

Transportation Asset Management Case Studies

Presented by



U.S. Department
of Transportation
**Federal Highway
Administration**

D A T A I N T E G R A T I O N

The Colorado Experience





Note From the Director

The Federal Highway Administration Office of Asset Management is aggressively promoting a different way for transportation agencies to distribute their resources among alternative investment options. This new way of doing business, referred to as "Asset Management," is a strategic approach to maximizing the benefits resulting from the expenditure of agency resources.

For any transportation agency, the progression toward effective Asset Management practices will involve a range of activities. These endeavors will differ from State to State. For example, some agencies will pursue a data integration strategy in order to ensure comparable data for the evaluation of investment alternatives across different asset classes. Others will move to deploy economic analysis tools to generate fact-based information for decision-makers. Still others will want to integrate new inventory assessment methods into their decisionmaking processes.

Much can be learned from those who are readying their organizations for Asset Management. To spark the exchange of information, we initiated a series of case studies last year, focused on agencies that are leading the way. The series involves four tracks: data integration, economics in Asset Management, the Highway Economic Requirements System–State Version, and life-cycle cost analysis. Through the years, we will add new State reports to each of the tracks and create new tracks addressing other facets of Asset Management, such as change management and performance measurement.

On behalf of the Office of Asset Management, I am pleased to add this case study on data integration to the series. We believe the case studies will help agencies meet the challenges of implementing Asset Management programs.



David R. Geiger
Director, Office of Asset Management
May 2004

Note to the Reader

The Transportation Asset Management Case Study Series is the result of a partnership between State departments of transportation and the Federal Highway Administration (FHWA) Office of Asset Management. FHWA provides the forum in which to share information, and the individual States provide the details of their experiences. For each case study report, FHWA interviewed State transportation staff, and the resulting material was approved by the State. As such, the reports rely on the agencies' own assessment of their experience. Readers should note that the reported results may or may not be reproducible in other organizations. ■



Night paving on the Transportation Expansion Project, I-25 in Denver

Executive Summary

Since 2000, the Colorado Department of Transportation (CDOT) has undertaken several important initiatives designed to improve transportation planning, decisionmaking, and resource allocation. Today, CDOT recognizes that data integration plays a critical role in improving business processes and managing assets. Thanks to institutional policy changes and forward-thinking information technology planning, the department is successfully integrating data to support Asset Management.

CDOT approached the issue of data integration to support Asset Management from both the policy and information technology perspectives. On a policy level, CDOT has been reorganizing its business planning processes since the early 1990s by defining investment categories and associated performance measures. CDOT also officially recognized Asset Management as a critical function within the department by appointing an Asset Management Task Force.

These institutional actions set the stage for connecting departmental goals with business planning to ensure efficient allocation of resources. At the same time, the Information Technology branch of CDOT has been working to better serve this business approach by providing more efficient information transfer across asset and program areas. ■

AGENCY FACTS

CDOT manages an aging interstate highway system that carries more than 40 percent of statewide highway travel.

Colorado's transportation needs are shaped by many geographic, economic, and societal factors. In terms of geography, Colorado covers 104,100 square miles and has the highest average elevation of any State, about 6,800 feet above sea level.

Large variations in Colorado's terrain, climate, and demographic characteristics contribute to a broad economic base. Colorado's diverse economy makes CDOT's job of providing transportation services a challenging one. The department must serve passengers, freight, and information moving on a local, interregional, interstate, and international level, while balancing the needs of urban and rural residents. It must, in allocating its resources among competing transportation projects and services, account for statewide goals to which transportation makes a critical contribution.

CDOT is responsible for a 9,135-mile State highway system that includes more than 3,700 bridges and 20 State-owned tunnels. Each year, this system handles more than 23 billion vehicle-miles of travel. Although interstate highways account for only about 10 percent (954 miles) of the total miles in the State system, they carry 40 percent of Colorado's highway travel.

Nearly 50 percent of the interstate system was built before 1965, and nearly 75 percent before 1970. With a 20-year design life, much of it now requires extensive repairs.

Colorado's harsh winters also take their toll on the highways. In 2003, CDOT maintenance crews plowed 5.9 million miles of highway and used more than 330,000 tons of asphalt to repair potholes and other road damage. Eight miles of road wind through the alpine tundra above 11,000 feet and take an average of 42 days to plow.

The State's transportation systems (including roadways, rail corridors, transit services, bicycle and pedestrian ways, and commercial and general aviation airports) are managed by CDOT under the direction of the State Transportation Commission. The Commission is statutorily authorized and composed of 11 commissioners who represent specific districts. CDOT administers an annual budget of \$780 million and more than

3,300 employees. Organizationally, CDOT delivers projects and services through its six Transportation Regions.

SETTING THE STAGE

What Did CDOT Have?

In the late 1990s, with the strong support of executive management and the Transportation Commission, CDOT began to reorganize its business planning process. The department developed an Investment Category Structure, a framework that enabled it and the Commission to relate statewide programs to goals and objectives, monitor progress, and provide accountability through defined performance measures. Five investment categories were defined as strategic focus areas that the department can use to align its strategic plan and resources to better address customer service needs and support its mission:

Several information systems in CDOT existed in stovepipes with little or no automatic transfer of data between them.

- **Mobility**—Programs, services, and projects that provide for the movement of people, goods, and information.
- **System Quality**—Activities, programs, and projects that maintain the function and aesthetics of the existing transportation infrastructure.
- **Safety**—Services, programs, and projects that reduce fatalities, injuries, and property damage for transportation system users.
- **Strategic Projects**—High-priority, statewide projects that are committed for accelerated funding.
- **Program Delivery**—Support functions that enable the delivery of CDOT's programs and services.

To supplement these investment categories, the Transportation Commission and Executive Management Team developed departmental goals, objectives, and performance measures. The following table lists the investment categories, goals, and performance measures used by CDOT.

Category	Goals	Performance Measures
Mobility	Improve mobility Increase travel reliability	Roadway Congestion Index and newer Travel Rate Index Number of road closures by closure type Duration of road closures by closure type Customer perceptions of travel time variability
System Quality	Preserve the transportation system Keep the system available and safe for travel	Pavement surface condition rating of “fair” or “better” Bridge sufficiency rating of “fair” or “better” Bridge needs versus programmed work, by on-system and off-system bridges Maintenance condition survey (current level of service) for preservation activities
Safety	Reduce transportation-related crashes, injuries, and fatalities, and the associated loss to society	Reductions in statewide fatal crash rate, statewide injury crash rate, and statewide total crash rate Customer perceptions of CDOT’s safety activities
Strategic Projects	Accelerate the completion of projects Increase investment in the program	Funds budgeted, encumbered, and expended for each project Estimated completion dates and status of each project
Program Delivery	Deliver high-quality products and services in a timely fashion Attract and retain an effective and qualified workforce Foster an environment that respects workforce diversity	Performance measures defined at the Program Level

The Investment Category Structure was unique in the following ways:

- It integrated several elements critical to Asset Management within a coherent, overarching framework.
- It structured investments based on policy objectives and impacts on performance rather than on funding sources.
- It facilitated the analysis of tradeoffs among capital, maintenance, and operations program categories.

The department complemented the Investment Category approach by updating the statewide planning process and the program prioritization process, establishing maintenance program levels of service, instituting the use of customer surveys, and updating relevant information technology (IT) applications. CDOT also began to focus on Asset Management, by forming an Asset Management Task Force in 2001.

As CDOT undertook these policy changes, staff realized that many business processes were not directly supported by advanced IT. For example, several departmental systems, including database systems, existed in “stovepipes” with little or no automatic transfer of data between them. Many of the systems were outdated and existed on mainframe or PC platforms that made integration of major data systems such as bridge and pavement management systems nearly impossible. Each of the systems was generating its own reports for customers, including the Transportation Commission and FHWA. This structure made it difficult to obtain critical information needed for decisionmaking. CDOT then asked the question, “What can IT do to support business better?”

By 2002, the performance measures within the Investment Categories were helping CDOT evaluate the effectiveness of its plans and policies. The goals indicated the department’s desired future direction, and Asset Management defined how assets should be treated to meet business objectives. The missing element was integrated data to inform this decision-support system.

What Does CDOT Want?

CDOT envisions an integrated business process to support decision-making and long-range planning. Ultimately, CDOT would like to be able to analyze the tradeoffs and determine the returns on transportation investments across different funding categories. For example, the

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department would like to be able to inform its Transportation Commission about the benefits to the traveling public of a certain level of expenditure in pavement preservation in comparison to the benefits from bridge improvements.

Integrated data to support this balancing process is critical.

IT is a major force behind successful data integration, which in turn is needed to support Asset Management. For CDOT, Asset Management represents a strategic approach to managing transportation infrastructure that will help the department achieve three major goals:

- Cost-effectively build, preserve, operate, and reinvest in its facilities to improve performance.
- Offer its customers the best value for the dollar spent.
- Enhance its credibility and accountability as a steward of transportation assets.

CDOT is moving quickly toward a completely integrated data system, supported by the rapid development of its geographic information system (GIS) services, the implementation of the Strategic IT plan, and the migration of stovepipe/desktop applications to an enterprise environment. The Strategic IT Plan, created in 2001, halted development of all IT systems and consequently attracted the attention of the entire department. The plan required the justification of the business case for all new applications and approval of the Information Technology Management Team (ITMT) to ensure its consistency with the overall strategy. The Strategic Plan's five high-level goals are as follows:

1. Treat information as an asset used to make key decisions, and manage it accordingly.
2. Ensure that integrated IT planning occurs.
3. Ensure a flexible, adaptable IT structure.
4. Ensure that IT remains customer-focused.
5. Recognize e-government as a vision.

The evolving integrated data system will support resource allocation decisionmaking crucial to the update of CDOT's next 20-year transportation plan.

HOW IS CDOT GETTING THERE?

Overall Approach

CDOT is implementing data integration to support Asset Management by coordinating efforts at the policy and technical levels.

From the technical standpoint, careful IT planning and thoughtful GIS planning are contributing to the necessary platforms on which CDOT is building its integrated data system.

CDOT established a strong policy framework to support Asset Management and data integration.

Policy Framework

CDOT has formed three active policy groups made up of executive management staff. Coordination among the three groups is ensured through overlapping memberships.

The first group, the Asset Management Task Force, was established in 2001 to oversee the implementation of an Asset Management Plan. The Task Force is headed by the Deputy Director of CDOT and includes 10 representatives from across the department. The Task Force operates on the premise that Asset Management is “a way of doing business,” and has these major objectives:

- To provide high-level leadership and encourage departmental executives and managers to accept the program
- To translate recommendations quickly into actions, maintain a long-term perspective on objectives and tasks, periodically assess planned versus actual accomplishments, and perform mid-course adjustments when needed
- To coordinate actions across the department’s organizational units and guide development and implementation of integrated practices where needed (e.g., data collection and processing, evolution of GIS capabilities)
- To provide a credible and effective organizational basis for communicating plans and accomplishments to the Transportation Commission, and to implement the Commission’s recommendations regarding Asset Management efficiently and effectively

CDOT developed an Asset Management Plan that recommends specific actions to build upon and expand these objectives. Highlights of the plan include:

- Completing all elements of the Investment Category structure
- Incorporating Asset Management principles into CDOT's planning and programming processes, building on a tiered structuring of assets
- Integrating Asset Management information on a GIS platform and renewing IT strategic planning to support Asset Management throughout the department
- Strengthening program delivery mechanisms and measures

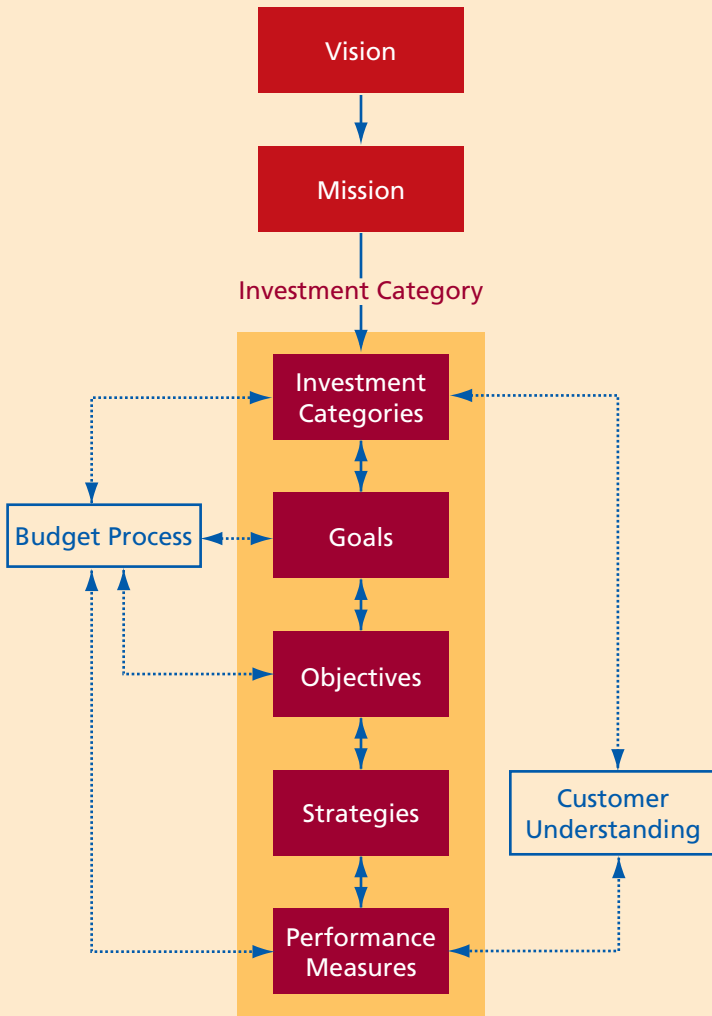
The diagram on the next page shows CDOT's Asset Management process and where the Investment Category Structure fits in this process. CDOT identified nine steps needed to develop its Asset Management program:

- Creating an investment strategy (done)
- Obtaining executive management support (done)
- Establishing departmental task force (done)
- Developing an Asset Management Plan (done)
- Identifying implementation steps for near-term, mid-term, and long-term tasks (ongoing)
- Integrating departmental data (ongoing)
- Continuing to validate Performance Measure Program (ongoing)
- Incorporating tradeoff analysis across programs (ongoing)
- Integrating into planning process (ongoing)

CDOT's Asset Management Process connects departmental goals with business planning to ensure efficient allocation of resources. The Investment Category Structure is the business-planning process that establishes goals, objectives, monitors progress, and provides accountability through performance measures. As stated earlier, investment categories include mobility, system quality, safety, strategic projects, and program delivery. The Asset Management plan recommends a set of actions to build upon and expand the objectives of the Asset Management Task Force.

The second policy group, the Information Technology Management Team (ITMT), was formed in mid 2001 to address IT policy and technical issues, as described in the Information Technology Support section below.

Colorado Department of Transportation Asset Management Process



The third group, a subcommittee of the Executive Management, was established in August 2003 to refine CDOT's performance measures. The group is evaluating the strengths and weaknesses of the performance measures and comparing the department's practices to best practices across the Nation.

The department is currently evaluating how these three committees might be restructured. For example, due to the overlap in membership, many Asset Management topics are being addressed in ITMT meetings. The goal is to maximize executive management's time while staying focused on a few key initiatives.

Information Technology Support

Integration of data, technologies, and applications is critical to carrying out the department's Strategic IT Plan.

CDOT established a Strategic Information Technology Plan in the early 1990s to drive the development of coordinated, non-stovepipe applications. However, the plan was not enforced, and independent desktop applications continued to be

developed by a variety of different units within CDOT.

The department realized that the IT function could be more aligned with the direction of its integrated business processes. Based on recommendations contained in three reports,¹ the Information Technology Resource Team was formed, then reconstituted in mid 2001 as the Information Technology Management Team (ITMT). The ITMT guides information technology policy and fosters integrated IT planning. The team is composed of the CDOT division directors who are owners and major stakeholders of the business systems. The ITMT drove the update of the Strategic IT Plan.

The ITMT reviews all requests for new software, applications, and IT support within CDOT to ensure that the applications and components are integrated with the enterprise IT framework. This review ensures that

¹ Three reports helped the Information Technology Management Team analyze IT issues objectively and in detail: *Asset Management Strategic Architecture*, CIBER, March 2001; *Asset Management Implementation Plan and Tiered System Process*, Cambridge Systematics, Inc., September 2001; and *Asset Management Requirements*, CIBER, March 2002.

IT applications are linked to the department's objectives. The executive director and management team strongly support the ITMT and provide it with the resources needed to effectively carry out its tasks.

Integrated Data System Framework

CDOT's data integration approach consists of three components: meta-data,² the enterprise data model, and use of GIS as a centerpiece.

Metadata

The process of developing a data dictionary has allowed CDOT to catalogue its data and identify duplicate data.

Enterprise Data Model

CDOT uses several management systems that support Asset Management. Broadened application of these systems, additional improvements in systems features and capabilities, and integration of systems logic or data will advance CDOT's Asset Management practice. Following is a summary of the major systems:

- **Pontis Bridge Management System.** CDOT now uses AASHTO's Pontis as a database repository for inventory and condition information on State-owned (on-system) and local (off-system) bridges. Part of the information collected is shared with maintenance management for performance-based budgeting, as described below.
- **Pavement Management System.** The Pavement Management System (PMS) assists the department in tracking current pavement condition and estimating future needs to maintain the pavement network according to specified performance goals. The PMS recommends the most cost-effective pavement surface treatments and maintenance activities. It also serves as a planning tool to support funding and allocation decisions on the network and project levels. Seventy percent of

² Metadata: Information that describes or characterizes data. Metadata are used to provide documentation for data products. In essence, metadata answers the who, what, when, where, why, and how about every facet of the data that are being collected and documented.

the construction and maintenance surface treatment projects the CDOT regions select are based on the recommendations made by their PMS.

- **Maintenance Management.** CDOT's Maintenance Management System (MMS) tracks expenditures and accomplishments by activity in nine maintenance program areas. This system has been supplemented with a performance-based budgeting tool that incorporates explicit levels of service related to the condition of highway maintainable items and to levels of activity performance or responsiveness.
- **Budget and Financial Management.** CDOT's financial management systems provide information on the funding and expenditure components of Asset Management (e.g., the "true" costs of Asset Management activities that include indirect cost components and other adjustments that are not accounted for in infrastructure management systems).

The IT department is converting the data in several of CDOT's management systems into Oracle relational data using the Enterprise Data Model. The Maintenance Management and Bridge Management systems data are already in this format, while the Pavement Management System data will be converted in 2004. Financial, Roadway, and Traffic Management Systems data will follow. Once all data are in place, generic tradeoff analysis will be possible.

GIS as a Centerpiece

Within its Division of Transportation Development, CDOT has operated a GIS for 17 years that is widely accessible by CDOT staff. The GIS displays information on highway, aviation, and several other transportation assets. It is updated through links to databases associated with individual management systems. GIS is now being used for a number of applications, including analyses of environmental impacts, project scope studies, mapping maintenance and bridge needs for decisionmaking, and planning studies.

Efforts are also underway to expand the usefulness of GIS to a wider audience within the department. This effort entails promoting GIS information as an asset, strengthening its analytic capabilities to be useful to a number of groups, and providing information in a way that assists high-

level decisions. Greater use of GIS on the Internet, continued development of Web-based tools, ability of users to obtain customized maps and ad hoc reports, data mining capabilities, and the combination of GIS tools with complementary analytical capabilities of specialized management systems also point to growing uses of GIS at CDOT in the future.

A 1:24,000 scale basemap has been established, and all transportation data sets are available through an interface with the map. Data are referenced linearly by route and reference point. Currently, only bridge locations, pavement data, traffic counts, and other inventory type highway data are available through access to the basemap. The referenced data are complete, current, and statewide. In selected areas, environmental, engineering level survey control points, and other information are available.

GIS data collection standards have been developed so that any location-referenced data collected on several corridors will be consistent and easily integrated with other corridor data. These types of data include aerial photography, clearance areas for natural or cultural environmental resources, wetland areas, endangered species, and archeological sites. Data are collected using various technologies, including remote sensing, the global positioning system, and surveying.

IS IT WORTH IT?

CDOT's data integration efforts have been focused and are still continuing to evolve. Through these and other Asset Management efforts, the department plans to assemble available data to make informed resource allocation decisions.

Institutionalizing these decisionmaking processes has been critical, especially in a time of high turnover and loss of experienced staff. Ultimately, the analytical and data integration tools CDOT is adopting will lead to more efficient uses of taxpayer money.

CDOT has identified several incentives to encourage implementation of its Asset Management Plan including data integration. The sidebar on page 16 lists examples of benefits, organized around the four key areas of the plan.

Data integration not only improved CDOT's information management, planning, and program delivery practices, but also reinforced its transportation policies.

Policy and Institutional Benefits

- More comprehensive understanding of the transportation impacts of the statewide program
- Ability to apply Investment Categories to program development and tradeoff analyses, which would result in more rational investment decisionmaking
- Ability to track and compare the results of all projects in a consistent manner
- Enhanced systemwide decisions—wider alternatives and potential cost savings for solutions to State transportation problems
- More informed and committed staff
- Increased public awareness and support

Planning and Programming Benefits

- Rational basis for standards, levels of service, and interpretation of performance throughout the transportation system
- Stronger basis for program delivery and accountability
- Increased ability to track the success of programs in terms of defined goals and objectives at the departmental and program levels
- Greater understanding of how various funding levels will impact system performance
- Objective understanding of basis for allocation of resources

Program Delivery Benefits

- Identification of opportunities for risk and cost reduction such as that associated with data collection, analysis, and management
- Improved accountability to constituencies
- Ability to maintain program consistency and ensure full value received for funds expended
- Maintenance of stable system condition at minimum life-cycle costs

Information and Analysis Benefits

- Better, smarter use of existing system capabilities
- Security of critical support and effective planning for information needs, now and in the future
- Promotion of better communication

WHAT HAS CDOT LEARNED?

A major obstacle to change at CDOT was the reasoning, “We have always done it this way.” But, over time, the department has developed a more visionary leadership and a culture more open to change. Many lessons have been learned from data integration and Asset Management efforts:

- An agency’s governance structure should be assessed before change is initiated.
- “One-size” improvements do not address all problems—tailored applications are often needed.
- A task force that represents various data owners helps to build consensus and acceptance of the importance of data-supported decisions.
- The investment category analysis approach helps staff to step back and see the whole picture.
- Upper management support is critical.
- Acceptance by mid-level management and employees is vital to success.

WHAT’S NEXT?

CDOT’s Asset Management and data integration initiatives will continue to evolve as decision-support needs change and as new technology and approaches become available. Meanwhile, CDOT is working toward its goals:

- Short-term: CDOT has tied high-level goals and objectives to employees’ daily work by establishing key program objectives at the chief engineer’s level. The regions, which report to the chief engineer, are held accountable for meeting these objectives through their performance reviews. In 2004, integrating the Chief Engineer’s Objectives with the performance measures program at all levels will ensure that key objectives are met.
- Long-term: The enterprise data system will continue to grow as more data systems are converted. Eventually it will support the 5-year programming and 20-year planning cycles.
- Long-term: CDOT will continue to communicate its accomplishments in the areas of performance measures and Asset Management to the legislature and elected officials. As external communication increases, data integration becomes even more critical to providing reliable information to transportation stakeholders.



I-70 in Glenwood Canyon, east of Glenwood Springs

Closing Thoughts

Since the late 1990s, CDOT has been constantly improving its data management practices to support better investment decisionmaking through Asset Management. At times changes have come quickly, while at other times they have been slow, but the department has always had a consistent goal in mind—to ensure efficient resource allocation. CDOT is constantly nurturing and reevaluating its business processes and information management tools to ensure this goal is met. In their words, “We are never really done.”

References

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Castlewood
Canyon Bridge
on SR 83 south
of Frantown



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Photographs courtesy of Colorado Department of Transportation; Gregg Gargan, staff photographer

Front cover: Hanging Lake Tunnel on I-70 at Glenwood Canyon

Inside cover: Parmalee Gulch entrance onto US 285



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