Transportation Asset Management Case Studies

Presented by

U.S. Department of Transportation
Federal Highway Administration

BRIDGE MANAGEMENT

Experiences of California, Florida, and South Dakota

San Francisco Bay Bridge, San Francisco, CA

Note From the Director

The Federal Highway Administration Office of Asset Management is promoting a different way for transportation agencies to distribute their resources among alternative investment options. This new way of doing business, "Asset Management," is a strategic approach for getting the best return on dollars spent for transportation improvements.

Each State transportation agency will likely have different methods for implementing an Asset Management strategy. For example, some agencies will pursue a data integration strategy in order to ensure comparable data for the evaluation of investment alternatives across asset classes. Others will move to deploy economic analysis tools to generate fact-based information for decisionmakers. Still others will want to integrate new inventory assessment methods into their decisionmaking process.

Pontis® is a comprehensive bridge management system tool developed to assist in the challenging task of bridge management. Initially developed by FHWA, Pontis® now is an AASHTO BRIDGEWare® product. It stores bridge inventory and inspection data; formulates networkwide preservation and improvement policies for use in evaluating the needs of each bridge in a network; and makes recommendations for what projects to include in an agency's capital improvement program for deriving the maximum benefit from limited funds. The software is continuously upgraded and improved based on various users' input.

The FHWA in 2002 sponsored the development of a training course for Pontis® that was offered to State highway agencies beginning in July 2002 as part of the National Highway Institute training curriculum. Since then, the course has been modified to include changes in the software and has been presented in 17 States.

A majority of the States licensing Pontis® use this tool for collecting bridge inventory and inspection data only. On behalf of the Office of Asset Management, I am pleased to present this case study highlighting the business and decisionmaking processes for three State transportation agencies: California, Florida, and South Dakota. The Office encourages other States to move to the next level in using the software capabilities to the full extent. This study, along with the previous studies on data integration, economics in Asset Management, the Highway Economic Requirements System—State Version, and life-cycle cost analysis, will help agencies meet the challenges of managing their transportation programs and implementing Asset Management.

David R. Geiger

David R. Geiger, P.E.
Director, Office of Asset Management

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 from 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.

Yankton Meridian Bridge on US 81 over the Missouri River, SD

Executive Summary

State Departments of Transportation are integrating electronic databases and software applications to achieve efficiencies and meet their performance goals. California, Florida, and South Dakota have been making progressive inroads using the Pontis® Bridge Management System, and here they share their approaches as a guide for other States who want to do the same.

All the information necessary to manage the integrity of California's bridge infrastructure is contained in a single database with sharing features achieved using the Pontis® data structure. Pontis® is used not only to generate bridge reports, but is also accessed by district maintenance crews, project planners, Caltrans management, and the California Transportation Commission for their various lists and reports.

Florida has simplified management and found cost-effective solutions by integrating Pontis® with the Citrix® MetaFrame Access Suite and the Project-Level Analysis Tool (PLAT). Citrix® MetaFrame is a Web tool for bridge inspections that efficiently provides users a single point of access from any location, for any number of people, using many devices, over any connection. PLAT is a decision support system tool that makes routine policy, programming, and budgeting decisions regarding preservation and improvement of the State's bridges.

Like all States, South Dakota's goal is to preserve their aging structures. Pontis® is a valuable tool in this regard because it calculates the rate of deterioration for all the various bridge materials such as concrete, prestressed concrete, steel, and timber. The South Dakota Department of Transportation saved approximately 900 annual man-hours in labor by customizing the Pontis® check-out/check-in process and abandoning their previous practice of entering inspection data from paper forms.

An overview of the bridge management practices in these three States is presented here to help State departments of transportation shape their Asset Management programs in a way that leads them to achieve their goals and performance measures efficiently and cost effectively. ■

BACKGROUND

Asset Management is presently a key focus area for many transportation agencies in the United States and abroad. Asset Management merges quality asset data with well-defined objectives to help improve a transportation department's business processes for resource allocation and utilization. In short, Asset Management is "a strategic approach to managing transportation infrastructure."

Asset Management uses data from the following management systems:

- Pavement Management
- Bridge Management
- Tunnel Management
- Ancillary Structure Management (sign structure, high-mast light poles, retaining walls, roadway appurtenances)
- Information Management

This case study focuses on the Bridge Management aspect of Asset Management and, in particular, the role played by the Pontis® Bridge Management System.

CASE STUDY

The Pontis® Bridge Management System is a tool used by 39 States, 5 municipalities, and 5 international agencies. It supports users in collecting bridge inventory and inspection data; in formulating networkwide preservation and improvement policies for use in evaluating the needs of each bridge in a network; and in developing recommendations for identifying projects to include in an agency's capital plan for deriving the maximum benefits from limited funds.

Pontis® integrates the objectives of public safety and risk reduction, user convenience, and preservation of investment to produce budgetary, maintenance, and program policies. Additionally, it provides a systematic procedure for the allocation of resources to the preservation and improvement of the bridges in a network. Pontis® accomplishes this by considering both the costs and benefits of maintenance policies versus investments in improvements or replacements.

Figure 1 is a map of the United States color coded to show which States are licensing Pontis® and how they are applying the software. As seen in the figure, most of the 39 licensing States use Pontis® only for collecting bridge inventory and inspection data. This case study highlights the business and decisionmaking processes for State transportation agencies in California, Florida, and South Dakota using Pontis® to manage their bridge inventory. Their experience is presented to encourage more States to move to the next level in using the software to its full extent. This study is based on interviews conducted with representatives of the California, Florida, and South Dakota State transportation agencies.

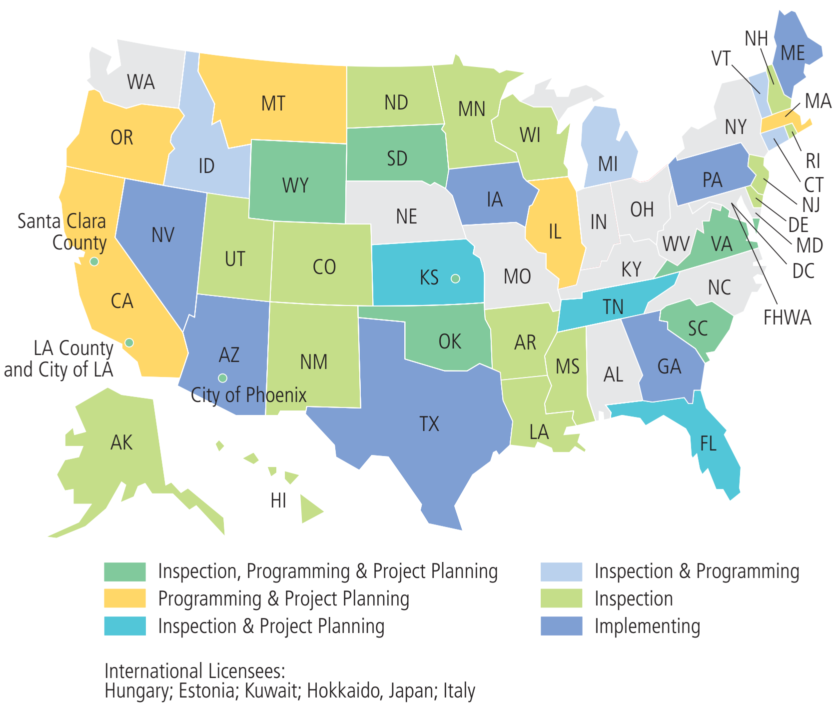


Figure 1. Pontis® licenses and applications for the year 2005.

CALIFORNIA

California is responsible for the inspection and preservation of approximately 24,500 bridges. The California Department of Transportation (Caltrans) Division of Maintenance Office in Sacramento, with a staff of more than 140 bridge inspectors, structural engineers, and bridge management engineers, performs periodic inspections and maintenance for all of California's 12 districts. In addition, two independent city/county agencies perform bridge inspections on their own inventory. Of the 11 bridge management engineers in the Division of Maintenance Office, 2 develop software, 2 run bridge management programs in Pontis®, 1 enters data, and 6 monitor all ongoing projects.

Database

All the information necessary to manage the integrity of California's bridge infrastructure is contained in a single database with sharing features achieved using the Pontis® data structure (figure 2). This interoperable database design eliminates the need to move information from one component to the other. Additional tables are linked to the Pontis® structure for various mission critical activities such as project tracking, maintenance recommendations, detailed fracture critical, scour and load rating information, and postearthquake inspection activities.

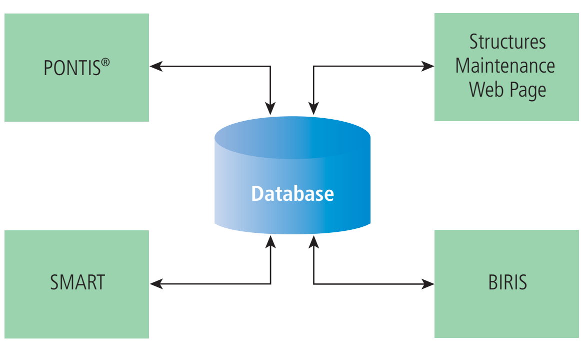


Figure 2. Caltrans bridge management system schematic.

Caltrans inspectors and engineers use three primary applications to access the different components of the database:

- SMART
- Pontis®
- BIRIS

The overall security of the bridge management database is controlled at two levels. At the top level, all users are required to log into the Oracle engine, and their privileges are set to the appropriate level. At the form level, the SMART interface application (figure 3) assigns additional controls at the user login and validates the individual data items against the predefined values in the *National Bridge Inspection Coding Guide.* Inspectors, for example, can update any data item available to them through this SMART interface, but they cannot delete a bridge from the system. Using the Internet, district maintenance crews can access current recommendations for each bridge but are only allowed to update a single field, which indicates that a work item has been completed.

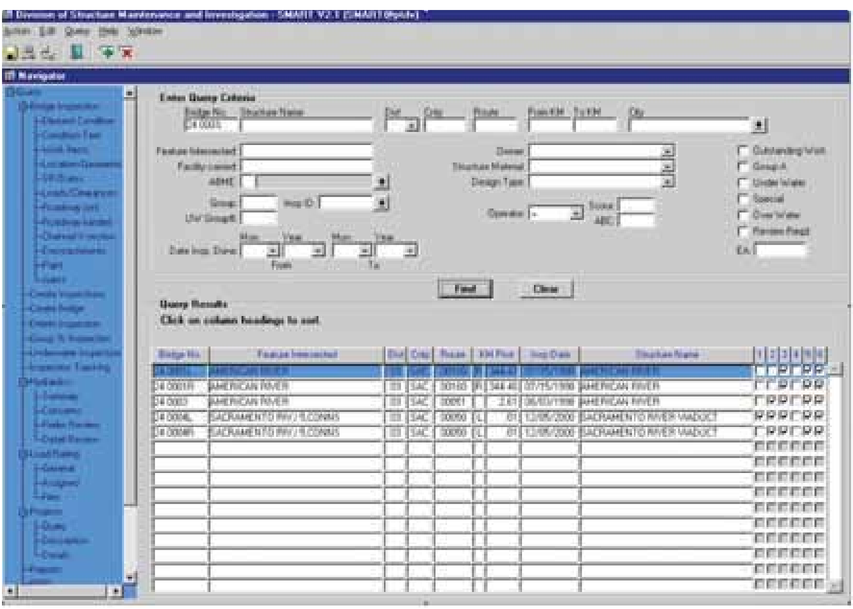


Figure 3. Caltrans SMART interface.

Bridge inspectors use SMART, a custom inspection collection and report generation software, which has a thin-client (Web-based) interface that allows inspectors to access the database from a remote location.

Bridge Inspections Using SMART

Caltrans inspectors are required to be State-licensed civil engineers. The inspection teams are responsible for all biennial inspections as well as fracture critical and underwater inspections. The teams collect inventory data and condition information in the field on system-generated pre-inspection reports and enter the inspection results into an electronic format to comply with National Bridge Inspection (NBI) standards. Their inspections are based on the American Association of State Highway and Transportation Officials "AASHTO Guide for Commonly Recognized (CoRe) Structural Elements" and custom developed elements that provide information on the condition of each element on the bridge. The information includes detailed fracture critical findings, load rating information, photos, and commentary for each structure in the bridge inventory. All textual as well as graphic information from these statewide inspections is then entered into the centralized bridge management database. Bridge inspectors use SMART, a custom inspection collection and report generation software, which has a thin-client (Web-based) interface that allows inspectors to access the database from a remote location.

The bridge information entered into the database through the inspection process is ultimately presented in a bridge inspection report. The inspection team is responsible for the inspection report and for making recommendations for preservation actions based on their findings in the field. The bridge inspection report documents the current condition of the bridge and all recommended work for that structure. This inspection report is the primary means of conveying the results of the inspection to the bridge owners.

In addition to the bridge report, the bridge management database is used to generate various lists and reports for district maintenance crews, project planners, Caltrans management, and the California Transportation Commission.

Project Prioritization Using Pontis®

The bridge management staff uses the Pontis® Bridge Management System to perform deterioration modeling and project prioritization. Within the Caltrans Division of Maintenance Office, the Office of Structure Maintenance and Investigation has the primary role for determining scope and priority for all bridge maintenance and preservation projects.

Bridge management engineers review and prioritize the needs identified by the inspectors. Projects are designed to minimize impacts to traffic and to maximize improvements with the funds available. Improvement projects involving, for example, new alignment or bridge widening, are initiated by the Caltrans Office of Planning along with Regional Transportation Planning Organizations.

These recommendations from all over the State are prioritized and validated by the Office of Structure Maintenance and Investigation against the project recommended priority list generated by Pontis® (figure 4). Bridge projects generated are manually coordinated with pavement management system projects, which is done through data extraction of projects from the bridge management database. Bridge managers use the comparison to coordinate the scheduling of projects. In some cases, Caltrans has operated

Bridge ID	Feature Intersected	Year	Predom. Action	Predom. Object	Cost ($)	Benefit ($)	BCR
24 0228R	Stockton, 34th,35th, & T	2007	Rehab Elem	Other Bridge Railing	10,894	127,237	11.68
57 0551F	Sign Structure	2007	Rehab Elem	Other Bridge Railing	9,351	106,703	11.41
57 0772	Route 67	2007	Rehab Elem	Other Bridge Railing	7,042	78,991	11.22
24 0289L	UP,BNSF, SCRTDLRT,Redding	2007	Rehab Elem	Other Bridge Railing	9,144	101,447	11.09
24 0069R	UP RR,BNSF,Amtrak, I ST	2007	Rehab Elem	Other Bridge Railing	30,159	331,653	11.00
57 0713R	San Luis Rey River	2007	Min Repair	Pourable Joint Seal	6,802	74,562	10.96
57 0568L	MTDB,BNSF, Amtrak,15,PAC	2007	Rehab Elem	Other Bridge Railing	5,671	62,018	10.94
17 0070	Route 80	2007	Rehab Elem	Other Bridge Railing	6,758	72,502	10.73
25 0099	South Fork American Riv	2007	Ovly Deck	R/Conc Approach Slab	6,869	70,879	10.32
57 0001L	San Mateo Creek	2007	Min Repair	Pourable Joint Seal	5,933	59,279	9.99

Figure 4. Pontis® work candidate priority list.

using a Corridor Maintenance Policy, where segments of highways with a variety of maintenance needs such as bridge, roadway, landscaping, and drainage are publicized for full or substantial closure prior to performing the necessary work.

The Division of Maintenance Office has adopted the bridge health index as one performance measure toward its goal of preserving the bridge inventory. The health index is a single number indicator of the structural health of the bridge. This indicator is expressed as a percentage value from 0 percent to 100 percent, corresponding to the worst and best possible conditions, respectively. The health index is calculated in Pontis® as a function of the fractional distribution of the bridge's element-level information across the range of their applicable condition states. Caltrans has begun an incentive program to encourage all districts to aim for a higher overall bridge health index.

Project Archiving Using BIRIS

California maintains a complete image archive of all bridge "as-built" plans, bridge reports, photos, and other significant correspondence in the bridge database. This information is scanned and indexed into the database by a staff specifically trained for this task. The images archived in the database are accessed using BIRIS, a Web application product developed specifically for Caltrans.

The database archive also contains

- Information on projects accomplished by State crews
- Completed State crew maintenance activities that are scheduled and performed based on recommendations by inspectors (documented in the database by the particular district crew performing the work via a custom developed Web page)
- Minor and major rehabilitation projects completed by contractors.

California maintains a complete image archive of all bridge "as-built" plans, bridge reports, photos, and other significant correspondence in the bridge database.

Conclusion

Caltrans enjoys effective management of its entire bridge inventory because the bridge management data are held in a single large database that is accessible to all users through Pontis® programming tools.

Bidwell Bar Bridge at Lake Oroville, CA

FLORIDA

Florida is divided into seven geographic districts and one Turnpike district, as shown in figure 5. Each district is responsible for element-level inspections of Florida's 11,100 bridges (6,300 State highway bridges and 4,800 local bridges). To maintain, manage, and evaluate the needs of the State's bridge inventory, five personnel in the State Maintenance Office and two programming personnel coordinate with the districts, the Work Program Office, and the offices of Planning and Engineering Support Services.

Bridge Inspection Program

Inspectors working for the Florida Department of Transportation (FDOT) are required to be State-licensed professional engineers or certified bridge inspectors who have completed the National Highway Institute course in bridge inspection and meet FDOT's experience requirements. Through the Bridge Inspection Program, engineers identify needs and make recommendations, which are recorded in the Pontis® Bridge Management System.

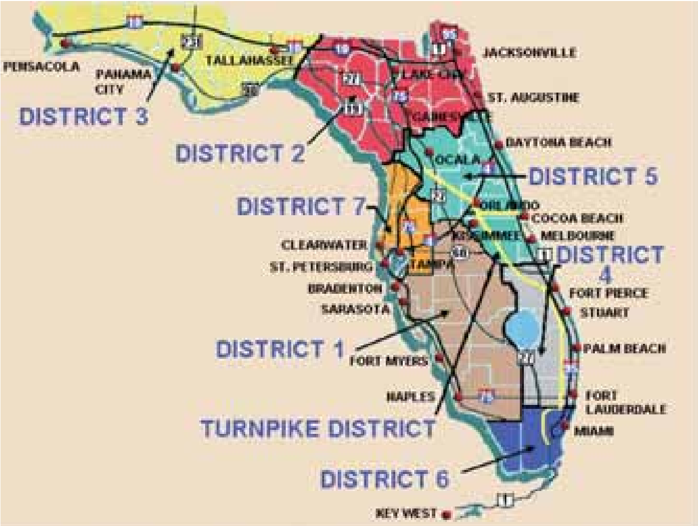


Figure 5. Florida district map.

The software can be customized to allow State DOTs to design a system that gives individuals access to Web tools for bridge inspections.

Inspections are done by FDOT engineers or with the help of consultants and are entered in Pontis® through Web access into a centralized Oracle database. Pontis® also allows the option of working from a database such as Sybase® ASA Adaptive Server Anywhere. To simplify the management of FDOT's resources and make them more cost effective to operate, FDOT has adopted the third-party software Citrix® MetaFrame Access Suite to integrate with Pontis®. Citrix® Metaframe provides a single point of access from any location, for any number of people, using many devices, over any connection. The software can be customized to allow State DOTs to design a system that gives individuals access to Web tools for bridge inspections. The benefits of Citrix® MetaFrame are as follows:

- Centrally consolidated applications, reducing costs and complexity
- Increased productivity
- Diminished business/technical disruptions
- "Observation dashboard" showing where, how, when, and by whom systems are accessed
- Software as a utility and access control
- Security that ensures only the intended users have access to the appropriate resources
- Office-like environment, ensuring no compromise in quality, regardless of location
- Users connect and compute over any network
- User movement from device to device, wire to wireless, office to office, site to site

FDOT's "Bridge Inspectors Field Guide of Structural Elements" is a modified version of the "AASHTO Guide for Commonly Recognized (CoRe) Structural Elements." CoRe elements and non-CoRe elements are grouped into a logical numbering sequence mimicking the AASHTO guide as follows:

- 1–99 deck elements
- 100–199 superstructure elements
- 200–299 substructure elements

- 300–399 miscellaneous elements and smart flags
- 400–499 FDOT miscellaneous elements (e.g., high-mast light poles and sign structures)
- 500–599 movable bridge elements

Feasible Action Review Committee

A Feasible Action Review Committee (FARC) in each district office is responsible for reviewing and prioritizing the needs identified by the inspectors. FARC uses the Project-Level Analysis Tool (PLAT), an integrated software customized for FDOT. PLAT (figure 6) is a decisions support system tool that makes routine policy, programming, and budgeting decisions regarding preservation and improvement of the State's bridges. The bar graph display is dynamic. As the user moves the mouse over the graph, it changes to show how conditions adjust by year. Engineers are able to visualize deterioration rates for different elements on the bridge (figure 7), to predict economies of scale, and to scope several scenarios.

Specific new PLAT models developed for FDOT are:

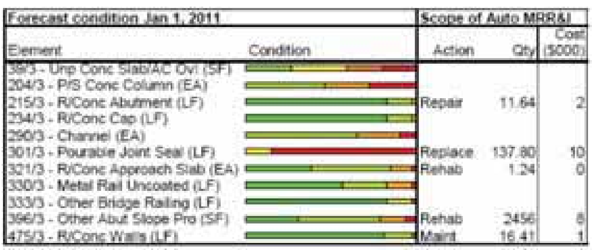
- Accident risk and user cost due to roadway width and alignment deficiencies
- User cost of load capacity, vertical clearance restrictions, and movable bridge openings
- Project-level prediction models for bridge element conditions and costs

These new PLAT models are displayed graphically in a spreadsheet format as an aid in decision making.

Engineers use PLAT to determine the economic health of a structure, and they use it as a design tool for candidate projects to program into the management process. When the engineer modifies a candidate by changing the element action selections, quantities, or various cost factors, PLAT responds, immediately updating its predictive results. This new project-level decision support framework complements and builds on the existing

Lake Ockeechobee Rim Canal Swing Bridge in Palm Beach County, FL

Figure 6. Project-level analysis tool.



Forecast condition Jan 1, 2011		Scope of Auto MRR&I		
Element	Condition	Action	Qty	Cost ($000)
39/3 - Unp Conc Slab/AC Ovl (SF)				
204/3 - P/S Conc Column (EA)				
215/3 - R/Conc Abutment (LF)		Repair	11.64	2
234/3 - R/Conc Cap (LF)				
290/3 - Channel (EA)				
301/3 - Pourable Joint Seal (LF)		Replace	137.80	10
321/3 - R/Conc Approach Slab (EA)		Rehab	1.24	0
330/3 - Metal Rail Uncoated (LF)				
333/3 - Other Bridge Railing (LF)				
396/3 - Other Abut Slope Pro (SF)		Rehab	2456	8
475/3 - R/Conc Walls (LF)		Maint	16.41	1

Figure 7. Predicted condition and candidate action.

network-level analysis in Pontis®. Florida is one of the few States integrating Pontis® to do network-level analysis applications.*

FDOT's development program classifies the inspectors' needs and recommendations into three categories:

- Routine maintenance
- Periodic maintenance and repair
- Replacements

Once the inspectors' recommendations are sorted into the three categories above, the next step is to create work orders in Pontis® and upload them to FDOT's customized mainframe Maintenance Management System

*Network-level analysis refers to a group of bridges (all bridges in a State, district, or county) and does not distinguish among individual bridges.

(MMS) (figures 8 and 9). Work orders are given priority ratings from 1 to 4, priority 1 being an emergency situation requiring work to be completed within 60 days; priority 2, an urgent situation with a 180-day limitation; priority 3, routine work to be done within 1 year; and priority 4, no immediate deadline but information is provided. One of FDOT's performance measures is to monitor delinquency of work orders. All work orders are scheduled and performed by the districts or by an independent asset management contractor.

State Bridge Replacement Program

The State Bridge Replacement Program addresses bridges on State highways, local roads, Federal-aid highways, and non-Federal-aid systems as well as construction of any new replacement bridges for pre-existing deficient structures. The Bridge Replacement Program objectives established by FDOT are consistent with Florida Statutes and place primary emphasis on structurally deficient or weight-restricted bridges on State highways. The FDOT State Maintenance Office develops this list annually to review the inventory for posted bridges that need replacement, thus accomplishing one of its performance measures. Pontis® generates a Deficient Bridge List (figure 10) using the following qualifying definitions (customized from FHWA's definitions of deficient bridges) to identify bridges:

- *Strength Replacement* bridges are either (1) structurally deficient or (2) posted for weight restrictions. These bridges are programmed for construction within 6 years of deficiency identification.
- *Economy Replacement* bridges require structural repair but are more cost effective to replace. These bridges are programmed within 9 years of deficiency identification.

State Bridge Repair Program

The State Bridge Repair Program addresses routine maintenance,

Broadway Bridge on US 92 over the Intracoastal Waterway, Daytona Beach, FL

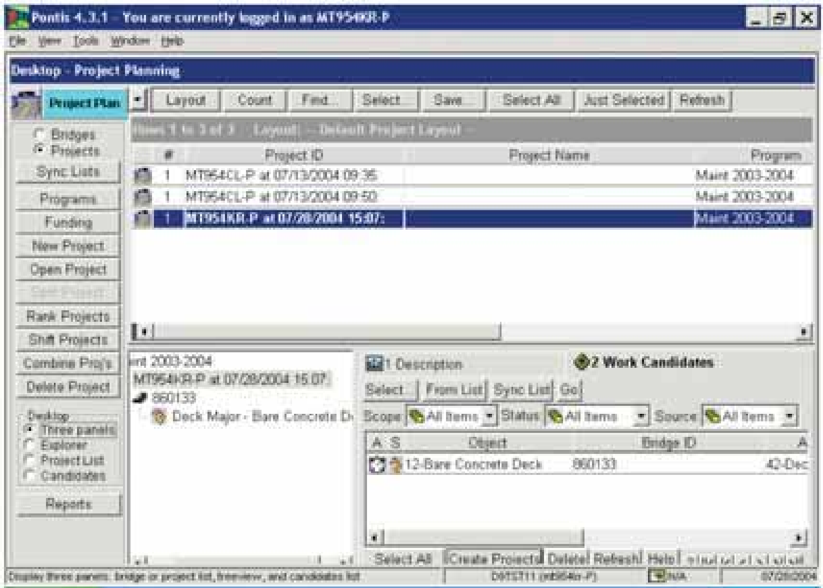


Figure 8. Work order in Pontis®.

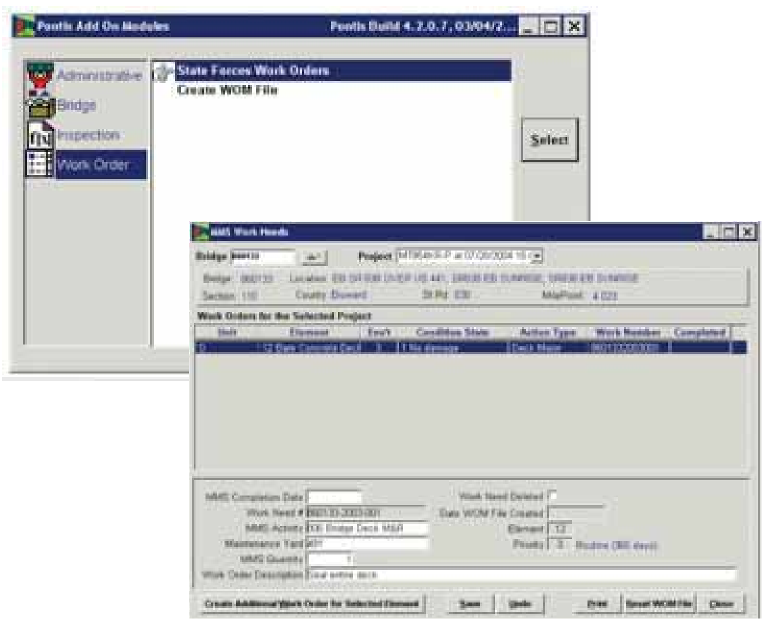


Figure 9. Work order in Maintenance Management System.


Figure 10. Deficient Bridge List customized applet in Pontis®.

periodic maintenance, and specified rehabilitation activities on bridge structures for which FDOT has maintenance responsibilities. Each district receives funding based on its portion of the total State bridge inventory. Funds are allocated based on number of movable bridges and fender systems, tonnage of structural steel for painting, and the district's total quantity of deck area for bridges with an overall structural appraisal rating of "fair" or "poor." These funds are programmed and managed by each district. The Turnpike District is responsible for repair of bridges on the Turnpike Enterprise system and bridge projects funded by Turnpike funds. Pontis® is able to assimilate bridges under all the different programs and show how they fit into the various funding categories.

As in the State Bridge Replacement Program, the State Bridge Repair Program identifies bridges programmed for replacement from the annual Deficient Bridge List (figure 10), identified by one of the following definitions:

- *Rehabilitation* includes strengthening a bridge to increase its load carrying capacity, deck replacement, deck rehabilitation, or superstructure rehabilitation.

- *Periodic Maintenance* includes movable rebuild, deck major repair, superstructure major repair, paint system replacement, deck joint replacement, deck overlay, scour countermeasures, or fender repair/replacement.
- *Routine Maintenance* includes deck joint, deck, railing, superstructure, substructure, and channel maintenance and repair.

States can customize their own definitions to fit their needs, as Florida has done.

Movable Bridge Program

Florida is the only State at this time that manages its movable bridges through Pontis®. FDOT's inventory of 98 movable bridges includes 3 lift type, 94 bascule type, and 1 swing type bridge. Florida customized Pontis® to coincide with the elements, units, and condition states of movable bridges in the FDOT "Bridge Inspectors Field Guide of Structural Elements," as follows:

- Drive system
- Gears
- Shaft bearings and couplings
- Brakes
- Hydraulic power units
- Piping and cylinders
- Control and interlock system
- Transformers/thyristors
- Submarine cables
- Programmable logic controllers and control consoles
- Miscellaneous and traffic control elements
- Navigational light system
- Operator facilities
- Resistance and warning gates
- Traffic signals

Conclusion

Florida is successfully achieving its performance goals by using the Pontis® Bridge Management System to store inspection information and generate work orders and priority ratings through MMS software. In addition, FDOT has customized Pontis® by adding the following modules to manage and report a variety of information from the FDOT database:

- An administrative module permits control of access to the bridge management system in Oracle and sets rights of users.
- A bridge module allows monitoring of the Deficient Bridge List, load rating information, scour, and channel profiles with plotting capabilities.
- A reports module enables customized inspection information, work orders, and management reports (figure 11).

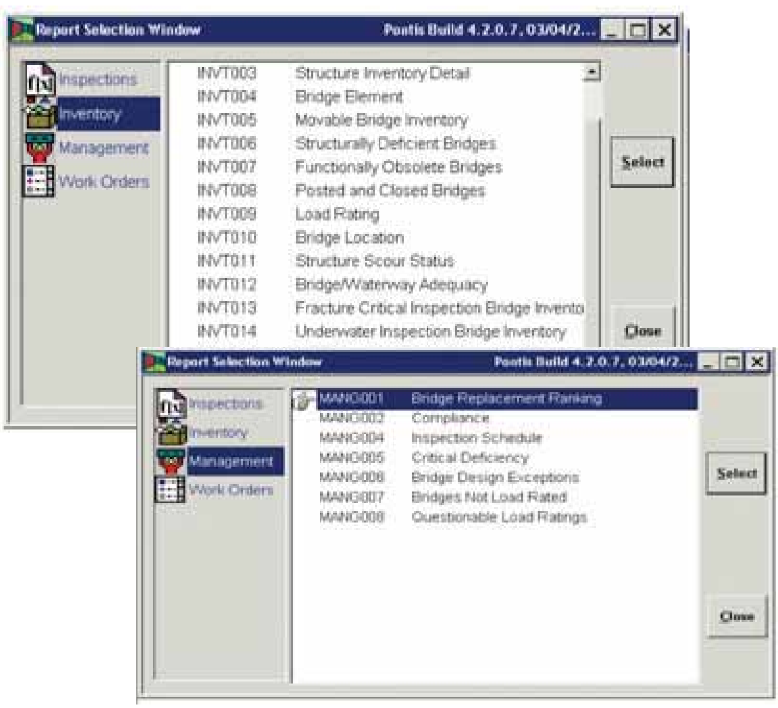


Figure 11. Customized reports.

SOUTH DAKOTA

The South Dakota Department of Transportation (SDDOT), under the guidance of the South Dakota Bureau of Information and Technology, adopted the Pontis® Bridge Management System to manage their bridge inventory. Pontis® software can be used with either an Oracle database or Sybase® ASA Adaptive Server Anywhere SQL client-server database. SDDOT has chosen to use Sybase® and Powersoft Infomaker® to generate reports and forms.

Bridge Inventory

SDDOT has customized Pontis® with data input screens (figure 12) that allow for entering of more data items than those required by the FHWA NBI translator. Key customization features include

- Six tables for roadway, structure unit, inspection information, substructure items, and accident data associated with bridges
- Forms for data entry
- New structure lists built around SDDOT's business practices
- Database security measures

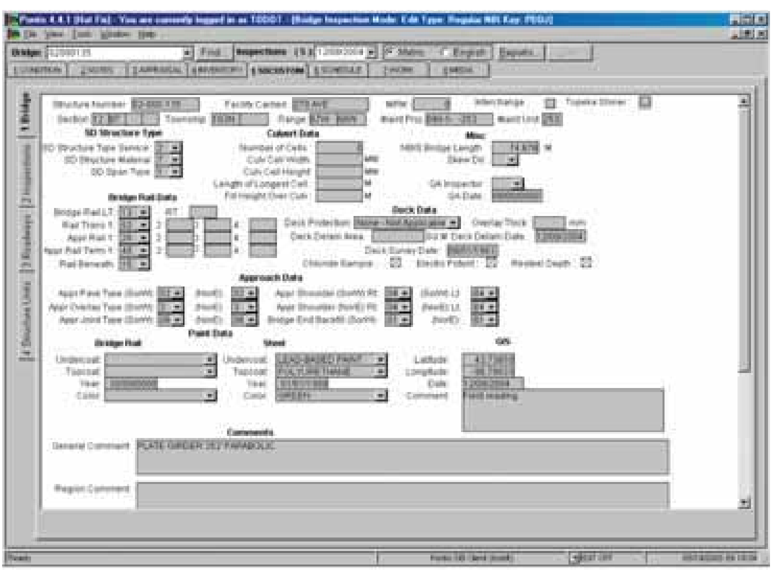


Figure 12. Customized form for bridge data.

- Data transfer techniques using Pontis® Data Interchange (PDI)
- Pontis® check-out/check-in quality assurance procedures
- Modified reports

SDDOT's bridge inventory data are valuable to a number of South Dakota State agencies. For example, the State Department of Agriculture uses the inventory and appraisal information to plan and locate new ethanol plants. The inventory shows which bridges are on the proposed routes and whether the existing bridges are posted for load limits. The State Historical Office has used the inventory information to locate historic structures in South Dakota.

Bridge Inspections

SDDOT inspects bridges using the AASHTO CoRe elements and some custom developed elements. For example, a precast culvert is added to track cast-in-place versus precast concrete culverts. SDDOT uses the FHWA NBI translator to create the NBI ratings for deck, superstructure, substructure, and culverts. State inspectors are responsible for inspection data at the element level and for running the NBI translator, while Central Office personnel are responsible for inventory, appraisal, and load rating

Forest City Bridge on US 212 over Lake Oahe, SD information. Consultants performing bridge inspections for local governments are responsible for inventory, appraisal, inspection data, and load rating information.

SDDOT saved approximately 900 man-hours per year in labor by customizing the Pontis® check-out/check-in process. The initial practice was to enter inspection data from paper forms. The objective of this customization was to accomplish both State and non-State electronic inspections according to SDDOT business rules. For instance, the customization allows SDDOT to limit only one bridge inspection to be checked-in and only certain data fields to be updated from the checked out database into their master database. They use this feature extensively throughout the year, as on average 2,000 bridges are checked out to consultants performing local government bridge inspections.

Bridge Management

Like Caltrans, SDDOT maintains only the State-owned structures, which total 1,811 and consist of 1,298 bridges and 513 culverts. The 4,062 structures owned by local governments include 3,469 bridges and 593 culverts. Like most States, a majority of the bridges in the South Dakota State system were built during the interstate era of the 1960s. Over 50 percent are reinforced concrete bridges, and about 36 percent are steel girder bridges, whereas for deck area, only 35 percent is reinforced concrete and 50 percent is steel girders (figure 13). Because the goal is to preserve these aging structures, SDDOT finds Pontis® a valuable tool because it calculates the individual rates of deterioration for all the various materials.

During 2002 and 2003, SDDOT used Pontis® to begin setting up improvement models based on established policies and standards. Efforts

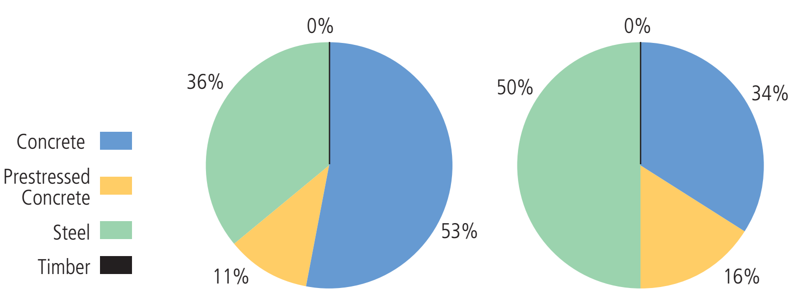


Figure 13. Material type by number of bridges (left) and by deck area (right).

in developing the preservation policy were concentrated on the most common elements in the inventory and the type of preservation work most commonly performed, namely,

- Deck treatments such as epoxy chip seal overlays
- Low slump dense concrete overlays
- Membrane and asphalt overlays
- Waterproofing joints
- Bridge rail modifications
- Steel fatigue retrofits
- Approach slabs and approach modifications

SDDOT recognized the efficiency of programming Pontis® for the most prevalent elements first, and in time, it plans to continue programming to cover policies for all NBI elements. The deterioration calculations were initially based on expert elicitations, and it is expected that as more element-level inspection data are collected, the historical data will supersede the expert elicitations. In other words, Pontis® has the capability of "learning" from the inspection information that is input every 2 years. Pontis® learns how different materials deteriorate at different rates and can thus modify repair and replacement policies. After, say, six inspection cycles, Pontis® can predict policies over a 20-year cycle.

The cost calculations for element actions in the preservation policy are based on using average bid prices from previous years' projects. SDDOT bridge management personnel ensure that the bid item quantity units are in the same format as defined element quantities in Pontis®. An example

Fort Pierre Bridge on US 14 over the Missouri River, Pierre, SD of cost calculation for low slump dense concrete (LSDC) overlay for a bridge deck in condition state 3 is illustrated in figure 14, where it is seen that the unit costs for decks in condition states 4 and 5 reflect the additional costs needed for removal, preparation, and new material. Pontis® calculates each condition as a separate and independent element.

As part of developing its preservation policy, SDDOT must define failure cost for each element in its environment. SDDOT has adopted the approach of letting Pontis® calculate the minimum failure cost for each element and adding a 10 percent increase to derive the revised failure costs. This formula is used to force Pontis® to trigger a definite action in the worst condition state for an element, rather than defaulting to the "Do Nothing" option.

SDDOT uses Pontis® to recommend bridge projects for its 5-year Surface Transportation Improvement Program. The bridge simulation in Pontis® allows the following three categories of projects, and further customization is possible if needed:

- Inspector-generated work candidate projects
- Projects that are part of long-range programs
- Projects generated by Pontis® based on incremental cost-benefit ratio

Bridge Bid Item	Quantity	Unit	Avg. Bid Cost (2004–2005)	Total Cost	
Bridge Elevation Survey	1	Lump Sum	$ 942.00	$ 942.00	
LSDC Bridge Deck Overlay	22.3	yd^3	$ 285.98	$ 6,377.35	
Concrete Removal Type 1A	297.7	yd^2	$ 17.45	$ 5,194.87	
Concrete Removal Type 2A	73.5	yd^2	$ 3.50	$ 257.25	
Concrete Removal Type 1B	29.4	yd^2	$ 70.15	$ 2,062.41	
Concrete Removal Type 1C	14.7	yd^2	$ 55.98	$ 822.91	
Concrete Removal Type 1D	14.7	yd^2	$ 62.53	$ 919.19	
Concrete Removal Type B	10	ft	$ 8.29	$ 82.90	
Class A45 Concrete Fill	3.9	yd^3	$ 180.50	$ 703.95	
Finishing and Curing	294	yd^2	$ 39.25	$11,539.50	
			Total LSDC cost =	$28,902.33	
			Total deck area =	297.7	yd^2
				$ 97	Per yd^2
				$ 11	Per ft^2
				$ 116	Per m^2

Figure 14. Cost calculations for low slump dense concrete overlay for bridge decks.

The first list generated is then reviewed and re-scoped to include indirect costs (e.g., mobilization, traffic control, contingencies, preliminary and construction engineering) and is rerun through the program simulation (figure 15). The revised list is then ranked manually by SDDOT personnel based on engineering judgment. Like Caltrans, SDDOT's use of Pontis® helps SDDOT achieve its performance measure of reducing the number of structurally deficient bridges and improving the overall health index at the network level.

Conclusion

Because of efficiencies it has gained using Pontis®, SDDOT has been able to go to the next level of bridge management, embarking on a project called Concept to Contract (C2C). C2C incorporates all management systems into the new State Transportation Improvement Program (figure 16).

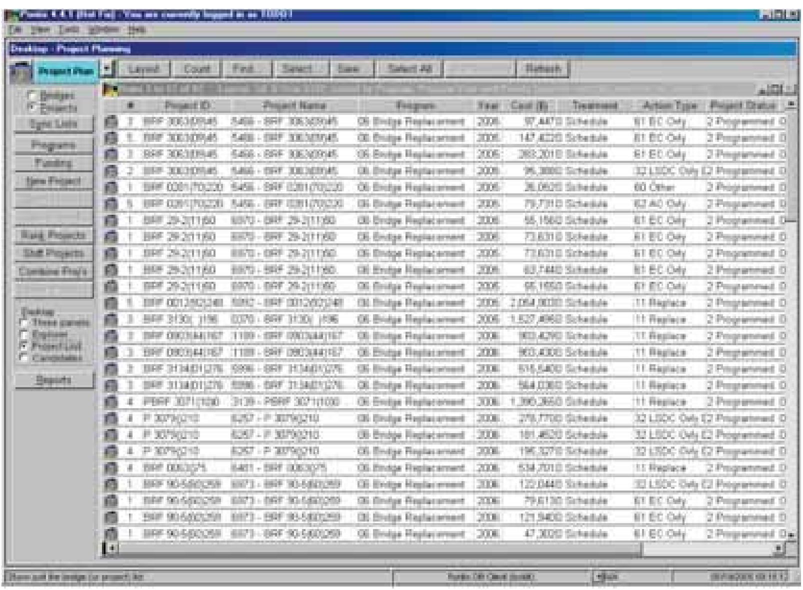


Figure 15. Sample programmed list.

C2C includes the following subsystems:

- *Maintain Candidate* is a consolidated database containing South Dakota's highway system needs.
- *Scoping and Estimating* identifies alternatives for specific work to be done on a project and its cost.
- *Scheduling and Task Management* identifies the tasks to be completed prior to bidding, and by whom.
- *Funding* identifies what funding to be used on what projects and when to use it.
- *Bid Letting* allows preparation of bidding documents and electronic interaction with contractors.

Through the C2C program, SDDOT envisions having several computer programs working together as a system to share common information that is part of a highway construction project. It is anticipated that the information will follow the life of the construction project from conception to the time it is advertised for construction.

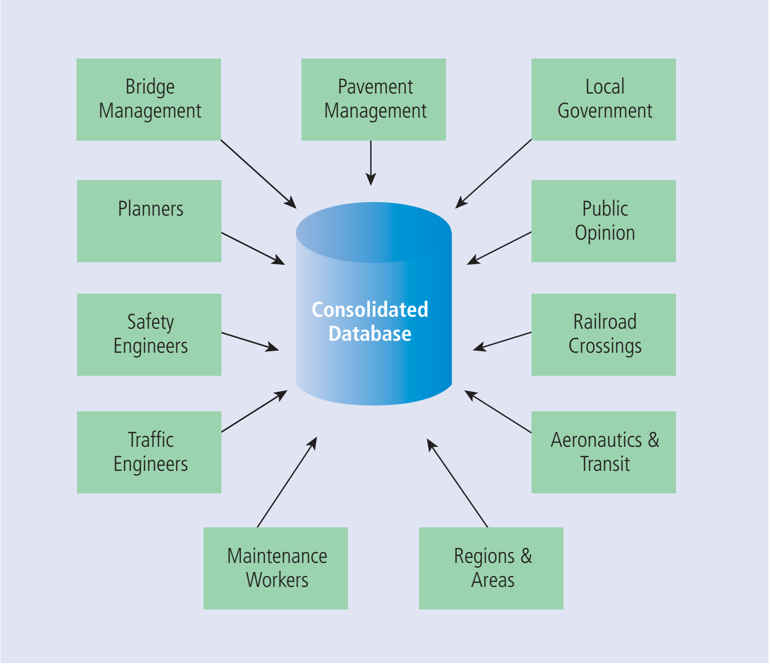


Figure 16. C2C concept.

STATE TRANSPORTATION AGENCIES AND PONTIS®

States using the Pontis® Bridge Management System have found its features beneficial in terms of how it supports users in collecting bridge inventory and inspection data; in formulating networkwide preservation and improvement policies for use in evaluating the needs of each bridge in a network; and in developing recommendations for identifying projects to include in an agency's capital plan for deriving the maximum benefits from limited funds. Further benefits are that Pontis® integrates the objectives of public safety and risk reduction; is convenient to use; and aids in the production of budgetary, maintenance, and program policies. Most notably, it provides a systematic procedure for the allocation of resources to the preservation and improvement of the bridges in a network by considering both the costs and benefits of maintenance policies versus investments in improvements or replacements.

Most of the 39 licensing States presently use Pontis® only for collecting bridge inventory and inspection data. This case study, in highlighting the business and decisionmaking processes for State transportation agencies in California, Florida, and South Dakota using Pontis®, hopes to encourage more States to move to the next level in using the software to its full extent.

Keystone Wye Bridge on US 16A, SD

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***Front cover:* Venetian Causeway, Miami, FL**

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