

Measurement Science Needs for Advancing Infrastructure Delivery



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Outline

- Introduce NIST and BFRL
- NRC Report: ***Advancing the Competitiveness and Efficiency of the U.S. Construction Industry***
- Advancing Infrastructure Delivery
- Workshop objectives

NIST At A Glance

Gaithersburg, MD



Boulder, CO



- NIST Research Laboratories
- Baldrige National Quality Award
- Manufacturing Extension Partnership
- Technology Innovation Program

- ~ 2,900 employees
- ~ 2,600 associates and facility users
- ~ 1,600 field staff in partner organizations
- ~ 400 NIST staff serving on 1,000 national and international standards committees

BFRL Mission

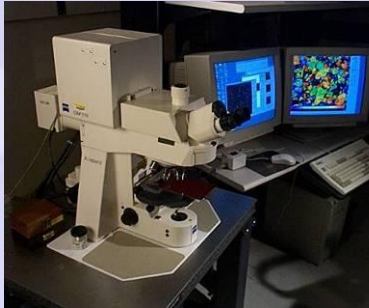
To promote U.S. *innovation* and *competitiveness* by anticipating and meeting the:

- measurement science,
- standards, and
- technology

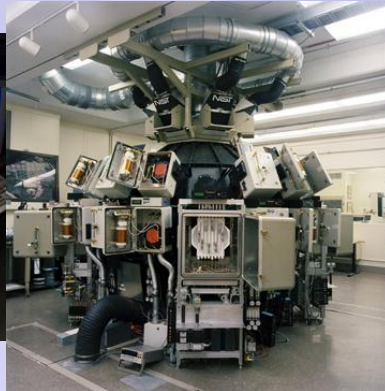


needs of the U.S. building and fire safety industries in ways that enhance *economic security* and improve the *quality of life*.

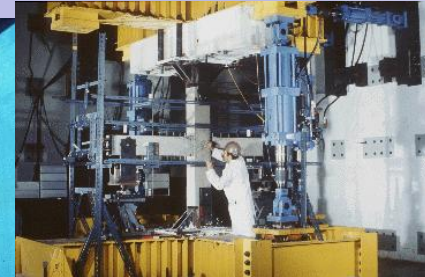
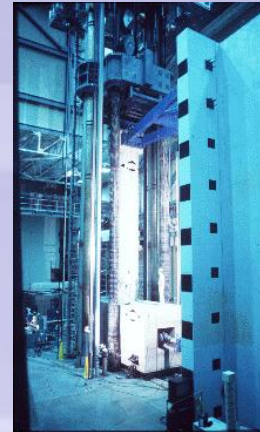
Measurement Science



*Virtual Cement and
Concrete Testing
Laboratory*



*Integrating Sphere for
Service Life Prediction
of Materials*

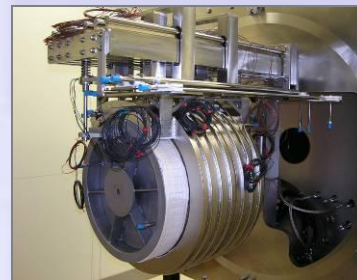


*Tri-directional Test Facility
Large-Scale Structures
Testing Laboratory*



Construction Site Metrology

*Residential Fuel Cell
Testing Laboratory*



*High Temperature
Guarded Hot Plate for
Advanced Thermal
Insulation Measurements*



*Large Fire
Research
Facility*



Cone Calorimeter

Scope of Measurement Science

The term *measurement science* includes:

- the development of performance metrics, measurement methods, predictive tools, and protocols as well as reference materials, data, and artifacts
- the conduct of inter-comparison studies and calibrations
- the evaluation and/or assessment of technologies, systems, and practices
- the development and/or dissemination of technical guidelines and basis for standards, codes, and practices—in many instances via testbeds, consortia, and/or other partnerships with the private sector

Activities with Potential for Breakthrough Improvements

- **Widespread use of interoperable technology applications and Building Information Modeling (BIM)**
- **Improved job-site efficiency through more effective interfacing of people, processes, materials, equipment, and IT**
- **Greater use of prefabrication, preassembly, modularization, and off-site fabrication and processes**
- **Innovative demonstration installations**
- **Effective performance measures to drive efficiency and support innovation**

BFRL Strategic Priorities



Measurement Science for:

- Net Zero Energy, High-Performance Buildings
- *Advancing Infrastructure Delivery*
- Predicting Life Cycle Performance of Infrastructure Materials
- Innovative Fire Protection
- Disaster-Resilient Structures and Communities

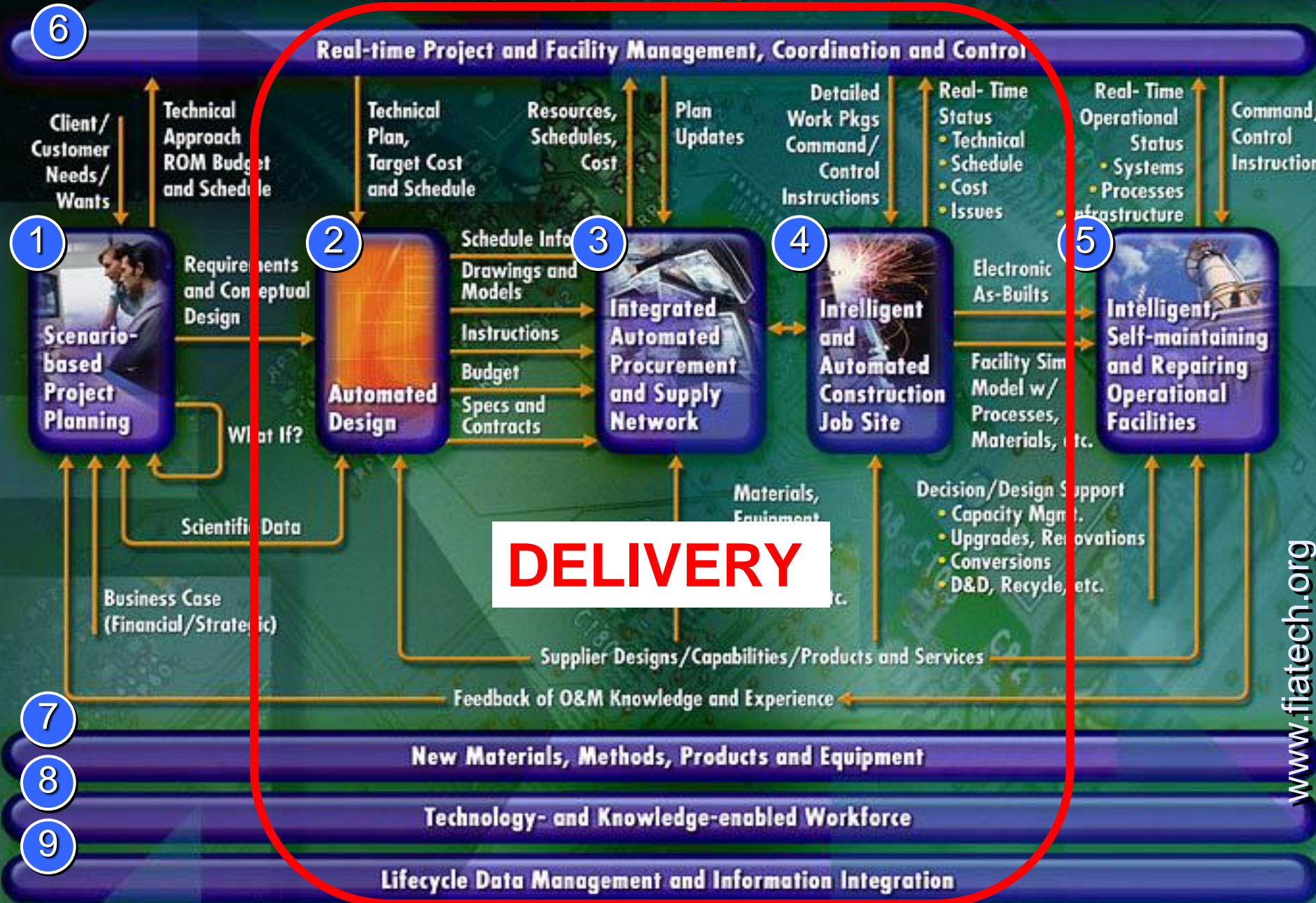


Infrastructure Development and Remediation

➤ Infrastructure Delivery

- Delivery = Design + Fabrication + Construction + Handover
- Leverage NIST work on construction integration, automation and productivity
- Build upon the NRC recommendations
- Focus on cross-cutting measurement science needs
- **Condition Assessment**
- **Resilience to Disasters**
- **Sustainability**

The FIATECH Capital Project Technology Roadmap Vision of the Future



What is the problem?

U.S. infrastructure is enormous and aging poorly

\$2.2 trillion cost for renewal of existing critical infrastructure

Significant expansion of infrastructure is needed

Infrastructure must be designed and built differently than in the past

Measurement science is needed to:

- enable automated access & integration of diverse information systems
- enable real-time monitoring & control of construction
- determine productivity at discrete & aggregate levels
- evaluate performance of promising automation & integration technologies

Advancing Infrastructure Delivery

Goal: *Achieve significant improvements in construction and operation of the Nation's physical infrastructure through the **development of measurement science that enables assessment and integration of information, communication, automation and sensing technologies.***

Results will enable U.S. industry to *move from paper-driven to data and model-driven processes.*

Physical infrastructure includes airports, bridges, tunnels, roads, ports, and other fixed portions of transportation systems, power generation and distribution facilities, water and waste facilities, government buildings, and public arenas.

ASCE 2009 Report Card

Infrastructure	Grade	5 Yrs Investment Needs	Other Information
Aviation	D	\$87 billion	
Bridges	C	(See Roads)	- More than 26% are deficient - \$17 billion annually needed
Dams	D	\$25 billion	- More than 85,000 dams in U.S. - 4000 deficient, including 1819 high-hazard potential dams - Average age ~ 51 years old
Drinking Water	D-	(See Wastewater)	- Leaking pipes lose ~ 7 billion gallons of clean water per day
Energy	D+	\$75 billion	- Demand for electricity grown 25% since 1990
Hazardous Waste	D	(See Solid Waste)	- Federal funding dropped to \$1.08 billion in 2008, lowest level since 1986
Inland Waterways	D-	\$50 billion	- Average age ~ 60 years old - Plan design life = 50 years - Replacing present system of locks cost > \$125 billion
Levees	D-	\$50 billion	- U.S. has ~100K miles of levees - 85% locally owned/maintained - Many are > 50 years old - \$100 billion to repair and rehabilitate nation's levees
Public Parks & Recreation	C	\$78 billion	- Contribute \$730 billion/year to U.S. economy - \$7 billion maintenance backlog
Rail	C-	\$63 billion	
Roads	D-	\$930 billion (Roads + Bridges)	- Current spending= \$70.3B/year - Estimated \$186B needed per yr
School	D	\$160 billion	Spending on the nation's school - 1998: \$17 billion - 2004: \$29 billion - 2007: \$20.28 billion
Solid Waste	C+	\$50 billion (Solid Waste + Hazardous Waste)	- In 2007, 254 billion ton of solid waste are produced - 1/3 recycled/ recovered, a 7% increase since 2000
Transit	D	\$265 billion	- Transit use increase 25% between 1995 and 2005 - \$15.8B/year needed to maintain conditions - \$21.6B/year to improve conditions
Wastewater	D-	\$225 billion (Drinking Water + Wastewater)	- The nation must invest \$390B over the next 20 years

Baseline Profiles for Infrastructure Sectors

- Key players and stakeholders
- Government entities/programs
- Industry and trade organizations
- Standards organizations
- Academics and research programs
- Journals and conferences
- Reports on needs, challenges, work processes, technology opportunities
- Documented roadmaps and priorities
- Relevant R,D&D projects
- Matches to the NRC recommendations
- Each sector has unique drivers, challenges and instructive examples

Workshop Objectives

1. Articulate measurement science needs to achieve significant improvements in the delivery of the Nation's physical infrastructure and have spill over benefits to other construction sectors.

Identify cross-cutting measurement science needs related to the application of new technologies and new methods or processes

2. Broaden the dialogue

- What does the future look like? What radical changes do we want to achieve?
- Identify critical technologies, challenges, barriers and measurement science needs
- Examine how “delivery technology” could improve cost, schedule, quality and functionality
- Document additions and revisions to the baseline assessment report
- Identify other relevant efforts, results and stakeholders to engage
- Are there other forums for collecting input?

3. Establish Sector Focus Groups

Next Steps

- Send additional comments and input for baseline assessment report by May 28 to Howard Andres at Energetics and cc: Mark Palmer
- Broaden the dialogue with stakeholders and relevant activities
- Distribute workshop results and update baseline assessment report to participants and stakeholders (June 21)
- Work with sector groups to complete target capabilities and barriers
- Determine where to focus to have maximum impact and greatest spill over benefits to other construction sectors
- Complete NIST Roadmap for Measurement Science for Advancing Infrastructure Delivery (FY 2011–2013 program) (September)