



TECHNOLOGY INNOVATION PROGRAM
National Institute of Standards and Technology
Gaithersburg, MD 20899

**ADVANCED SENSING TECHNOLOGIES FOR INFRASTRUCTURE:
ROADS, HIGHWAYS, BRIDGES AND WATER SYSTEMS**

THE NATIONAL RESPONSE TO THE 2008 TIP COMPETITION

The Technology Innovation Program (TIP) at the National Institute of Standards and Technology was established to assist U.S. businesses and institutions of higher education or other organizations, such as national laboratories and nonprofit research institutions, to support, promote, and accelerate innovation in the U.S. through high-risk, high-reward research in areas of Critical National Need. These areas need government attention because the magnitude of the problem is large and societal challenges are not being sufficiently addressed. All TIP funded projects must include at least one small or medium-sized U.S. business.

In June 2008, TIP published a white paper describing the scope of its first solicitation – “Advanced Sensing Technologies for the Infrastructure: Roads, Highways, Bridges and Water Systems.” The solicitation called for implementable, usable, and accurate sensing systems for the effective measurement of infrastructure performance characteristics such as fatigue, corrosion, stress, usage, damage, etc. These new sensing technologies could provide increased security and safety of key elements of critical infrastructure.

Out of 46 applicants to this competition, TIP selected nine projects for award and announced these decisions on January 6, 2009. Awarded projects from the first competition demonstrated TIP’s commitment to multi-disciplinary approaches and to encouraging broad teaming arrangements. Thirty-five research participants are involved in the nine projects. TIP emphasized system validation for this competition, and there are fourteen public sector entities (e.g., state agencies, water authorities, transportation authorities) involved (formally or informally) as testing partners to ensure the usability of the resulting systems. This unique involvement helps the projects toward achieving a transformative impact for infrastructure monitoring and inspection.

The nine awarded projects total \$42.5 million of TIP funds and \$45.6 million of cost shared funds provided by the participants. The awarded projects can be grouped by application area.

Highways - Bridges The nation’s 600,000 bridges are a prime concern for structural health monitoring since failure can have catastrophic consequences. Rational prioritization of scarce maintenance dollars is critical to maintaining these key elements of the nation’s highway infrastructure. Technical challenges to developing an automated monitoring system include providing long term power sources for sensors and data transmission; collection of appropriate, accurate data; ruggedization of the system for the harsh environment of bridges (e.g., temperature extremes, road salt); and integrating the data into information that can be used for decision making.

The six projects funded in this area follow:

- **Accellent Technologies, Inc.** (Sunnyvale, CA) plans to develop an extensible and self-powered sensor network using a peer-to-peer communication protocol for nondestructive evaluation and health monitoring of bridges, buildings, pipelines and other major infrastructure components.
- **Distributed Sensor Technologies, Inc.** (Santa Clara, CA, Joint Venture Lead) plans to develop an economical, fiber-optics-based system for monitoring the structural health of large infrastructure elements especially bridges without the need for installing large networks of individual sensors. (Partners: Optiphase, Inc.; Redfern Integrated Optics, University of Illinois at Chicago)

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- **Newport Sensors, Inc.** (Irvine, CA) plans to develop a novel nondestructive technology for early detection of corrosion in reinforced concrete structures such as bridges.
- **Physical Acoustics Corporation** (Princeton Junction, NJ, Joint Venture Lead) plans to develop a novel system for continuously monitoring the structural health of bridges using wireless sensors that “harvest” power from structural vibration/wind energy and assembles data from a variety of sensors for interpretation through damage assessment/reliability algorithms.
(Partners: University of Miami, University of South Carolina, Virginia Polytechnic University)
- **University of Michigan** (Ann Arbor, MI, Joint Venture Lead) plans to develop a comprehensive system for monitoring and assessing the structural health and integrity of major infrastructure elements such as bridges on a regional basis, with innovations ranging in scale from “smart material”-based sensors, up through structure-level data integration to a regional system for information aggregation and decision support.
(Partners: Li, Fischer, Lepech & Associates LLC; Monarch Antenna, Inc.; Prospect Solutions, LLC; SC Solutions; Weidlinger Associates, Inc.)
- **The University of Texas at Austin** (Austin, TX, Joint Venture Lead) plans to develop a pair of complementary sensor networks for bridge inspection: (1) an active, self-powered system for continuous monitoring for cracks or defects in fracture critical bridges and (2) a passive system for monitoring corrosion in reinforced concrete bridge decks.
(Partners: National Instruments Corporation; Wiss, Janney, Elstner Associates, Inc.)

Highways – Pavement The nation’s four million miles of public roadway represent a different challenge in prioritizing inspection and maintenance activities. Sinkholes, subsidence, and erosion can create voids under apparently intact pavement and lead to serious consequences. Problems can be cost-effectively addressed when caught early.

TIP awarded one project in this area:

- **Northeastern University** (Boston, MA, Joint Venture Lead) plans to develop a novel system based on instrument packages that can be installed on a wide variety of private and public vehicles to assess the conditions of bridges and roadways through several different and complementing methods at regular driving speeds during the course of ordinary use of the vehicles.
(Partners: University of Massachusetts Lowell; University of Vermont; Witten Technologies, Inc.)

Water and Wastewater Systems The nation’s 1.6 million miles of water and wastewater pipe are less visible but no less critical infrastructure. The challenge in inspection and monitoring is the lack of visibility. Projects addressing structural integrity monitoring in this area need to find ways of looking for damage without direct access to the inspection area.

TIP funded two projects in this area:

- **ELXSI Corporation** (Orlando, FL, Joint Venture Lead) plans to develop a novel, deep-penetrating scanning system for inspecting buried infrastructure such as pipelines, tunnels, and culverts that can detect fractures, quantify corrosion damage and determine the presence of voids in the surrounding soil to “see” beyond the structure to prevent accidents.
(Partners: Louisiana Tech University; UltraScan, LLC)
- **University of California at Irvine** (Irvine, CA, Joint Venture Lead) plans to develop a novel monitoring and inspection system for pipes and pipe networks in water and wastewater systems using wireless sensors incorporated in an advanced networked system using available limited optimal access points.
(Partners: Earth Mechanics, Inc., Irvine Ranch Water District, Orange County Sanitation District, Santa Ana Watershed Project Authority)

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