



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.

Paul M. Kivisto is bridge management engineer and Donald J. Flemming is state bridge engineer, Minnesota Department of Transportation.

Benefits of BRIDGIT Software

STEPHEN P. ABBOTT

TWO 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-

Men of all countries, of all ranks, of all states, foreigners or citizens, pilgrims or merchants, whether on foot or on horseback, whether poor or rich, whether with carriages or with horses loaded or unloaded, or with other animals, or in whatever manner they travel, can by virtue of our concession, without being held to any toll, pass freely over this bridge.

Inscription on 11th-century bridge at Tours, France
quoted by Joseph Gies in *Bridges and Men*

quarters. All major decisions in each bridge's life are influenced by an MDOT team comprising Bridge Maintenance, Bridge Design, and Bridge Management personnel.

BRIDGIT's optimization analysis is executed in two steps. First, different life-cycle activity profiles are developed for each bridge in the network or a selected shortlist in order to estimate the present and future costs of various repair and improvement scenarios. Second, an optimization analysis is performed to prioritize needs and select the most cost-effective options satisfying the defined constrained or unconstrained budget cases, as well as the level-of-service goals. After the most cost-effective option is selected for each structure, the results of the analysis are summarized to determine the level of funding required to address network deficiencies for a given period of time. MDOT intends to utilize the capability for long-term network needs analysis, and has begun using BRIDGIT results for individual bridges as the first step in a screening process to select improvement candidates for the upcoming capital and maintenance programs. BRIDGIT's analysis will identify functional problems, such as narrow deck width, insufficient vertical clearance, and deficient load capacity, as well as structural condition deficiencies.

BRIDGIT's methodology for decks and slabs parallels Maine's goal of maintaining and replacing the wearing surface of a bridge before the bridge deck deteriorates. This strategy prevents more costly damage and subsequent repairs while extending the

bridge's life span. BRIDGIT models decks separately from wearing surfaces, and the condition of each is recorded in terms of severity and extent of deterioration. Because the deck and wearing surface are treated as unique components with different deterioration rates, the condition of the wearing surface will either slow or accelerate the deterioration of the deck. This approach is not only intuitive, but provides a more realistic computer model—a particular advantage for MDOT because an aggressive wearing surface preservation program is needed to protect bridge decks from deicing salts.

Painted steel structures are an extreme challenge because cost-effective long-term treatments for such structures are very elusive. For example, the current high cost of painting sometimes makes full superstructure replacement a viable alternative. Accurate life-cycle cost comparisons of these options are possible with BRIDGIT. BRIDGIT models the steel elements separately from the coating protective systems. It is possible to perform analyses of structures based on coating condition alone, which aids in the selection of candidates for MDOT's bridge painting program. BRIDGIT can meet these challenges because of its cleverly designed paint modeling and its flexibility to allow an intuitive paint inspection coding system.

Ad hoc analysis and reporting capabilities are an essential part of the daily operations for a bridge management group. BRIDGIT excels in this area. It allows a user to group the bridge population by any National Bridge Inventory item, by any element, or by any created data item. Thus users can perform an analysis on any subset of the bridge network with very specific characteristics. Requests for information can involve, for example, timber bridges, posted or closed bridges, or structures with short detours in close proximity to each other. Different governmental or regional entities can make requests pertaining to their individual areas of responsibility. BRIDGIT provides the flexibility to subdivide the bridge network in any manner necessary to address the varied information needs of MDOT's customers.

BRIDGIT will continue to serve MDOT in the agency's future efforts to manage all public bridges. These activities will encompass forecasting long-range needs, selecting capital improvement candidates, developing and performing preventative maintenance workplans, inspecting bridges, and posting or closing bridges. BRIDGIT's approach to optimal management of taxpayer assets makes it an excellent decision support tool.

The author is bridge management engineer, Maine Department of Transportation.



Top: Bangor Brewer Bridge was replaced because it had a low weight limit, was too narrow, and did not provide sufficient vertical clearance. Such functional deficiencies are considered in BRIDGIT's evaluation of life-cycle costs.

Bottom: Because of the potential for sudden structural failure, unreinforced concrete has not been used in bridge construction in the United States for half a century or more. Many older U.S. bridges have unreinforced concrete details, such as this 60-year old pier cap supporting a steel truss.