Empowering Employees and the Organization by Implementing and Evolving a Maintenance Management System
Three Years In

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In the past several years, several states have undertaken maintenance management system initiatives characterized by formal, competitive procurements; lengthy project duration; and significant investment of time and resources by both the acquiring organization and the selected provider. A description is given of how Vermont, operating in a resource-constrained environment, has pursued "a path less frequently traveled" to successfully implement and continue to evolve a maintenance management capability that has empowered its employees and has generated value and benefit for the Vermont Agency of Transportation (VAOT). Vermont adopted a strategy of fielding an initial core capability for the Vermont maintenance activity tracking system (VTMATS) and then augmented the core capability through a series of additional releases. VAOT successfully addressed the training and organizational change challenges associated with the implementation and operation of a new system. The challenges VAOT faced are described in terms of time frame (initial operation, first year of operation, and beyond), the benefit and value that have been realized, and the surprises (both unanticipated "wins" and lessons learned). Also addressed are the organizational relationships that have been created or reinforced through the operation of VTMATS and the incentives and empowerment of system users. Use of VTMATS to support maintenance management activities is far greater than initial expectations, and other experiences show how user expectations and perspectives have changed significantly during the past 3 years. The acquisition and resource requirements associated with the Vermont experience are examined in terms of how VAOT has implemented and evolved the VTMATS in a resource-constrained environment using alternative strategies and approaches that are streamlined, yet still yield effective and economical results. How the system is expected to mature and change over time relative to user and organizational expectations also is discussed.

Early in 1992 the Vermont state legislature directed the Vermont Agency of Transportation (VAOT) to pursue the feasibility of acquiring or developing a maintenance management system. An effort was undertaken to research what was available through polling and surveying other states, and visiting and viewing systems. This led to the acquisition of Arizona's PeCoS system. After a couple of years, all the available knowledge and experience from all the stakeholders were incorporated into a request for proposals. Difficulties with the agency's infrastructure and stakeholder turnover also contributed to a resultant system that did not perform as anticipated. At this time, a decision was made to revise the agency strategy to an approach that emphasized the establishment of a core capability that would enable Vermont to determine the cost of doing business and provide a basis for intelligent planning and budgeting. The past 3 years have reinforced the wisdom of being willing to change course; focus on starting with the basics and getting them right; build on successes in a modular, incremental fashion; and allow stakeholder discovery to generate subsequent successes and organizational buy-in. The sections that follow describe the

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Vermont experience with the Vermont maintenance activity tracking system (VTMATS) in pursuing "a path less frequently traveled" and the value and benefit realized by VAOT and its employees.

ARRIVING AT THE PRESENT SITUATION

When VAOT decided to revise its strategy, it examined the experience of the prior year(s) and developed an approach that would leverage its successes as well as capitalize on opportunities to do things differently. The strategy had to be able to address the basic, core capabilities and allow the organization to retain the ability to adjust to change. The direction that was set addressed the project from three perspectives, each of which was essential to the overall success of the system: the user perspective, the management perspective, and the technological perspective. Each is summarized below.

User Perspective

Part of the revised strategy involved revisiting the VTMATS effort from the user perspective. One of the primary goals was to get the basic capability in the hands of the end users to capture work done and resources consumed so that data capture would be in process while other capabilities were being developed. Two of the key considerations were (a) to recognize the end user as the key element of data capture, data entry, and data integrity; and (b) to limit the amount of data that the user must capture while making entry as easy as possible. In addition, it was recognized that the best chance for success was to create a positive incentive for the user to provide quality data. Time reporting and time-sheet generation through the VTMATS provided that incentive.

Management Perspective

Gaining management buy-in is important, but retaining that support is even more important. This was achieved through the revised strategy by focusing on the core capabilities and getting them correct. This led to a series of "early wins" with respect to the core capabilities and generated the momentum required to retain management support. The existence of policies, procedures, and activity standards from the earlier effort proved to be a plus in saving time and effort and enabling work to progress at a rapid pace in generating the early wins. Finally, the decision-making process was streamlined by empowering the project manager to make binding decisions for the effort. The overall management structure was retained, but the project manager was granted much more authority to act, which yielded tremendous savings in time and resources.

Technical Perspective

Among the technical considerations, there were two keys to the overall approach. The first was a decision to take a broad view of designing for the long haul but implementing for the near term with basic/core capabilities. The second key was candidly assessing the limitations and constraints of the existing environment and working within those boundaries. In the case of the former, a strategy was adopted to perform design with a view toward the future, which meant developing an overall blueprint for the system even though detailed design and development would involve separate functions and incremental capabilities. For the latter, a candid assessment of the current infrastructure identified the existing strengths to leverage as well as the limitations to offset. The results were a flexible, modular design that could be implemented in separate increments and an architecture that could be adapted to the technical environment without being tied to a particular technology or unique environment. Other elements of the technical perspective included the following:

- Using rapid application development alternatives and techniques was pursued.
- Deciding to use a small, focused, dedicated development team with short and direct lines of communication resulted in a high percentage of quality code that did not require significant rework.
- Establishing and maintaining close control over the development environment and the data and following basic development standards preserved the desired level of design flexibility.
- Recognizing and making data transfer an important design consideration (knowing the infrastructure capabilities and limitations) resulted in a very efficient application.

FIRST THINGS FIRST

Recognizing that the real value was tied to the data, the decision was made to "follow the money" by implementing a daily work reporting capability that would capture the labor, equipment, and material used to perform work and the associated work accomplishment. Figure 1 represents the latest review of the daily work report (DWR) screen. The information on the DWR was arranged by organizational units (down to individual workers) and identified work activities performed at specific locations. Implementing this capability first put emphasis on the largest group of users and at the same time began capturing data that would be needed later to support other capabilities (e.g., planning, budgeting, and year-end reporting as well as seasonal reporting). Also, a decision was made to conduct one-on-one visits with users to load the application, perform training reinforcement, and obtain

FIGURE 1   Daily work report screen.

immediate feedback from initial users. The payback on this decision was substantial because the users understood what they were doing with the system and why, rather than simply responding to a system prompt. This was possible because of the reasonable number of users and workstations and the willingness of several maintenance personnel to assume a support role for the application. Over time, the support role that began as an additional duty became a full-time role for some, and for others that role provided a means for career transition and upward mobility within the organization.

The initial capability also included DWR accomplishment reporting and unit and statewide rollup reporting for the data associated with DWR. A detailed DWR listing by time frame is shown in Figure 2, and Figure 3 presents a statewide summary by district. This was immediately followed with the ability to generate employee time sheets from the data in the system. While users were continuing to report on a daily basis, the next increment was being prepared for release. It included

- Stockpiles,
- Special events,
- Expenditure accounts, and
- Rental contracts.

These capabilities were released in the spring of 1998. By fall of 1998 the winter storm report was ready before the upcoming winter season; and in the spring of 1999, Planning and Budgeting was ready to be fielded before the beginning of the next fiscal year in July 1999. In each case the implementation choices were made by weighing the benefit of what would be implemented against the value to the users and to the maintenance program.

At the same time that these incremental capabilities were fielded, there was a growing base of data available for use in the system. In late 1997, there were approximately 65,000 records. That number grew to a cumulative total of 360,000 records in 1998, 750,000 in 1999, and 1,280,000 to date in 2000.

HOW VERMONT USES THE DATA

With an expanding body of data available, opportunities began presenting themselves to the Maintenance Division, the districts, and the units for data analysis and reporting. It was no longer necessary for users or managers to wait for end-of-month, quarterly, or yearly reports to be generated to review productivity, cost, or accomplishment. Information was available on demand, as shown in the architecture in Figure 4. It also is important to recognize that the edits and error checking accomplished during source data entry resulted in better data quality. When it

became known that a database of quality information was available, the Maintenance Division began receiving requests for information for accounts from many other organizations and individuals. Some of the more significant uses of the data include the following:

- Adjusting and refining maintenance activity standards based on actual experience and even tailoring the standards based on local differences among units;
- Calculating unit costs for all maintenance activities, and comparing and analyzing the unit costs throughout the state;
- Capturing data and reporting on special events such as individual snowstorms, floods, and ice storms;
- Developing and managing budgets and allocations to districts and units;
- Developing annual program goals and objectives and reporting progress and results against the program plan;
- Comparing annual accomplishments and expenditures (unit-level and rollup reports);
- Comparing self with other organizational elements;
- Responding to inquiries from the organization, management, and the public (e.g., press and citizens);
- Performing federal reporting (system outputs accepted as valid reporting for the Federal Emergency Management Agency requirements);
- Performing insurance reporting and accident reporting;
- Managing expenditures and expenditure rates for activities and organizational units; and
- Reconciling central garage equipment usage with changes in actual equipment readings.

Many more possibilities will exist as more data become available and as additional capabilities are implemented.

OPPORTUNITIES REALIZED IN VERMONT

Vermont is approaching 3 full years following the implementation of VTMATS and has accumulated an expanding reservoir of quality, statewide maintenance data. VAOT knows what work was performed, what the work cost, where the work was performed and by which unit, and what was accomplished. During this time, the accumulation of small wins has produced a major victory for the agency and has substantiated the wisdom of the strategy pursued. Three years in, Vermont is able to

- Produce maintenance accountability and accomplishment reporting, by organizational unit or by event, for any time period;
- Prepare performance objectives and goals for the workforce and plan, budget, and monitor progress against the objectives;

File   Edit   View   Admin   Planning & Budgeting   Work Reporting   Rental   Reports   Window   Help

Work Reporting (List)

Unit: 0000 - View Statewide Data

Activity: [All]

From Date: 04/01/2000

To Date: 05/08/2000

Apply

DWR Num	DWR Date	Reporting Unit	Activity	Expenditure Account	Special Event	Asset
533969	5/6/2000	1900 - Dist 9, Office	0017 - General Admin	MD09 000		District 9 - Derby
533986	5/6/2000	1900 - Dist 9, Office	4220 - Paving	SMA0009 401	D9 FY00 Recycle Ho	N/A
533859	5/6/2000	1940 - Westfield	4110 - Patrolling and I	MD09 000		Non-Interstate
533971	5/6/2000	1500 - Dist 5, Office	0017 - General Admin	MD05 000		District 5 - Colcheste
533782	5/6/2000	1512 - Colchester B	4620 - Installing Culve	RSTR300 405	D5 2000 FED CULV S	N/A
533990	5/6/2000	1200 - Dist 2, Office	0017 - General Admin	MD02 000		District 2 - Dummers
533764	5/5/2000	1460 - Windsor	4210 - Leveling	SMA0004 401	D4 FY00 VT44 A - U	N/A
533765	5/5/2000	1460 - Windsor	0014 - Leave Time	MD04 000		District 4 - White Riv
533746	5/5/2000	1800 - Dist 8, Office	0017 - General Admin	MD08 000		District 8 - St Albans
533734	5/5/2000	1012 - T-Shop, Colchester	5830 - Working for Ot	OBDSMAIN 000		Traffic Shop
533738	5/5/2000	1012 - T-Shop, Colchester	4940 - Painting Edge L	MARK300 400	Statewide STP Edge	Non-Interstate
533736	5/5/2000	1400 - Dist 4, Office	0014 - Leave Time	MD04 000		District 4 - White Riv
533733	5/5/2000	1400 - Dist 4, Office	0017 - General Admin	MD04 000		District 4 - White Riv
533721	5/5/2000	1230 - Londonderry	0017 - General Admin	MD02 000		District 2 - Dummers
533727	5/5/2000	1230 - Londonderry	4630 - Ditching	MD02 000		N/A
533724	5/5/2000	1230 - Londonderry	0014 - Leave Time	MD02 000		District 2 - Dummers
533717	5/5/2000	1130 - Wilmington	4880 - Washing Bridg	PVNT200 401	D1 FY00 Bridge Was	Non-Interstate

Insert   Modify   Close

Ready

FIGURE 2   DWR detailed listing by date.

MATS System Administration - [DWR Totals]   _ ☐ ☒

File   Edit   View   Admin   Planning & Budgeting   Work Reporting   Rental   Reports   Window   Help   _ ☐ ☒

Date: 04/01/2000 🔘   To Date: 04/30/2000 🔘   Apply

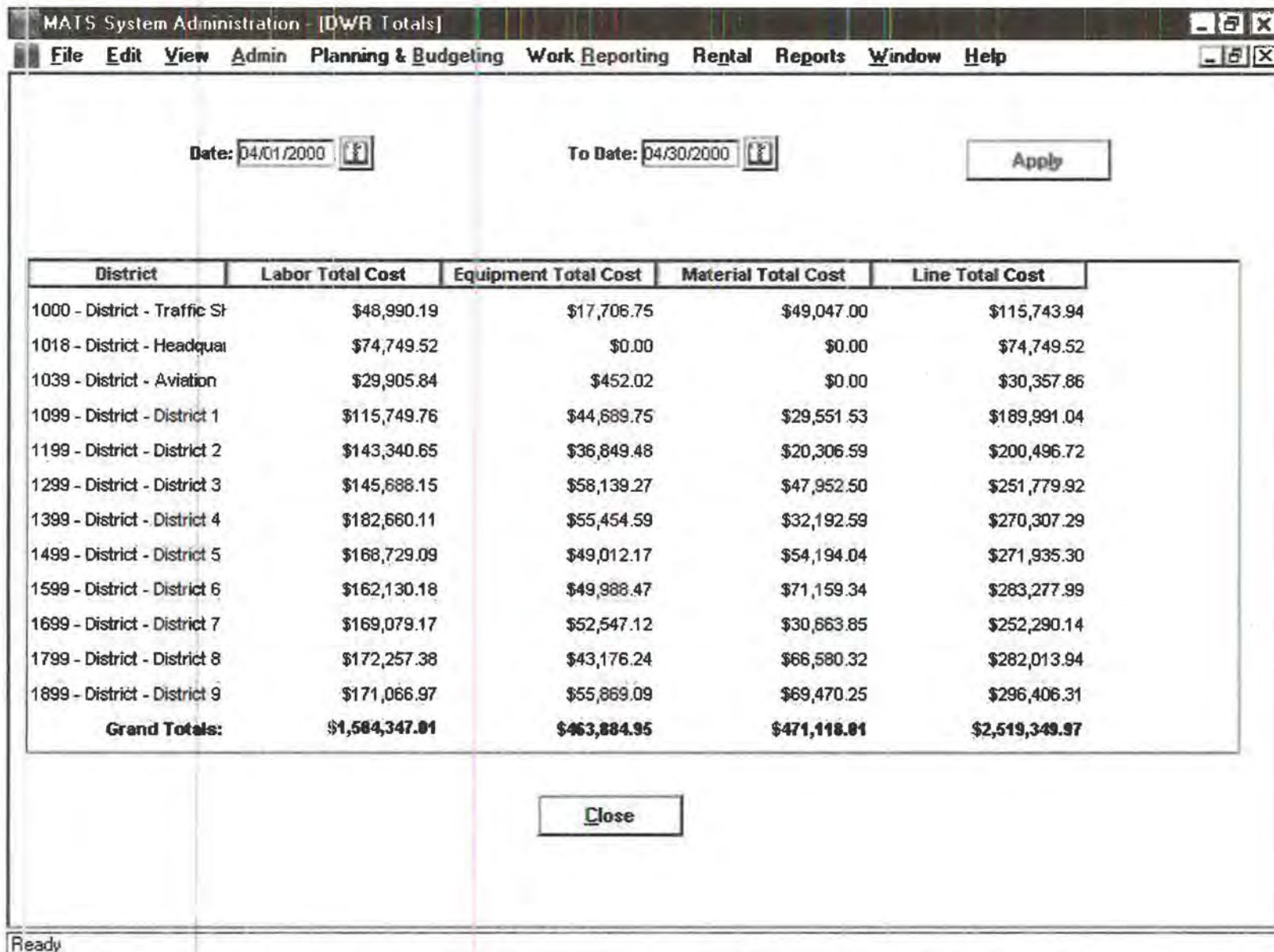| District	Labor Total Cost	Equipment Total Cost	Material Total Cost	Line Total Cost
1000 - District - Traffic St	$48,990.19	$17,706.75	$49,047.00	$115,743.94
1018 - District - Headquar	$74,749.52	$0.00	$0.00	$74,749.52
1039 - District - Aviation	$29,905.84	$452.02	$0.00	$30,357.86
1099 - District - District 1	$115,749.76	$44,689.75	$29,551.53	$189,991.04
1199 - District - District 2	$143,340.65	$36,849.48	$20,306.59	$200,496.72
1299 - District - District 3	$145,688.15	$58,139.27	$47,952.50	$251,779.92
1399 - District - District 4	$182,660.11	$55,454.59	$32,192.59	$270,307.29
1499 - District - District 5	$168,729.09	$49,012.17	$54,194.04	$271,935.30
1599 - District - District 6	$162,130.18	$49,988.47	$71,159.34	$283,277.99
1699 - District - District 7	$169,079.17	$52,547.12	$30,663.85	$252,290.14
1799 - District - District 8	$172,257.38	$43,176.24	$66,580.32	$282,013.94
1899 - District - District 9	$171,066.97	$55,869.09	$69,470.25	$296,406.31
Grand Totals:	**$1,584,347.01**	**$463,884.95**	**$471,118.01**	**$2,519,349.97**

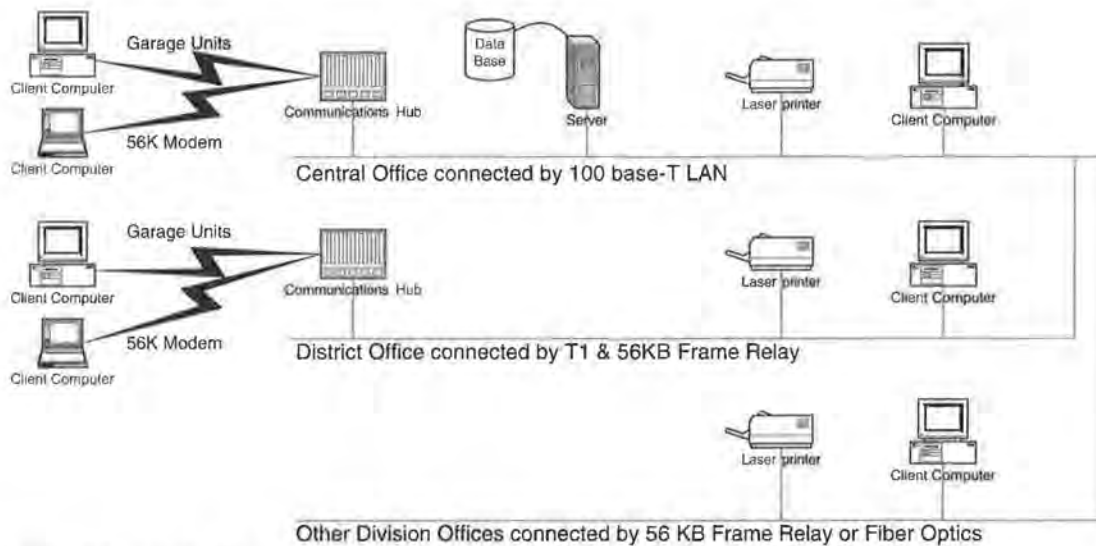Close

Ready

FIGURE 3   DWR statewide summary by district.

FIGURE 4 VTMATS production environment.

• Minimize the burden on the end user for data entry while maintaining a high level of accountability and data management;

• Respond rapidly to inquiries from senior management, the legislature, and municipalities with accurate, detailed information;

• Demonstrate a knowledgeable, empowered user community that understands what they are doing with the system and why, rather than simply responding to a system prompt;

• Gain support for future enhancements based on the value being delivered by the current capabilities of VTMATS;

• Interface with the financial system for equipment usage, expenditures, labor costs, materials costs (including federal projects reporting), and rental contracts;

• Provide time reporting and time-sheet printout;

• Prepare proactive planning and budgeting based on documented activity standards, unit costs, and levels of service;

• Provide accurate materials management (stockpile management); and

• Continue moving forward with an overall strategy based on design flexibility and architectural/technological independence that permits VAOT to leverage its strengths and accommodate its constraints.

Additional value is realized through the ability to provide both detailed and summary information at the unit, district, and statewide levels empowering users and managers throughout the agency. Overall there is less reliance on paper and an increasing use of electronic transfer and sharing of information. A positive indication of this general empowerment is the fact that the number of users doubled between the first and second years of operation with many requests coming from nonmaintenance personnel. Another example of empowerment occurred during a recent outbreak of a computer virus. VAOT was able to assist in the "cleanup" effort by mobilizing the extended VTMATS support staff to visit every computer and perform the necessary diagnostic work; and through the use of special events, VAOT was able to identify the costs of this effort.

WHERE DO WE GO NEXT?

Three years in, Vermont finds itself in a position to continue moving forward, capitalizing on the credibility achieved and the victories gained rather than trying to overcome hurdles, obstacles, and setbacks. The near-term decision is to stay the course and follow the strategy that has produced the successes to date—specifically, to build on the past 3 years by adding and implementing more capability within VTMATS by weighing the benefit and value of each capability to the users and the maintenance program. Of paramount importance in pursuing this path is retaining the ability to adjust to change and capitalize on opportunities that arise. Preserving design flexibility and architectural independence and understanding our limitations are the keys to future success for Vermont.

Figure 5 summarizes the direction followed from a technical perspective. Some of the functional and business initiatives that are currently under consideration for "where we go next" include

• Building and expanding on inventory information;

• Creating linkages to both bridge and pavement management;

	Startup	Current	Future
Database Server			
Make	IBM PS/2	Compaq Proliant 3000	Compaq Proliant 3000
Processors	1/150 MHz	2/500 MHz	2/1000 MHz
RAM	208 MB	4 GB	4 GB
Hard Drives	2/10 GB	3/24 GB	5/90 GB
Operating System	NT 3.51	NT 4.0	NT 2000
Databases			
Databases	SQL Server 6.0	SQL Server 7.0	SQL Server X.X
			Oracle Y.Y
Users			
Modem	40	35	30
LAN/WAN	30	75	90
Other	0	0	100
Other Servers			
Other Servers	NA	NA	Web
			Application
Client Computers			
Make	Compaqs	Compaqs	Any
Processor	33 MHz	266 MHz	Any
RAM	8 MB	32 MB	Any
Operating System	Windows 3.1	Windows 95	Inter/Intranet capable
		Windows 98	
		Windows NT	

FIGURE 5   Technical environment.

• Refining and creating more comprehensive interfaces to the finance, human resources, equipment, environmental, and agriculture communities;

• Developing linkages to data warehouse and geographic information system initiatives;

• Providing Internet access to selected maintenance data;

• Discovering additional uses for the data through proactive "data mining"; and

• Developing partnerships with other state transportation departments and the federal community to share software and data and lessons learned.

Viewed as a whole, these initiatives might seem overly optimistic, but based on the results of the past 3 years it is believed that having a strategy of creating incremental, value-based capabilities and following it will continue to produce major victories for Vermont.