

response to the need for more effective and efficient bridge management, Congress, through the Intermodal Surface Transportation Efficiency Act, required the implementation of bridge management systems by state departments of transportation and metropolitan planning organizations.

Two national-level bridge management software programs have been developed: Pontis, developed through a collaborative effort between the Federal Highway Administration and state departments of transportation, and BRIDGIT, developed by the National Cooperative Highway Research Program. Both programs utilize element-level inspections, predict the future condition of the elements in the network using sophisticated deterioration modeling techniques, and optimize long-term expenditures for preservation and improvement of the highway bridge network. Decisions can then be made on the basis of economics and structural safety.

The National Highway System Designation Act of 1995 officially repealed the legislative mandate for bridge management system implementation by state highway agencies. Nevertheless, DOTs continue to pursue use of these systems. Today Pontis, which is now distributed by the American Association of State Highway and Transportation Officials, has been licensed by 40 state DOTs. Other states either have developed and are implementing their own bridge management software or are evaluating existing software for implementation. BRIDGIT has been well received within smaller bridge-owning agencies. Pontis is now an AASHTOWare-supported product. BRIDGIT is currently available through NCHRP and is expected to be supported by AASHTO in the near future.

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## Managing Minnesota's Highway Bridges

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**T**HE FEDERAL HIGHWAY ADMINISTRATION encourages states to use bridge management software programs to optimize transportation resources. Minnesota has decided to use Pontis as a bridge management tool

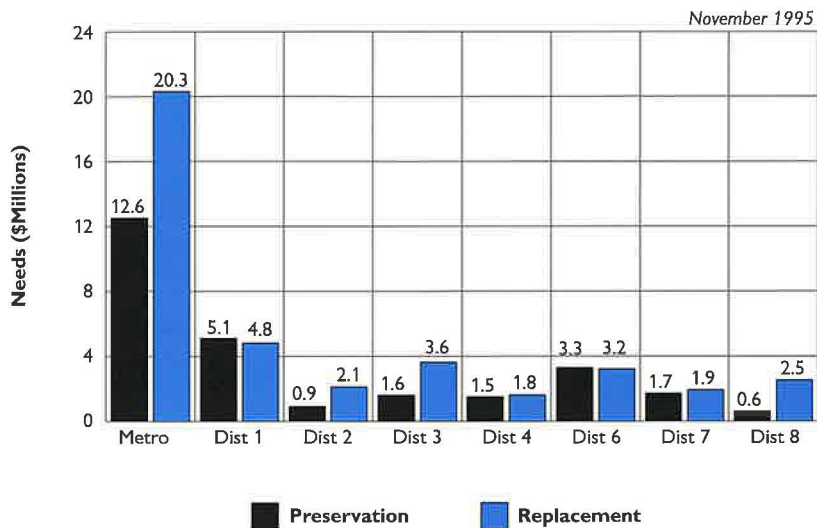
to provide information in support of (1) network-level bridge planning, (2) network-level bridge maintenance planning, and (3) project-level bridge planning.

Pontis' mathematical models can be used to optimize bridge funding for maintenance, repair, and rehabilitation, as well as for improvements. Both agency and user costs are taken into account. Agency costs are defined as the actual costs required to preserve or replace a bridge or a portion of a bridge. User costs are those costs incurred by the bridge user for detours, load postings, clearance limitations, and accidents due to poor geometrics or clearances on the bridge. The deterioration rates of various bridge elements and the costs of actions to fix or replace those elements are critical to calculating accurate benefit/cost ratios.

The focus of the Pontis preservation optimization model is on finding the long-term steady-state policy, for each bridge element in each environment, that will minimize maintenance funding requirements while ensuring that the element will not fail. The optimization model incorporates changes in condition, the effectiveness of agency or owner actions, and the cost of those actions into a benefit/cost ratio format for each element and determines the most cost-effective long-term actions. The Pontis improvement model is used to consider actions such as widening, raising, and strengthening bridges to minimize user costs due to detours and accidents. Pontis then combines the results of the preservation and improvement models to determine overall maintenance, rehabilitation, and replacement needs.

### Pontis Element-Level Inspections

For the calculation of benefit/cost ratios, Pontis requires a different means of recording bridge inspection information from that previously used in Minnesota. In the past, bridges have been categorized into various components, and each component has been rated according to its condition. Under the Pontis element-level inspection system, bridge elements are defined and rated according to the type, severity, and extent of deterioration. A condition rating scale of 1 to 5 is used, with 1 being the best rating and 3, 4, or 5 the worst, depending on the element. Element-level reporting requires that data on each element be recorded to show the total quantity of each and the quantity in various conditions. Inspection of Minnesota's 19,570 state and local bridges is now documented using element-level techniques. Data are gathered on the extent of



**FIGURE 1** Pontis network-level summary depicting district bridge preservation and replacement needs.

problems such as deck cracking, deteriorated paint, steel corrosion, and concrete deterioration. These data are then used to develop detailed maintenance programs such as deck crack sealing, spot painting, and expansion joint repair.

### Use of Pontis Outputs

Minnesota has used Pontis outputs since 1995 to help plan budgets, bridge maintenance activities, and bridge construction projects. Pontis outputs can be used for three main purposes: (1) to provide defensible data for network-level target funding levels; (2) to identify and describe bridge maintenance needs; and (3) to provide information needed for the development of cost-effective programs for bridge maintenance, improvement, and replacement. The outputs provided include historical conditions and funding levels; anticipated deterioration rates of bridge systems; costs for various maintenance, improvement, and replacement activities; present conditions of the system; and a ranking of proposed bridge activity. Mn/DOT is starting to use project-level reports to help prioritize bridge work. Pontis applies its optimization methodology from the network to the project level, and helps agencies determine the best candidate projects. Future enhancements to Pontis will improve the capability to provide project-level recommendations.

Planners need outputs that show the impacts of various funding options on future system conditions and levels of service. Charts and graphs that show proposed funding, optimal funding, and

resulting bridge needs are most valuable for this purpose. An example is shown in Figure 1—a Pontis network-level summary, developed by Mn/DOT in 1995, depicting district bridge preservation and replacement needs for the next 10 years.

Minnesota has used these and other Pontis outputs to help in making decisions on funding and prioritization of bridge work. Use of bridge management software will enable all transportation agencies to plan for the best use of transportation funding.

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## Benefits of BRIDGIT Software

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**T**WO OF THE MOST DIFFICULT QUESTIONS asked of any bridge agency professional are how much money should be invested in the bridge network during the next 20 years and which bridges should receive funding for capital improvements, for rehabilitation, for repair, and for preventative maintenance in the next 2 years.

The answers to these questions lie in one simple performance measure that most bridge management engineers use as a guiding principle: minimizing life-cycle costs for bridges in the network. The life-cycle cost is the sum of three unique costs that occur over the life of a bridge: (1) design and construction costs, (2) traffic disruption and public costs, and (3) operations and maintenance costs. The Maine Department of Transportation has a strong commitment to preventative maintenance, rehabilitation, and repair. Over the long run, a bridge properly maintained in the early stages of deterioration is less costly. The goal is to minimize all taxpayer investments in bridge building, travel time, travel costs, and bridge operational costs. The BRIDGIT software supports this goal of bridge management.

BRIDGIT's methodology complements Maine's centralized organizational structure. Maine is a relatively small, mostly rural state with about 3,600 public bridges by state definition. Authority for long-term planning, preventative maintenance, capital improvement, inspection, posting, and bridge closing (excluding about 300 Maine Turnpike Authority bridges) generally resides in MDOT head-