Intelligent Systems Division Overview

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The NIST Laboratories

NIST’s work enables
• Advancing manufacturing and services
• Helping ensure fair trade
• Improving public safety and security
• Improving quality of life

NIST works with
• Industry
• Academia
• Other agencies
• Government agencies
• Measurement laboratories
• Standards organizations

Providing measurement solutions for industry and the Nation
Intelligent Systems Division

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 intelligent cyber-physical systems used in technology-intensive manufacturing and construction in ways that enhance economic prosperity and improve the quality of life.
Manufacturing Drivers

- Increasing pace of technological change
  - Product and process innovation
  - Shorter time-to-market
- Growth of international trade and distributed manufacturing
- Continual push for higher quality, better performing customized products
- Increasing productivity and reducing costs
- Need to reduce environmental impacts
- New safety and security challenges
Manufacturing Matters
– the Engineering Laboratory (EL)
Role

• Manufacturing is challenged by a changing world and more aggressive and adept competition

• Technology - to spur innovation and enhance productivity and quality - is a critical factor for the success of U.S. manufacturers

• EL helps manufacturers to innovate and compete more effectively by providing by providing measurement science to help advance technology and reduce risks of technology adoption
Scope of Measurement Science

ISD measurement science research and services include:

• development of performance metrics, measurement and testing methods, predictive modeling and simulation tools, knowledge modeling, protocols, technical data, and reference materials and artifacts

• evaluation of technologies, systems, and practices, including uncertainty analysis

• development of the technical basis for standards and practices—in many instances via testbeds, consortia, standards development organizations, and/or other partnerships with industry and academia
How Do We Help?

We help bring industry stakeholders together to develop measurement and standards solutions:

• Requirements and performance standards
  • To define, specify, measure, and evaluate robot & automation system performance and capabilities, safety, and security
  • Repeatable, objective, quantitative test methods and associated environments, artifacts, and data

• Interoperability standards
  • Requirements, interface definitions, data modeling
  • Conformance assessment tools

• Infrastructural technology to help build next-generation unmanned systems
  • Architectures
  • Open source tools, implementations

  – Typically working in partnership with industry standards organizations and consortia
Driving Manufacturing Technology Innovation Through Measurements and Standards

Process has been proven in many NIST-led standards projects, e.g.,
- ASTM E54.08
- ASME B5/TC52
- ASME B89.1.12
EL Strategic Goals

Measurement Science and Standards for:

- Smart Manufacturing, Construction, and Cyber-Physical Systems
- Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure
- Disaster-Resilient Buildings, Infrastructure, and Communities
EL Programs Aligned with EL Strategic Goals

- Smart Manufacturing, Construction, and Cyber-Physical Systems
  - Smart Manufacturing Processes and Equipment
  - Next-Generation Robotics and Automation
  - Smart Manufacturing and Construction Systems
  - Systems Integration for Manufacturing and Construction Applications

- Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure
  - Sustainable Manufacturing
  - Sustainable, High-Performance Infrastructure Materials
  - Net-Zero Energy, High-Performance Buildings
  - Embedded Intelligence in Buildings

- Disaster-Resilient Buildings, Infrastructure, and Communities
  - Fire Risk Reduction in Communities
  - Fire Risk Reduction in Buildings
  - Earthquake Risk Reduction in Buildings and Infrastructure
  - Structural Performance Under Multi-Hazards

Our programs are identified, developed, carried out, the results implemented, and consequences measured in partnership with key customer organizations.
Smart Manufacturing Processes and Equipment Program

Objective: To develop and deploy advances in measurement science that will enable rapid and cost-effective production of innovative, complex products through advanced manufacturing processes and equipment

- **Additive Manufacturing Measurement Standards** – helping users best apply metal-based additive manufacturing systems for agile manufacture of innovative complex, custom products, through ASTM F42 standards

- **Machine Tool Performance Standards** – reducing risks for purchasers of high-tech machine tools needed to produce high value-added products, through development of ISO 230 and ISO 10791 standards for machine tool performance

- **Machining Process Modeling Tools** – enabling enhanced machining productivity and longer tooling life through new machining process and material measurement methods that improve models and simulations used to design and optimize manufacturing processes

- **Micro- and Nano-manufacturing Measurement Science** – enabling improved micro- and nano-scale product quality and yield through new measurement methods for improved process control
Next Generation Robotics and Automation Program

Objective: To develop and deploy advances in measurement science to safely increase the versatility, autonomy, and rapid re-tasking of intelligent robots and automation technologies for smart manufacturing and cyber-physical systems applications in the following thrust areas:

- **Sensing and Perception** – enabling next-generation robots that can safely collaborate with humans in unstructured environments and without costly fixturing

- **Manipulation and the Macro-, Micro-, and Nano-Scales** – enabling dexterous manipulation that is essential for agile operation and for a greater breadth of applications, including at the micro and nano scales

- **Mobility for Manufacturing** – allowing manufacturing vehicles to operate safely and more effectively in the same workspace as humans

- **Autonomy** – making possible agile and reconfigurable robots that are easily tasked to perform new manufacturing operations through intelligent planning and modeling
Smart Manufacturing and Construction Systems Program

Objective: To develop and deploy advances in measurement science to enable real-time monitoring, control, and performance optimization of smart manufacturing and construction systems at the factory or site

- **Smart Factory Networks** – enabling cost savings and ease of integration for factory networks of equipment and sensors, by developing performance and conformance tests for data exchange and cybersecurity standards through IEEE and ISA

- **Information Modeling and Testing** – enabling seamless information exchange throughout production activities, by developing validation and conformance tests for information exchange standards through ISO and the Dimensional Measurement Standards Consortium (DMSC)

- **Performance Measurement and Optimization** – enabling optimization of manufacturing across the shop floor, by developing standards for measuring key performance indicators through the Association for Manufacturing Technology (AMT)
Progress Benefits from Leveraging Across Application Domains

Core mission manufacturing programs leverage deep experience in supporting other government agencies with measurement science for intelligent systems:

- DARPA Transformative Apps
- DARPA TRANSTAC
- DARPA ASSIST
- DHS Emergency Response Robots
- DHS Sensor Networks
- ARL Performance Measures for Robotics Collaborative Technology Alliance
- ARL ANS Technology Readiness Level Evaluation
- ARL Demo II
- ARL Demo III
- Army TACOM Intelligent Ground Vehicle Ontology
- DOT Vehicle-Based Safety Systems
- DARPA LAGR
- DARPA Mobile Autonomous Robot Software
- DARPA Multiple Autonomous Underwater Vehicles
Intelligent Systems Beyond Manufacturing

- Demonstrated value and dramatic potential to save lives, improve performance and safety, provide new capabilities, and reduce operational costs
- Fundamentally changing how our national defense forces operate
- Poised to be the most dynamic growth area in aerospace, automotive, and other industries
- Provide crosscutting technology advances for manufacturing

*Intelligent and unmanned systems are important to our federal agency customers, who have come to us for help with key measurement science challenges*
Other Agency Partners
ISD Facilities and Testbeds

- Industrial Control System Networking and Security Testbed
- Smart and Wireless Sensors Laboratory
- Intelligent Mobility Lab
- Manufacturing Robotics Testbed
- Robot Test Facility for Performance Metrics and Standards
- Pulse-Heated Kolsky Bar Facility
New Robotics Test Facility

- Characterize and enhance performance of next-generation robots for safety, versatility, autonomy, and rapid re-tasking
- Enable development of safety and performance standards and test artifacts for intelligent robot systems
- Provide test-beds for manufacturing and construction applications
- Support applications for bomb disposal, search and rescue, and military ground operations

9,000 sq. ft. facility, including a high bay test area
Partnering with ISD

- Joint projects with Consortia, Individual Companies, Other Federal Agencies, Universities
  - CRADAs
  - Research Agreements
  - Grants and Contracts
- NIST Associates (Guest Researchers)
- Postdocs, Summer Undergraduate Research Fellowship (SURF)
- Patent licensing
- SBIR Program
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