The Engineering Laboratory

Advancing measurement science and standards for U.S. industry

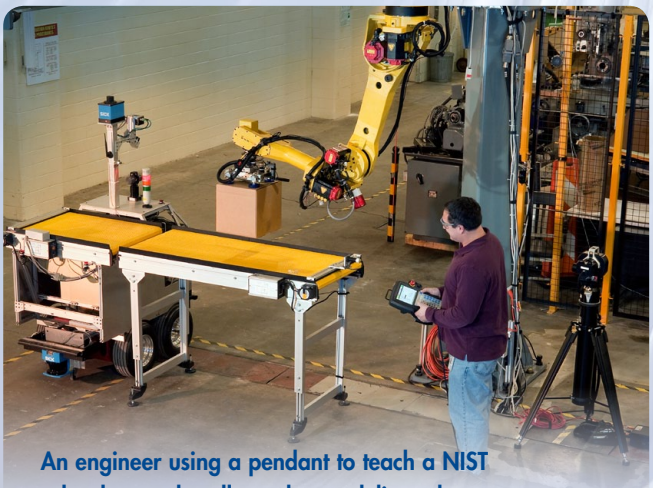
Putting advances in measurement science and standards to work for U.S. industry and for the benefit of all Americans is the chief objective of the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST). Impacts range from saved lives to longer-lasting roads and bridges and from more capable machine tools and more flexible supply chains to more energy-efficient homes and buildings.

EL is one of six major research-and-development laboratories at NIST--the federal government's oldest physical science agency and the only one devoted entirely to U.S. industrial competitiveness. EL delivers measurement and test methods, predictive tools, performance metrics, the technical underpinnings of codes and standards, and a variety of services. All of these outputs are integral to products and processes in the nation's manufacturing, construction, and infrastructure sectors.

Research and Services with an Impact

Consider a few examples of impacts and benefits. EL's contributions have:

- Helped to cut the annual toll of fire-related deaths by at least half, thanks to NIST's technical leadership in the development of standards for smoke alarms, flammability of mattresses, and protective equipment for fire fighters.
- Pioneered the development of standards for exchanging product-related information, improving supply-chain interoperability in the automotive, aerospace, and ship-building industries and saving more than $150 million annually.
- Paved the way for the development and widespread adoption (by more than 500 manufacturers) of an open building automation and control standard (BACnet) that is delivering significant savings in energy usage and operating costs, worldwide.
- Improved safety standards for industrial robots, while opening the way to more cost-effective use of the technology in smaller factories.
- Led to 40 major and far-reaching changes in U.S. building codes that will improve the safety of buildings, occupants, and first responders—an outcome of EL's investigation of the 9/11 collapse of the World Trade Center (WTC) and WTC 7 buildings.



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An engineer using a pendant to teach a NIST robot how to handle packages delivered to a conveyor by an automated guided vehicle.

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The SPHERE (Simulated Photodegradation by High Energy Radiant Exposure)

EL Overview

Through its measurement-focused research and services, EL supplies critical enabling solutions to U.S. manufacturers, the construction industry, and the broad array of businesses and other organizations that build, own, operate, or maintain the nation's vast physical infrastructure. These technical contributions help U.S. industry to innovate, raise productivity, and compete strongly in domestic and international markets.

Many of EL's responsibilities have been assigned to NIST by Congress. These include fire prevention and control, earthquake hazards reduction, sustainable manufacturing and construction, manufacturing enterprise integration, and construction safety.

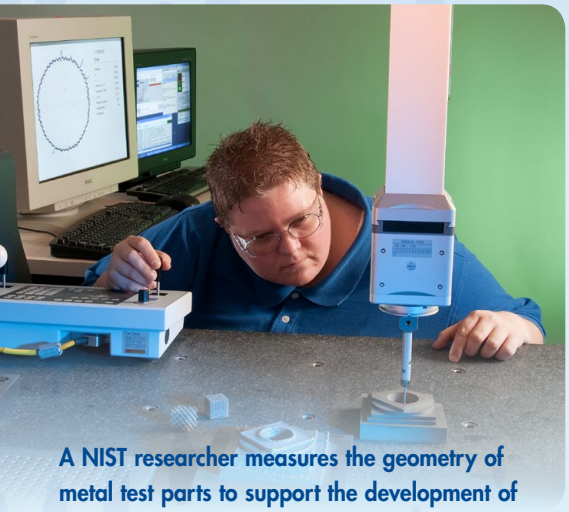
EL serves as the NIST lead for conducting studies of disasters and failures, a job spelled out in several laws. Since 1969, EL has investigated about 40 earthquakes, hurricanes, building and construction failures, tornadoes, and fires—all with the ultimate aim of identifying improvements in codes, standards, practices, and technologies.

World-Class Expertise

With research interests that span from microsensors and nanomaterial-based fire retardants to solar arrays and skyscrapers, EL has assembled a rare blend of complementary core competencies. Recognized for excellence the world over, this expertise encompasses:

- Intelligent sensing and control, robotics, and automated systems;
- Systems engineering and integration;
- Smart manufacturing processes and enterprise integration;
- Energy-efficient and intelligent operation of buildings with healthy indoor environments;
- Sustainability, durability and service-life prediction of building and infrastructure materials;
- Fire protection and fire dynamics within buildings and communities; &
- Resilience and reliability of structures at risk to multiple hazards.

Open-office plan fire experiment conducted to study the Cook County Building Fire.



A NIST researcher measures the geometry of metal test parts to support the development of standards for additive manufacturing processes.

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Smart, Sustainable, Efficient, Resilient

EL's goals, strategies, and programs are closely aligned with critical national needs. Key areas of focus are energy, manufacturing, and infrastructure. In all three of these priority areas, our nation faces significant—and, often, interrelated—challenges and opportunities. And in each, EL's particular combination of measurement know-how and industry experience, state-of-the-art facilities, and many one-of-a-kind instruments are key technical ingredients of a successful U.S. response.

With an emphasis on **smart systems,** several major EL research projects aim to speed development, adoption, and integration of leading-edge intelligent technologies. These innovations will boost U.S. manufacturing and construction capabilities as well as enhance the quality and durability of its cyber-physical infrastructure.

Another aim of EL research efforts is to further progress toward greater **sustainability** and **energy efficiency** in major industry sectors and across the built environment. One example is a project directed toward high-performance net-zero-energy buildings—the means to substantially reduce energy consumption, since buildings account for 72 percent of electric power use. Another aims to enable an open, standards-based information infrastructure to support sustainable manufacturing practices across supply chains.

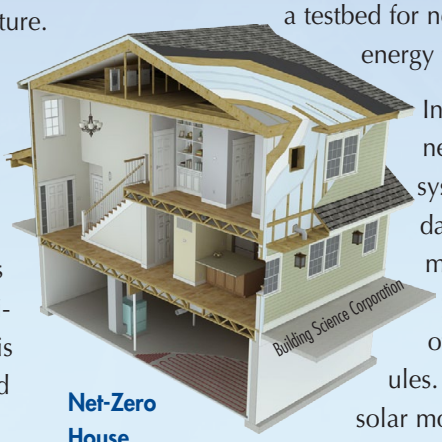
With a large percentage of the nation's buildings and infrastructure clustered in disaster-prone regions, EL also is developing measurement methods, models, and predictive tools that will help to make buildings, infrastructural systems, and entire communities more **resilient** in the face of natural and human-made hazards.

Specialized Research Facilities

EL research on manufacturing, buildings, and cyber-physical systems benefits from nearly 20 advanced facilities and testbeds, which are housed on NIST's Gaithersburg, Md., campus and also are available for cooperative and independent research by others.

NIST is expanding its National Fire Research Laboratory to accommodate testing full-scale structures—up to two stories high—and their components under realistic fire conditions.

The new Net -Zero Energy Residential Test Facility is designed to produce as much energy as it consumes over the course of a year and to serve as a testbed for new home-scale energy technologies.

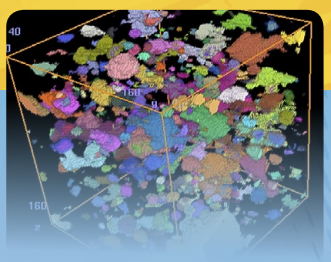


Net-Zero House

In addition, a major new photovoltaic system will provide data needed to develop models that better predict energy output of photovoltaic modules. Consisting of 2,500 solar modules, the new system will feed directly into the electrical grid, generating enough electricity to power 67 homes.

A new Robotics Test Facility will support performance measurements and research devoted to developing next-generation robots, with an emphasis on versatility, safety, autonomy, and rapid re-tasking.

The Laboratory at a Glance



Microtomography image of the pore structure of a fire-proofing material.

Mission

To promote U.S. innovation and industrial competitiveness in areas of critical national priority by anticipating and meeting the measurement science and standards needs for technology-intensive manufacturing, construction, and cyber-physical systems in ways that enhance economic prosperity and improve the quality of life

Vision

To be the source for creating critical solution-enabling measurement science, and critical technical contributions underpinning emerging standards, codes, and regulations that are used by the U.S. manufacturing, construction, and infrastructure industries to strengthen leadership in domestic and international markets

Core Competencies

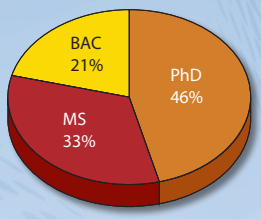
Measurement science and standards for engineering systems focused on manufacturing, construction, and cyber-physical systems.

World-class expertise in:

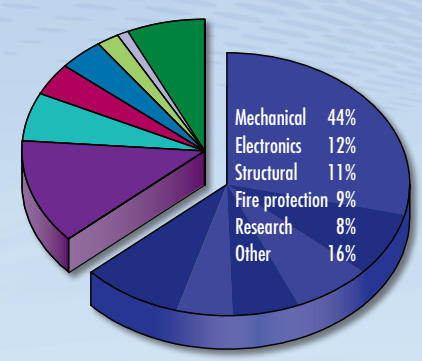
- Intelligent sensing, control, processes, and automation
- Systems integration, engineering, and processes
- Energy efficient and intelligent operation of buildings with healthy indoor environments
- Sustainability, durability and service life prediction of building and infrastructure materials
- Fire protection and fire dynamics within buildings and communities
- Resilience and reliability of structures under multi-hazards

Professional Staff

NIST Full-time Employees	230
EL Associates	224



Technical Specialties



Engineering	64%
Computer Science	13%
Physical Science	6%
Chemistry	4%
Economics	4%
Physics	2%
Math	1%
Other	6%

Goals

- **Smart Manufacturing, Construction, and Cyber-Physical Systems**
- **Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure**
- **Disaster-Resilient Buildings, Infrastructure, and Communities**

National Fire Research Laboratory

Facilities and Testbeds

Building and Fire

- Virtual Cement and Concrete Testing Lab
- Integrating Sphere for Service Life Prediction of Materials
- Large-Scale Structures Testing Lab
- Construction Site Metrology Lab
- High Temperature Guarded Hot Plate for Advanced Thermal Insulation Measurements
- Residential Fuel Cell Testing Lab
- National Fire Research Lab
- Cone Calorimeter

Manufacturing

- Industrial Control System Testbed
- Smart and Wireless Sensors Lab
- Intelligent Mobility Lab
- Manufacturing Robotics Testbed
- Robot Test Facility and Test Artifacts for Emergency Response Robots
- Pulse-Heated Kolsky Bar for Machining Properties
- Manufacturing Systems Integration XML Testbed

To see all of EL's software and tools go to: www.nist.gov/el/software.cfm

Organization

Programs and Contacts

Goal: Smart Manufacturing, Construction, and Cyber-Physical Systems		
Smart Manufacturing Processes and Equipment	Alkan Donmez	alkan.donmez@nist.gov
Next-Generation Robotics and Automation	Elena Messina Mike Shneier	elena.messina@nist.gov michael.shneier@nist.gov
Smart Manufacturing and Construction Systems	Fred Proctor	fred.proctor@nist.gov
Systems Integration for Manufacturing and Construction Applications	Simon Frechette	simon.frechette@nist.gov
Goal: Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure		
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Sustainable, High-Performance Infrastructure Materials	Ed Garboczi Joannie Chin	edward.garboczi@nist.gov joannie.chin@nist.gov
Net-Zero Energy, High-Performance Buildings	Bill Healy Piotr Domanski	william.healy@nist.gov piotr.domanski@nist.gov
Embedded Intelligence in Buildings	Steve Bushby	steven.bushby@nist.gov
Goal: Disaster-Resilient Buildings, Infrastructure, and Communities		
Fire Risk Reduction in Communities	Nelson Bryner	nelson.bryner@nist.gov
Fire Risk Reduction in Buildings	Jason Averill	jason.averill@nist.gov
Earthquake Risk Reduction in Buildings and Infrastructure	Jack Hayes	jack.hayes@nist.gov
Structural Performance Under Multi-Hazards	Stephen Cauffman	stephen.cauffman@nist.gov

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Applied Economics Office	Robert Chapman	robert.chapman@nist.gov
Building & Fire Codes & Standards	Nancy McNabb	nancy.mcnabbn@nist.gov

To learn more about the NIST Engineering Laboratory and to explore opportunities for collaboration:
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or email: **el@nist.gov**

August 2011

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