bay Area as a whole, both through an improved transportation system and the presence of a new, vigorous institutional collaboration. The private sector benefited from having a venue in which to test advanced traveler information products.

TravInfo™'s primary successes lay in developing a network of public and private professionals who collaborated on advanced traveler information projects in a variety of settings and providing a platform for different organizations to network and form partnerships. These networks and partnerships are the most significant and unique outcome of the field test and promise to result in many innovative traveler information services and products beyond the originally deployed traffic Web sites. Among the potential products are cable television outlets, digital cellular phones, personal digital assistant units, and in-vehicle navigators.

An unusually strong commitment from individual team members, parties involved in the partnership, and project management was evident in the TravInfo™ project. Two critical positions, the project manager and the Steering Committee chair, were led by especially committed individuals. Project staff members also showed a great deal of determination to make the project a success. Although this level of commitment did not materialize at all organizational levels, especially with local public agencies, it was a major strength of the TravInfo™ project.

The value of TravInfo™ is contained in the lessons learned from the Field Operational Test. The TravInfo™ experience can be shared with others who may develop similar systems elsewhere. The key lessons were: 1) adopting a process that is flexible enough to respond to institutional and technological changes, 2) building contingency plans to manage risks at various stages of project development and implementation, 3) recognizing the opportunities and challenges of the open-partnership approach, and, 4) acknowledging uncertainties of consumer demand for advanced traveler information systems.

TravInfo™'s partners will derive more benefits over the long term than the short term. New ideas have emerged, new approaches developed, and new partners solicited, which is in keeping with the TravInfo™ field test's key objective of developing social capital for appreciation over time. From the field test, TravInfo™ operators learned how to run the system better, and information service providers gained a better understanding of consumers' purchasing habits and the importance of marketing for their products. Beyond the economics of the information system, the partners learned the value of making firm commitments to collaborative partnerships.

New challenges and new issues have emerged with full deployment of the TravInfo™ project. The issues were: whether the project partners should continue to support data feeds; whether the private sector would continue to be interested in using TravInfo™ data; where the Traveler Information Center should be housed on a long-term basis; what contracting options for system refinements the Board will have, given the untested nature of granting third parties access to the system consultant's software; how to determine a reasonable system life-cycle cost for deployment planning and funding projections; whether project partners would continue to provide in-kind matches made during the field test; the degree to which the data coverage is adequate for public- and private-sector needs; how to improve the operational quality of the Traveler Information Center through automation; the feasibility of simplifying the Traveler Advisory Telephone System from seven digits to three to make it easier to remember and dial; and how to market TravInfo™ services for broad dissemination of traveler information.

Finally, the major challenges faced in the TravInfo™ field operational test were notably similar to those of other such tests throughout the U.S. The similarities were setting ambitious project goals that were unattainable within the limited time reserved for the field test; underestimating the extensive time required to develop mutual understanding and trust between participating parties; recognizing an uncertain consumer market for

commercialization of the service being tested; having inadequate information about how to put a consumer value on the information it was providing; defining appropriate roles for the parties involved; and appreciating the importance of having enough time and funds to “place” the product and convince people to use it.

REFERENCES

1. Metropolitan Transportation commission, "TravInfo Draft Deployment Plan, June 1998

2. Bay Area Ad Hoc IVHS Committee, 1992, "TravInfo, Bay Area Intermodal Traveler Information System," October 1992.

3. Randolph Hall, Youngbin Yim, Asad Khattak, Mark Miller, Stein Weissenberger, "TravInfo Field Operational Test Evaluation Plan," PATH Working Paper UCB-ITS-PWP-95-4, May 1995. Yim, Youngbin, Randolph Hall, Asad Khattak, Mark Miller, Stein Weissenberger, "Summary TravInfo Evaluation Plan," PATH Reports to Caltrans 95-C4, March 1995.

4. Yim,Youngbin, Randolph Hall, Alex Skabardonis, Robert Tam, Stein Weissenberger "TravInfo Field Operational Test: Work Plan for the Target, Network, and Value Added Reseller (VAR) Customer Studies," California PATH Working Paper UCB-ITS-PWP-96-13, University of California, Berkeley, April 1996.

5. Hall, Randolph, Youngbin Yim, Brian Pfeifle, Stein Weissenberger, "TravInfo Evaluation: Institutional Element Phase 1 Results," California PATH Working Paper UCB-ITS-PWP-95-01, University of California, Berkeley, January 1995.

6. Hall, Randolph, Dimitri Loukakos, Stein Weissenberger, Youngbin Yim, "TravInfo Evaluation: Institutional Element Phase 2 Results," California PATH Working Paper UCB-ITS-PWP-96-14, University of California, Berkeley, March 1996.

7. Yim, Youngbin, Elizabeth, Deakin, "TravInfo Evaluation: Institutional Study Final Results," California PATH Working Paper, UCB-ITS-PWP-2000-2, University of California, Berkeley, February 2000.

8. PMR Group, "ATIS – Alternative Revenue Approaches," January 1999.

9. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study (September 1996 – June 1997)", California PATH Working Paper, UCB-ITS-PWP-98-7, University of California, Berkeley, March 1998.

10. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *System Reliability and Communications Interface (9/96 – 12/97)*", California PATH Working Paper, UCB-ITS-PWP-98-21, University of California, Berkeley, September 1998.

11. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study*: Operator Interface Analysis-Phase III*",

California PATH Working Paper, UCB-ITS-PWP-98-22, University of California, Berkeley, September 1998.

12. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *Operator Interface Component-Phase IV: Institutional Analysis*", California PATH Working Paper, UCB-ITS-PWP-98-30, University of California, Berkeley, November 1998.

13. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: Response Time Analysis", to be published PATH Working Paper.

14. Miller, Mark and Dimitri Loukakos, "Final Report for TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study", to be published PATH Research Report.

15. Yim, Youngbin, Jean-Luc Ygnace, "Private-sector Views on Public-Private Partnerships Regarding Advanced Traveler Information Systems," 2nd World Congress of Intelligent Transportation Systems, November 1995.

16. Loukakos, Dimitri, Randolph Hall, Stein Weissenberger, Youngbin Yim, "TravInfo Evaluation: Value Added Resellers (VAR) Study Phase 1 Results," California PATH Working Paper UCB-ITS-PWP-96-13, University of California, Berkeley, April 1996.

17. Yim, Youngbin, Robert Tam, "TravInfo Evaluation: Information Service Provider Study Phase 2 Results," unpublished working paper, November 1999.

18. Yim,Youngbin, Randolph Hall, Stein Weissenberger, "TravInfo Evaluation Traveler Response Element: the Broad Area Study, Phase 1 Results," California PATH Working Paper, UCB-ITS-PWP-97-9, University of California, Berkeley, March 1997.

19. Yim, Youngbin, "TravInfo Evaluation Traveler Response Element: the Broad Area Study, Phase 2 Results," unpublished working paper, February 1999.

20. Khattak, Asad, Youngbin Yim, Linda Stalker, "Does Travel Information Equally Influence Commuter and Non-Commuter Behavior? Results From The San Francisco Bay Area TravInfo Project," Transportation Research Record, #1694, pp. 48-58, Transportation Research Board, National Research Council, Washington D.C., 1999.

21. Koo, Ronald, Youngbin Yim, Randolph Hall, "TravInfo Evaluation Traveler Response Element: the Target Study, Phase 1 Results," California PATH Working Paper, UCB-ITS-PWP-98-24, University of California, Berkeley, September 1998.

22. Koo, Ronald, Youngbin Yim, "TravInfo Evaluation Traveler Response Element: The Target Study, Final Results," California PATH Working Paper, UCB-ITS-PWP-2000-3, University of California, Berkeley, March 2000.

23. Yim, Youngbin, Randolph Hall, Ronald Koo, Mark Miller, "TravInfo Evaluation: TravInfo 817-1717 Caller Study Phase 1 Results" California PATH Working Paper, UCB-ITS-PWP-98-25, University of California, Berkeley, September 1998.

24. Khattak, Asad, Youngbin Yim, Linda Stalker, "Willingness to Pay for Travel Information: Combining Revealed and Stated Preferences with a Random Effects Negative Binomial Regression Model," Preprint published at the 79th Annual Meeting of Transportation Research Board, January 2000.

25. Yim, Youngbin, "TravInfo Evaluation: Travinfo 817-1717 Caller Study Phase 2 Results" unpublished working paper, June 1999.

26. Yim, Youngbin, "TravInfo Evaluation: Information Service Provider Study - Traffic Web Site Users and Their Travel Behavior," California PATH Working Paper, UCB-ITS-PWP-2000-5, University of California, Berkeley, May 2000.

27. Yim, Youngbin, Brian Pfeifle, Paul Hellman, "Evaluation of Radio Traffic Information in the San Francisco Bay Area," in Intelligent Transportation: Realizing the Benefits, Proceedings of the 1996 Annual Meeting of ITS America, Volume 1, Houston, TX, April 15-18, 1996.

28. Yim, Youngbin, "Consumer Response to Advanced traveler Information Systems: Focus Group Results," ITS America, 9th Annual Meeting Conference Proceedings, April 19-22, 1999.

29. Urban, Glen, John Hauser, Design and Marketing of New Products, 2nd ed. Englewood Cliffs, N.J.

[1] Other projects at the time emphasized the effectiveness of technologies for information delivery and value of the information while TravInfo™ also focused on the institutional arrangements and associated issues. The SWIFT project in Seattle also dealt with institutional arrangements. However, it began after TravInfo™.

[2] For example, ADVANCE (Chicago), FAST-TRAC (Oakland County, Michigan), and TravTek (Orlando) each involved the testing of in-vehicle navigation products.

[3] Various products such as information kiosks and Personal Digital Assistants were developed but did not utilize TravInfo™ data.

[4] The Bay Area Freeway Service Patrol is a joint project of the Metropolitan Transportation Commission Service Authority for Freeways and Expressways (MTC SAFE), the CHP, and Caltrans.

[5] A request for transit-related information transfers the caller to the selected transit service provider.

[6] A request for carpooling, vanpooling, and commuter check transfers the caller to either RIDES for Bay Area Commuters, Solano Commuter Information, or Commuter Check (an employer-sponsored program).

[7] A TATS voice-processing system input microphone is located at each operator workstation.
[8] This includes the time until the incident is first observed, reported to proper authorities, then forwarded on to the TIC.
[9] The work week, that is, Monday through Friday.
[10] Some changes have been made since the operator interface evaluation was conducted. In particular, rarely used items have been removed and ordering is now alphabetical.
[11] This estimate accounts for adjustments made for incidents the operators did not consider for TIC entry and for multiple CAD listings of the same incident.
[12] Information service providers are also waiting until they are able to have a national rollout of their products and services.
[13] This is based on an MTC estimate for commute time in 1998.