The Washington Region's Continuing Transportation Funding Shortfall

by John Swanson, Senior Transportation Planner
Metropolitan Washington Council of Governments

For quite some time, in good times and in bad, the story has basically been the same: the Washington region is facing an ongoing transportation funding shortfall. Revenues are simply not keeping up with needs. The region is growing at a rapid pace, and new people and new jobs are creating new transportation demands. In addition, the existing transportation system needs urgent attention. Our Metro transit system and Interstate highways are no longer new. Maintenance and rehabilitation expenses were expected to soak up the vast majority — at least 70 percent — of future transportation revenues.

For more than a decade, the National Capital Region Transportation Planning Board (TPB) has been shining a spotlight on the funding shortfall. In 2000, the TPB's long-range transportation plan highlighted the far-reaching extent of the financial squeeze, noting that the region needed an increase of 50 percent to meet the region's transportation needs. Since that time, the list of unfunded needs has grown. The short-term funding picture is even bleaker. A TPB analysis in 2004, called "Time to Act", found that available funding would meet less than half of the region's critical transportation needs between 2005 and 2010.

Metro's Needs are Critical

The funding needs of the Washington Metropolitan Area Transit Authority (WMATA) are particularly critical. The Metro system, once shiny and new, is showing its age. An increasingly larger portion of funds is now dedicated to maintenance and rehabilitation. In 2004, following the release of TPB's "Time to Act" report, the WMATA board approved a funding scheme called "Metro Matters", which committed $3.3 billion over six years from state and local governments to purchase new buses and rail cars and fund basic infrastructure investments. Even at the time, it was clear that "Metro Matters" was a stop-gap solution.

In October 2008, Congress passed legislation authorizing $1.5 billion in federal funding over the next ten years. U.S. Representative Tom Davis of Virginia introduced the legislation in 2005. This bill stipulates that federal dollars are contingent upon Maryland, Virginia, and D.C. providing one-for-one matching dollars, and requires management changes, including the permanent establishment of an inspector general position and expansion of the WMATA board to include federal representatives. In total, the Davis legislation will provide an infusion of $3 billion over ten years, which will be used to support Metro's capital program, including the purchase of rail cars and buses, repair of leaky tunnels, and deteriorating station platforms, and other investments that can improve system performance on a daily basis. WMATA estimates it needs to purchase more than 300 railcars to replace the original, deteriorating ones. The funding under the Davis legislation only applies to capital and preventive maintenance expenses on existing WMATA systems, and may not be used to increase the mileage of the rail system.

A boost of $3 billion will go a long way toward addressing Metro's funding uncertainties, but it only represents a portion of anticipated needs. In October 2008, as Congress was wrapping up the funding bill, Metro General Manager John B. Catoe Jr. announced that the system needs more than $11 billion over 10 years — approximately double the rate of capital investment spending each year since 2002 — to maintain and improve its services.

Recent short-term funding prospects present new opportunities: the passage of the American Recovery and Reinvestment Act (ARRA) in

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Funding Shortfall *(Cont. from 16)*

February 2009 prompted Metro to identify "shovel-ready" capital projects eligible for federal funding. While this funding will provide short-term assistance, Metro continues to face budget shortfalls to the tune of $176 million — or 13 percent of Metro's operating budget — for FY2010. According to Metro Board Chairman Jim Graham, these conditions will require Metro to "do more with less." It is evident that daunting challenges remain.

Tolls Are a Growing Funding Source

Another development in recent years has been the changing attitude toward tolls. Just over a decade ago, a proposal to finance the new Woodrow Wilson Bridge with tolls was not politically acceptable. Today, three out of the five most expensive projects planned for the next six years are toll projects — Virginia's two HOT lanes projects (on the I-495 Beltway and I-95/395) and Maryland's Intercounty Connector. In addition, tolls from the Dulles Toll Road are a key component of funding for the Metrorail extension to Dulles Airport, which is currently under construction. The TPB's 2006 long-range financial analysis found that tolls and private sources can be expected to provide seven percent of anticipated revenues between now and 2030. A similar analysis in 2003 found that toll and private money accounted for just one percent of forecasted revenues.

We can expect more toll lane projects in the future. Transportation funding continues to be tight and congestion is rapidly getting worse. The TPB has taken a lead in looking at pricing policies, including toll lanes. In 2003, the TPB convened more than 200 elected officials, community leaders, planners, and academics for a conference that explored innovative pricing strategies and helped to galvanize regional interest in tolling as a solution to the region's perpetual transportation funding shortfall.

New electronic toll-collection technologies and a new sense of public support have made toll lanes more viable. A TPB scenario analysis, released in 2008, analyzed the potential effects of widespread road pricing in the Washington region. The study "Evaluating Alternative Scenarios for a Network of Variably Priced Highway Lanes in the Metropolitan Washington Region" outlined several different scenarios for adding new priced lanes, pricing existing highways, and enhancing bus services on tolled lanes. The study was funded by the Federal Highway Administration of the U.S. Department of Transportation.

The Shortfall Continues

Despite additional funding for Metro and the increased use of tolls, the transportation funding shortfall continues to grow. A 2006 TPB financial analysis found that although transportation revenues have actually increased since 2003 (the 2005 federal transportation reauthorization legislation — SAFETEA-LU — provided a major boost), the shortfall has still increased. This is in large part due to the construction costs that have eaten up much of the gain in revenue. During the years 2004-2006, nationwide construction expenditures jumped about 28 percent, compared to an increase of just 17 percent over the eight years prior to 2004. These rises were linked to increasing global demand for concrete, asphalt, and other materials. Several efforts to raise revenues in Virginia have been stymied. In November 2002, voters rejected a referendum that would have increased the sales tax by a half cent to raise revenue for transportation projects. In February 2008, the Virginia Supreme Court invalidated a package of taxes and fees that the Northern Virginia Transportation Authority (NVTA) planned to use for transportation priorities. The Court ruled that the NVTA could not raise and spend such revenues because it is not a directly elected body.

As the nation headed into recession in 2008, state and local governments faced severe budget crises that undermined transportation funding even further. The new Obama administration offered relief through an infrastructure stimulus package, approved in February 2009, which provided $700 million for transportation in the Washington region. These funds will largely be spent on deferred maintenance and rehabilitation projects.

Looking Toward Systemic Change

Short-term funding infusions are

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Infrastructure Age, Security, and Natural Hazards

by Rae Zimmerman, Carlos E. Restrepo and Jeffrey S. Simonoff
New York University

Infrastructure comprises essential services for diverse needs and customers. It encompasses energy, transportation, communications, water supply, and environmental protection, among others. It is also faced with a wide variety of threats, increasingly from natural hazards, terrorism, and day to day failures that can result in devastating accidents. One intuitively attractive indicator of condition and need is infrastructure age. Yet, it is a complicated concept to define. The age of infrastructure facilities, in terms of construction year, can be dramatically affected by rehabilitation, retrofits, and maintenance. Moreover, age has a complicated relationship with many other factors that affect performance such as environmental stresses, usage, design, operations and maintenance practices, and dependencies and interdependencies among infrastructures. Few barometers of infrastructure condition have been able to cull out age. The ASCE (2009) report card assigns infrastructure an average of "D", and age is difficult to separate out in this characterization.

Over the past few decades, infrastructure facilities and their services have been faced with escalating hazards and threats. Simonoff, Restrepo, Zimmerman and Naphtali (2008) noted increased federally declared disasters at a rate of 2.7% per year from 1990 to 2005, and three quarters of the top 12 hurricanes, i.e., with the highest dollar damage, have occurred since 2000 (Blake, Rappaport, and Landsea 2007). Terrorist attacks on transit are noteworthy throughout Europe as the Mineta Institute has identified, summarized by Zimmerman and Restrepo (2009), and attacks such as the Madrid and London bombings since September 11, 2001 have been spectacular. Electric power facilities have experienced similar attacks in countries outside of the U.S. (Simonoff, Restrepo and Zimmerman 2007). If age does contribute to vulnerability by means of weakening the condition of facilities so they cannot withstand the impact of these events, it will become an increasing problem in the face of these rising trends.

A number of observations point to associations between age and infrastructure condition both directly and indirectly. For bridges, the U.S. Department of Transportation Federal Highway Administration (FHWA) National Bridge Inventory measures age (as year built) and also performance. In New York State (NYS) alone, the proportion of bridges rated in the inventory as structurally deteriorated and functionally obsolete declined with decreasing age. For hazardous liquid pipelines, which transport crude oil, gasoline, and related products, Restrepo, Simonoff and Zimmerman (2009: 40) found that 12% of accidents between 2002 and 2005 were attributed to internal and external corrosion, a potentially age-related condition, and a quarter of natural gas transmission incidents were also due to these factors (Simonoff, Restrepo and Zimmerman in preparation). For dams, the National Inventory of Dams assigns three hazard levels: high, significant, and low. High hazard dams are defined as those whose failure may potentially cause losses in human life, property and infrastructure; significant hazard dams have a lower likelihood of affecting those factors; and low hazard dams are those whose failure can be expected to damage agricultural land and roads. Hazard ranking increases with age. For example, in NYS low hazard dams have a mean age of 66 years whereas high hazard dams have a mean of 84 years. Water main breaks routinely occur in older water distribution lines (Cooper 2009), although Cooper (2009) and a U.S. EPA study (2002) found environmental factors as significant. Leakage rates or lost water is an alternative measure of damage, and has, according to U.S. EPA (2007) and U.S. Geological Survey, accounted for 1.7 trillion gallons of lost water.

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Bridge Diagnostics

by Jeffrey L. Schulz, P.E. Chief Testing Engineer,
Bridge Diagnostics Incorporated

Aging infrastructure poses a serious challenge to policy-makers. It also presents a serious logistical problem, as someone needs to provide the services needed to keep aging infrastructure functional and to identify problems before they endanger the safety of those who use this infrastructure on a daily basis. Bridge Diagnostics Incorporated (BDI) is a Colorado company that has been testing bridge infrastructure since 1989, conducting hundreds of field tests in that time. In addition, BDI manufactures equipment specifically designed for bridge testing. This article will explain how bridge testing works and what it does to protect bridge infrastructure from aging-related harm.

In what has often been compared to an EKG for people, BDI performs "live load testing" on all types of structures, most often, highway bridges. The basic goal of each of these tests is to gain a more accurate picture of how the structures are actually behaving under heavy load. An example of how this is useful is the common experience of encountering an "Oversized Load" while traveling. Companies moving these large loads must register them first with the state Department of Transportation (DOT) to ensure that they can cross the bridges safely. It can be very expensive if it is determined that a bridge cannot handle the load and must then be re-routed. In addition, issues such as political pressure and/or security considerations are often involved in the decision to allow certain loads to cross, indicating that factors other than the structure's ability to handle the load can also come into play.

Political considerations aside, in order to determine if the load can cross the bridge safely, the engineer must compare two basic quantities: the applied load (weight and axle configuration of the vehicle) and the capacity of the structural members (how much can the bridge hold without being overstressed). Assumptions must be made by the engineer to arrive at both quantities such as how much of the overload is carried by a particular beam or the strength of the concrete in the girders. Guidelines for determining these quantities are spelled out in the applicable AASHTO design codes. However, in the above-described situation, where the load may be approaching a critical level of the structure's capacity, a load test can provide a more accurate estimate of how the load is being distributed around the structure. This kind of information can often allow the bridge owner to feel more comfortable about allowing the heavy load to cross the structure since the decision will be based on a more accurate analysis. In general, bridges carry load more efficiently than assumed during a simple analysis. This means that often heavier loads can cross quite safely, although this is not always the case.

The photo below and on page 20 illustrate a typical test. Military installations all over the country must transport heavy loads, in this case, an M1 tank. Bridges nearby the installations will typically be owned by the county or state and there will be questions regarding how well these structures can handle these heavy loads whilst

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Diagnositics *(Cont. from 19)*

crossing them on a frequent basis. These particular tests determined that the bridges and vehicles were distributing the load better than expected.

BDI has been involved in load testing for over 400 structures around the U.S. and the world, the vast majority of which have been determined to be in adequate condition to carry the specified loads. There have only been a few structures in which we have recommended immediate remedial action. This experience, however, does not necessarily translate into being able to make a broad statement about the structures that have not been tested. This sample is mostly limited to a family of structures that are generally in favorable condition and in which the owner would like to keep the structure in service. In cases where a visual inspection indicates significant deterioration, BDI will often recommended that rather than spending time and effort on testing, the resources should be dedicated to repairs instead since, no matter what the test results, one of the end recommendations would be to go ahead and perform repairs anyway.

The basic testing process involves the installation of very sensitive strain and deflection sensors on the bridge's primary structural members as seen in the photo below and on page 27. Access to the bridge is usually supplied with a manlift or scaffolding and the sensors are attached at pre-determined locations. Then, a vehicle that has been weighed at the local scales crosses the bridge at approximately 5 mph and data is recorded on all sensors at approximately 40 samples per second. A typical data graph is shown on page 27. The truck crossing is repeated multiple times and at multiple lateral truck locations to capture the entire behavior of the bridge and to ensure good data quality.

After the test is completed, all of the instrumentation is removed. Due to the specialized equipment that has been developed by BDI, a typical bridge can be ready for testing in less than one day. Alternative testing techniques usually require much longer setup and are therefore are more expensive.

Once back at the office, a computer model of the bridge is developed and is loaded exactly the same way that the actual bridge was loaded in the field. Now, a direct comparison can be made between what the actual bridge is doing and what the computer model is predicting it should do. The next step we follow is to modify certain components of the computer model until its response matches that of the actual structure. This is done in a very systematic way and follows general engineering principles. The end

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Legal Insights

Transportation Appropriations Act

by Joseph Maltby, J.D., Research Associate

The Transportation Appropriations Act for the 2009 – 2010 fiscal year is currently winding its way through Congress. The bill has already reached conference between the House of Representatives and the Senate, where differences between the two versions are being ironed out through negotiation and amendments. The present version of the bill does contain some funding for initiatives related to aging infrastructure and infrastructure improvements.

$1.1 billion is being set aside for surface transportation capital infrastructure. These funds will be distributed as discretionary grants to state and local governments and independent transit agencies. Funds will be awarded competitively to projects which will have a significant impact on a metropolitan area, a region, or the nation as a whole. Projects are encouraged to relate in some fashion to the construction of roads, bridges, freight rail, or mass transit. The funds are required to be distributed in an equitable fashion between urban and rural communities, with no less than $250 million going to rural areas, as opposed to the funds being divided purely by need or population. Funds are also required to be spread among a variety of transportation modes. No individual grant may be larger than $300 million, no more than 2.5 percent of the funds may be distributed to any individual state, and any project must include at least 20 percent in matching funds from the grant recipient, though this cost-sharing rule may be relaxed for rural projects. Regulations governing the grant program will follow the bill's eventual passage.

Additionally, the Office of Transportation Planning, Research, and Development is slated to receive $8.2 million for operational expenses, funding research activities, and grants. The Federal Railroad Administration is slated to receive $25 million for rail line relocation and improvement on top of railroad obligations it authorizes the Treasury Department to issue. The transit agency for the District of Columbia and surrounding metro area has been designated to receive $150 million for its operations, but must obtain specific approval from the Secretary of Transportation for any capital or preventative maintenance projects.

These funds do not come without some strings attached. Highway projects using federal aid are required to purchase their materials from an American supplier or receive a waiver from the Secretary of Transportation. The general public is given 15 days to comment on the waiver before it can be enacted. There are also some rules clearly being included to satisfy particular constituencies. Federal funds also may not be used for any tolled highway within the state of Texas unless the highway charged a toll before the project began. Amtrak may not use any federal funds for its operation if it prohibits the transportation of secure firearms. The definition of "secure" is laid out in some detail. A large portion of the funds being made available to the D.C. transit authority are being designated for safety system improvements, which is not surprising considering the recent incidents on their trains.

These amounts are small compared to the total size of the bill. This suggests aging infrastructure has lessened as a priority as public attention has moved onto other issues and as time has elapsed since any major disasters associated with aging infrastructure. Indeed, the D.C. transit agency train crash is recent enough to merit a large pool of funding. In addition, funding is constrained by requirements that placate specific contingencies

(Continued on Page 29)

ASCE *(Cont. from 4)*

Increase and improve infrastructure investment from all stakeholders.

While great strides can be made with sustainable development and ongoing maintenance, significant funds must be invested to make necessary long-term improvements. All levels of government, owners, and users must renew their commitment to infrastructure investments in all categories. All available financing options must be explored and debated.

Conclusion

With a cumulative grade of "D" for 15 of the nation's critical infrastructure systems, the 2009 *Report Card for America's Infrastructure* demonstrates that the condition of our nation's infrastructure continues to be below average, and in some cases, is slipping toward failure. That same infrastructure has a direct impact on our personal and economic health and its condition is endangering our nation's future prosperity. While the 2009 American Reinvestment and Recovery Act did address some areas of immediate need, it only represents a down payment on the larger, systemic problems our infrastructure faces.

A healthy infrastructure will enable us to remain a strong and prosperous nation, but only if we move forward with vision, leadership, and community involvement and support. With perseverance and a common goal, we can work together to rebuild our once great infrastructure. ❖

Inspections *(Cont. from 13)*

analysis)
- Investigative methods and forensics
- Environmental issues
- Written communication for building inspection engineers
- Standards of practice
- Professional practice/ethics

Cursory building and home inspections are often done for real estate transactions to identify visual material physical deficiencies. There are various "standards" for home inspection and numerous states have licensed home inspectors with regulations that are more descriptive than evaluative in nature. Commercial and industrial real estate transaction inspections are often done to meet the guidelines established by The American Society of Testing and Materials (ASTM). Even property condition assessments that follow the guidelines established by ASTM E2018 may not be adequate for older buildings that need to be evaluated for preservation purposes. The U.S. Department of Housing and Urban Development has created a Residential Rehabilitation Inspection Guide that was published as part of its PATH program (Partnership for Advancing Technology in Housing). The American Society of Civil Engineers has crafted a standard SEI/ASCE 11-99 titled "Guideline for Structural Condition Assessment of Existing Buildings" that is more thorough in its requirements for evaluations pertaining to preservation, rehabilitation, and strengthening of existing buildings.

The initial evaluation by a Building Inspection Engineer includes document review and a visual condition assessment with photo documentation. Field testing using a variety of non-destructive instruments is common. Laboratory testing may be needed, and a team of specialized individuals may also be needed for very specific evaluations.

Older, larger, and more unique buildings, particularly buildings with historic or sophisticated systems, require higher levels of engineering and building science knowledge to assess their condition and identify potential corrective actions. ❖

More information about Building Inspection Engineers and Board Certified Building Inspection Engineers can be found at http://nabie.org.

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AASHTO *(Cont. from 6)*

related areas;
3. LISTSERV email mailing list enrollment and new list requests;
4. A Help Desk assistance request system;
5. An on-line System Preservation Technical Library;
6. An Event Calendar; and
7. A Preservation News Archive.

All of these programs through AASHTO help to maintain our aging infrastructure and help to provide safe reliable transportation facilities for years to come. ❖

For more information on AASHTO, its publications, committees, and programs, please visit www.transportation.org.

AASHTO COMMITTEES

Joint AASHTO/AGC/ARTBA Committee
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- Subcommittee on Information Systems
- Subcommittee on Internal and External Audit
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- Subcommittee on Personnel and Human Resources
- Subcommittee on Public Affairs
- Special Committee TRAC
- Subcommittee on Safety Management
- AASHTO Strategic Highway Safety Plan

Standing Committee on Planning
- Census Transportation Planning Products Program (CTPP)
- Subcommittee on Asset Management

Standing Committee on Public Transportation
- Multi-State Technical Assistance Program (MTAP)

Standing Committee on Rail Transportation
Standing Committee on Highways
- Subcommittee on Bridges and Structures
- Subcommittee on Construction
- Subcommittee on Design
- Subcommittee on Highway Transport
- Subcommittee on Maintenance
- Subcommittee on Materials
- Subcommittee on Right of Way and Utilities
- Subcommittee on Traffic Engineering
  - National Committee on Uniform Traffic Control Devices
- Subcommittee on Systems Operation and Management
- Joint AASHTO/ACEC Committee
- NTPEP Oversight Committee
- Special Committee on International Activity Coordination
- Special Committee on U.S. Route Numbering
- Special Committee on Wireless Technology
- Technology Implementation Group
- Value Engineering Technical Committee

Standing Committee on Research
- Research Advisory Committee

Standing Committee on Water Transportation
Standing Committee on Performance Management
Standing Committee on Highway Traffic Safety

Funding Shortfall *(Cont. from 17)*

not enough; more systemic long-term change is needed. The upcoming authorization of the federal transportation legislation offers an opportunity to restructure the nation's transportation policy and to substantially increase funding levels over the long term. Although the new legislation is due by September 30, 2009, the date when the current SAFETEA-LU legislation expires, Congress will likely extend the current legislation for several months before taking up a new bill

In September 2008, the TPB approved a set of policy principles calling for more funding, more attention to metropolitan-level challenges, and more balance among transportation modes. According to Ron Kirby, Director of Transportation Planning for the TPB, the policy principles "reflect the growing consensus across the nation that the current structure of federal transportation funding is ill- suited to addressing pressing needs for system maintenance, new infrastructure, and the increasingly urgent problems of congestion, rising energy costs, and global warming."

In order to tackle these problems, the funding shortfall must be solved. Chris Zimmerman, Arlington County Board Member, said it was important to "clearly advocate for raising the gas tax, and call for authorization to occur on time so that additional funding is not delayed."

Empowering metropolitan-level planning and decision making is also essential. "I think there is a real opportunity presented by this bill" said Tim Lovain, former Alexandria City Council Member. "There's the very real possibility that this authorization will redirect a substantial share of resources to metropolitan regions." ❖

Sustainability *(Cont. from 9)*

As pointed out during an Illinois House of Representatives computer technology committee meeting in 2007:

We are beyond the "Digital Divide" and are now in the "Digital Desert" where all levels of the economic strata are affected by a lack of broadband connectivity. The three most critical issues facing Illinois are Job Erosion, Network Infrastructure, and Education. (James Carlini, 2007)

As they say, if we do not heed the mistakes made in the past, we are condemned to repeat them in the future. We cannot afford to let any portion of the United States lag behind in this restructuring of the infrastructure.

Understanding what infrastructure consists of today, how it is a multi-layered platform, and how it is a platform for commerce that must be secure, can only help decision makers prioritize projects and understand their full impact on the stabilization of the regional economy. ❖

James Carlini, MBA, is a certified Infrastructure Consultant and is President of CARLINI & ASSOCIATES, INC. His white paper: Intelligent Business Campuses: Keys to Future Economic Development was published by the International Engineering Consortium in their Annual Review of Communications in 2008. He pioneered the concept of "Measuring a Building's IQ", which was published in several trade journals in 1985 and 1986 as well as published as a chapter in Johnson Controls Intelligent Building Sourcebook (Prentice-Hall 1988). He has also been used as an expert witness in civil and federal court on network infrastructure and various mission critical networks. He has been a keynote speaker at various national and international conferences and has also served as an award-winning adjunct faculty member at Northwestern University for two decades in both the undergraduate and Executive Masters programs. He has advised on major projects including the Chicago 911 Center (Consultant to the Mayor's Office), network infrastructures at the Chicago Mercantile Exchange (trading floor technologies), GLOBEX (international network), and the DuPage National Technology Park (800 Acres). For questions, please contact Mr. Carlini at* ***james.carlini@sbcglobal.net* *or (773)-370-1888. For more information about Mr. Carlini, please view* ***www.carliniscomments.com.***

Investments *(Cont. from 10)*

Four existing analytic methodologies (right-hand column) must be integrated to realize the approach while meeting all design specifications, demonstrating the feasibility of the method.

Additional work to integrate the methods and to field test the integrated approach must be done for the approach to bring much needed discipline to the jumbled and often inconsistent procedures used to make these critical investment decisions.

Spending money is easy. Accounting for it, managing it, and getting a reasonable return on the investment are, however, more demanding challenges. Planners and decision makers at all levels need sound and objective measures to determine proper and optimal courses of action. Ignoring these issues will simply repeat the failing grades our nation has earned on its infrastructure disbursements in the recent past. Failure to change the decision-making status quo will only result in a continued decline in the vital underpinning of our economy, competitiveness, and quality of life. But time is of the essence. For the United States to capture the full benefit of these investments this approach must be completed quickly and correctly — the first time — or the opportunity will be lost. ❖

For a copy of ASME-ITI's feasibility study on optimizing infrastructure investments, please email James Creel at **creelj@asme.org**.

Table. Financial Portfolio Optimization Provides the Framework for Infrastructure Portfolio Optimization

Process for Financial Assets	Process for Infrastructure Assets	Required Tools
1. Develop strategic goals and plan. Define: a. Strategic and operational objectives & their relative priorities; b. Constraints, e.g., budget total, geographic "balance," product lines, etc. c. Valuation metrics to measure objectives and constraints.	1. Same	Analytic Hierarchy Process (AHP)
2. Value existing portfolio relatives to strategic and operational objectives – gap analysis of value, risk: existing dependencies – from owner's perspective	2. Same, except from *both* owner's and public's perspectives "dual perspective," below.	Regional Input-Output Model OR Regional Systems/Economics Model
3. Assess new financial investment opportunities individually – full value, risk, performance relative to objectives	3. Same, but dual perspective with full multi-attribute value, risk, resilience, etc. – public *and* owner	Engineering-Economics Model
4. Estimate correlations among existing & new assets or with market as whole (covariance or "beta")	4. Same, but estimate *physical interdependencies* among existing & new assets – unintended consequences, cascades & systemic failures	Regional Input-Output Model OR Regional Systems/Economics Model
5. Optimize investment portfolio – efficient frontier; *maximize* value at acceptable risk level, within budget & other private constraints (performance, "balance," lines of business, etc.)	5. Same, but set aside investments private investors will make; then *maximize* multi-attribute value at acceptable risk level, within budget & other constraints (distributional balance, equity, etc.)	Portfolio Optimizer, either integrated with AHP OR Specially adapted to examine virtually all investment combinations
6. Examine constrained, optimal portfolios – owner's perspective only – Select portfolio, invest, manage & evaluate performance for next iteration.	6. Same, but Examine constrained optimal portfolios – *public's* perspective only – Select portfolio, invest, manage & evaluate performance for next iteration.	Sensitivity analysis using any or all of the above tools

Sustainable Water *(Cont. from 15)*

Sector has through the gasoline tax, utilities reason that they will face challenges they cannot realistically meet to achieve their mission to protect public health and the environment.

Funding for the CWTF would be targeted and prioritized to pollutant sources that are causing the largest problems. The GAO report looked at funds that could be administered and used; what activities should be eligible; and, what type of financial assistance should be provided. They researched potential revenue streams from taxes on five industries:

1. Beverages
2. Fertilizers and pesticides
3. Flushable products, including soaps, detergents, cooking oils, and toiletries
4. Pharmaceuticals
5. Water appliances and plumbing fixtures

Of course, none of these will be an easy sell, each having its own arguments against new taxes as well as lobbyists on Capitol Hill. Neither did the GAO report look at secondary impacts of a particular tax.

The Constant Theme — Public Outreach

No matter what different approaches these options offer there is one common theme that runs throughout: public awareness and appreciation is an important component to insure any sustainable future for water infrastructure.

The ARRA was an enormous boost, but for those who did not have their shovels ready, it may make the coming reality of needs even more of a public understanding dilemma. The average American may wonder why, despite federal funds spent on infrastructure, their rates are on a routine incline as water utilities make new requests. Public opposition to price hikes may make rate increases even less politically palatable than they are currently. Given the enormous funding requests and the competing needs in a faltering economy, politicians and water boards will not pursue long term needs unless the public is supportive. Citizens must understand the vital role water services play in their community for public health, the environment, and as the basis for a successful economy.

In a report by the Water Environment Research Foundation to be published later this month, *Strategic Asset Management and Communication Report on Public Communication – Perceptions and Early Communications Tools*, researchers determined that public outreach, in itself, will not drive asset management. According to their findings, however, elected and appointed officials agreed that public outreach and education is needed to support the decisions necessary for infrastructure sustainability.

Having understood this several years ago, WEF created a public education initiative to provide communications tools called, *Water Is Life, and Infrastructure Makes It Happen*™. Municipalities and local organizations have access to free, downloadable, and customizable outreach materials that contain thought compelling slogans and eye-catching graphics to grab the publics' attention. WEF's goal has been to provide utilities a communications strategy and encourage them to work in local coalitions for water infrastructure. The approach relies on stakeholders working together using consistent messaging. The partnership strengthens their voice to engage the public and make their case. Local leaders are empowered to take necessary steps to support water infrastructure.

Will sustainable infrastructure funding get buried, pushed aside for fear of the ever increasing deficit and tax burdens? Or, can we once and for all realize the critical nature of water infrastructure to U.S. public health, the environment and as a foundation component of the economy? Combined, the four reports summarized here will inform and help elevate the debate within the water and finance sector for sustainable infrastructure investment. ❖

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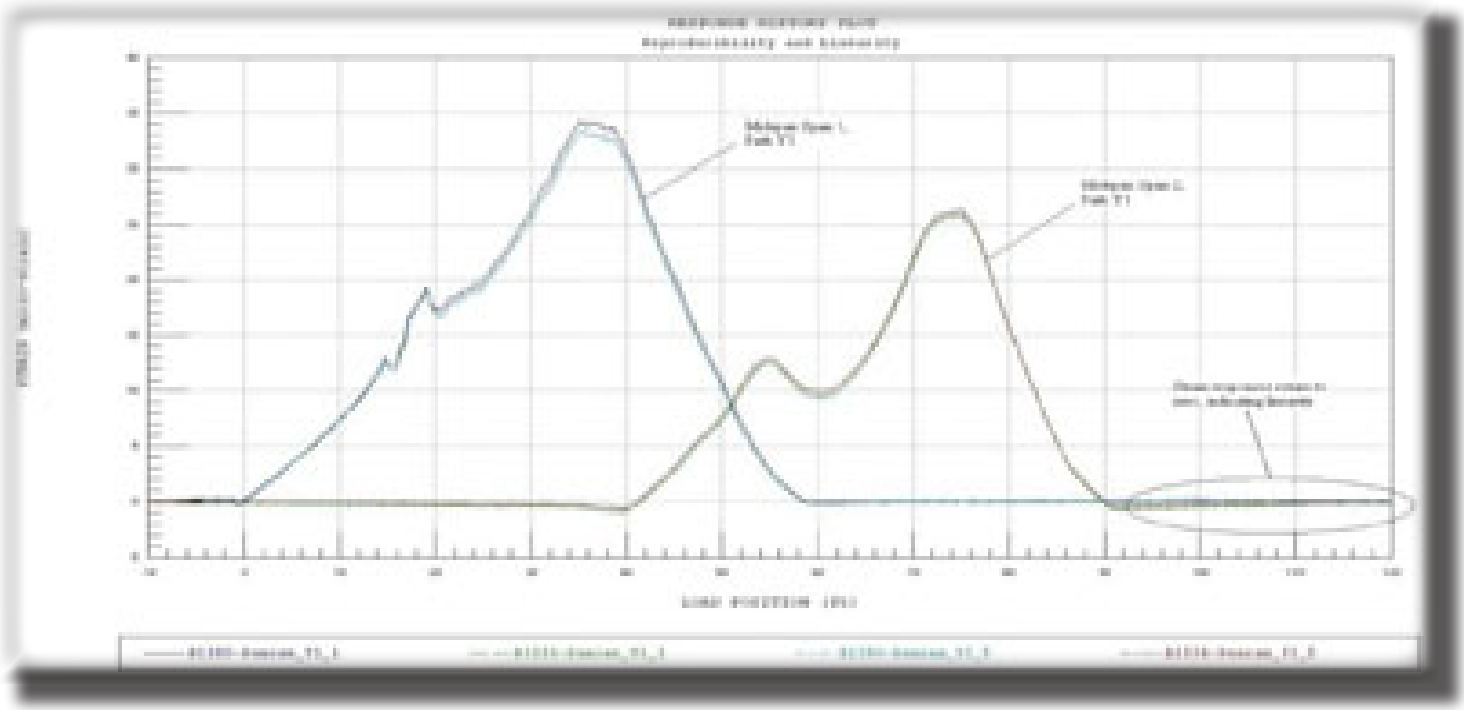
Diagnositics *(Cont. from 20)*

result is an accurate model that behaves like the actual bridge, and can confidently predict the behavior of the actual bridge under very heavy loads.

The typical results are that the bridge has more capacity and better distribution than originally assumed since things like sidewalks and guardrails actually carry some of the load. It should be noted that the testing and analysis procedures used for these investigations have been developed and refined by BDI over the last 20 years. The primary focus of these procedures has been to be able to implement them quickly and efficiently, therefore allowing them to be completed for a very reasonable cost.

With regards to aging infrastructure, as described above, the bridges that our particular firm has dealt with have been predominantly in adequate condition. Again, perhaps because of the types of structure we are involved with, we are not seeing a totally accurate view in whether or not there is any particular danger to the travelling public. The best source for this type of information would come from the state DOTs directly as they have detailed Bridge Management Systems that are basically databases on the condition of their bridges; most of the data there will be from their visual inspections that they must conduct every two years.

BDI is familiar with a variety of structural evaluation technologies. For more information on BDI's field testing and analysis services, please visit our website at http://www.bridgetest.com/index.html. ❖



Security *(Cont. from 18)*

Equally compelling as age-related failures are the catastrophic failures of relatively new infrastructure from factors such as lack of redundancy and flexibility that might otherwise have reduced the likelihood of failure and its consequences. Over two dozen bridge collapses tracked by the National Transportation Safety Board occurred among bridges that were not among the oldest. For example, bridges collapsed that were built during the 1950s and 1960s with prevailing non-redundant design. The Mianus Bridge, constructed in 1958, collapsed in 1983 in part due to maintenance problems. Similarly, the collapse in 1987 of the Schoharie Creek Bridge, which opened in 1954, was attributed to structural elements that contributed to susceptibility to bridge scour that ultimately undermined the bridge supports.

In addition to design and construction, environmental factors can decrease the lifetime and vulnerability of infrastructure. Examples are freeze-thaw cycles, undermining of structural support due to soil erosion and failure to replace soil after construction, electric currents, and vibration. Dependencies and interdependencies among infrastructures, which can be either spatial or functional, have dramatically altered the vulnerability of infrastructure. The rates at which different infrastructures recover from their dependency on other infrastructure is highly variable as the 2003 U.S.-Canada Blackout showed (Zimmerman and Restrepo 2006).

Thus age of infrastructure is one of a number of factors that affects infrastructure performance and its susceptibility to catastrophic failures, contributing to them and relating to them in a complicated way. Although age is commonly used as a surrogate for vulnerability, research on exactly how consistently it is defined and how it relates to environmental factors, design and construction practices, and interdependencies is critical. Moreover, if age does affect infrastructure condition, research is needed on how this affects the ability of infrastructure to withstand terrorist attacks and natural hazards. Finally, on a positive note, new innovations in planning and design can override effects that age can have on infrastructure lifetime estimates and resiliency needs, such as: using innovative materials that can resist heat, corrosive effects of water inundation, and physical impacts; redundant designs, avoidance of single point failure points, and flexible services to compensate for whatever negative affects may occur; and green technologies for resilience that may not be as age sensitive or can be more easily upgraded.

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and by earmarks to pet projects of specific congressional officials. A larger constraint is the requirement to spend funds across geographic areas regardless of need or of the respective populations served by an improvement, but this rural-urban divide is an essential characteristic of U.S. political system. Without this requirement and a demand to spend funds across all 50 states, an appropriations bill would never pass the Senate. The ultimate conclusion that can be drawn from the bill as it exists now is that some progress will continue to be made at the federal level on the aging infrastructure problem, but a solution is still far away. ❖

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