National Institute of Standards and Technology
U.S. Department of Commerce

Bringing Industrial AI to Smart Manufacturing – **Measurement and Evaluation Needs**

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NIST Mission

To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life

Measurement Science	• Creating the experimental and theoretical tools – methods, metrics, instruments, and data – that enable innovation
Standards	• Disseminating physical standards and providing technical expertise to documentary standards that enable comparison, ensure interoperability, and support commerce
Technology	• Driving innovation through knowledge dissemination and public-private partnerships that bridge the gap between discovery and the marketplace

NIST AT A GLANCE

Industry's National Laboratory

3,400+
FEDERAL EMPLOYEES

5
NOBEL PRIZES

2 CAMPUSES
GAITHERSBURG, MD [HQ]
BOULDER, CO

3,500+
ASSOCIATES

10
COLLABORATIVE INSTITUTES

400+
BUSINESSES USING NIST FACILITIES

ManufacturingUSA®

14
NATL OFFICE FOR MANUFACTURING INSTITUTES

51
MANUFACTURING EXTENSION PARTNERSHIP CENTERS

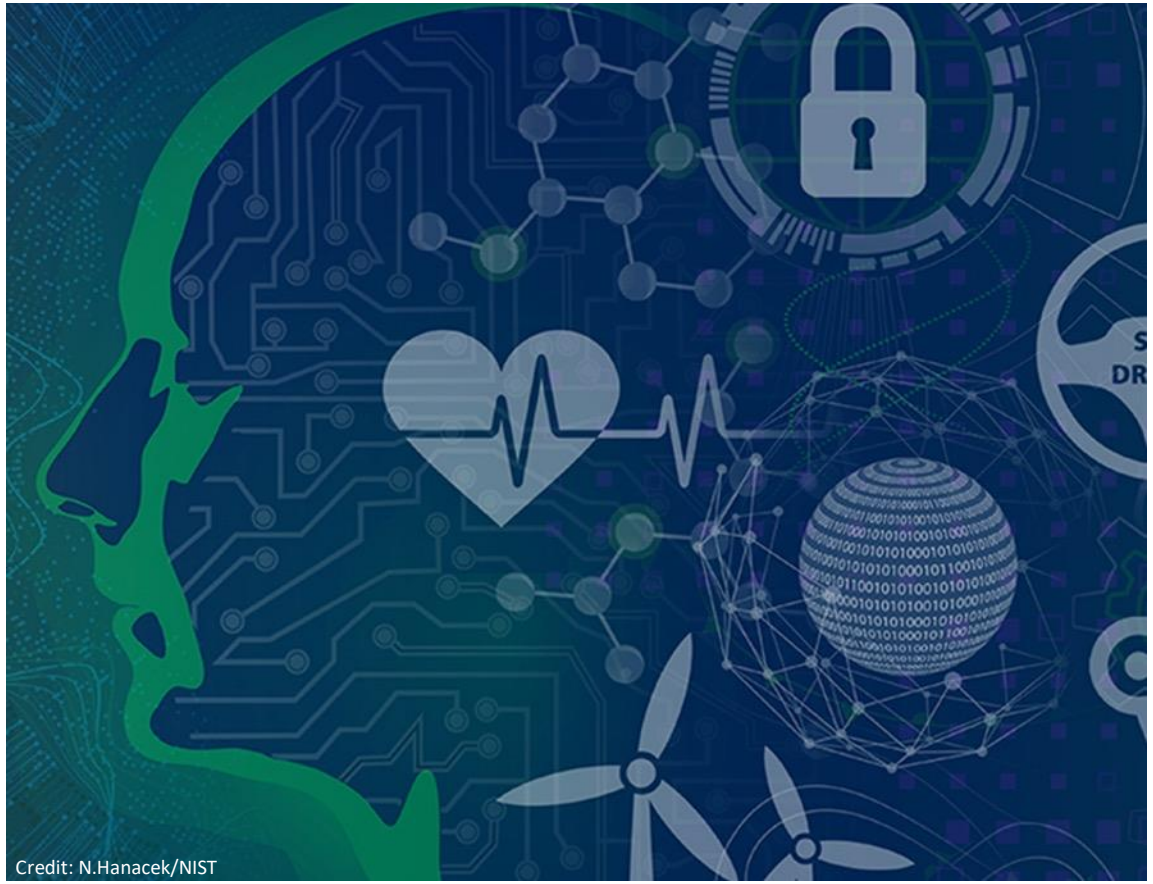
U.S. BALDRIGE PERFORMANCE EXCELLENCE PROGRAM

Strategic Priorities, National Impacts

Cybersecurity

Advanced Manufacturing

Strategic Priorities, National Impacts



Artificial Intelligence

Internet of Things

Measurement Science

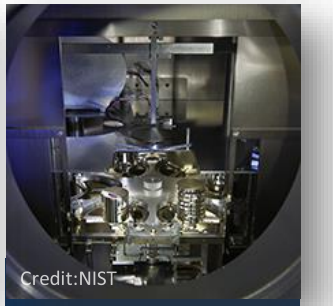
Used in the context of creating **critical-solution enabling tools** – metrics, models, and knowledge – for U.S. manufacturers. This includes:

- Development of…
  - Performance metrics
  - Measurement and testing methods
  - Predictive modeling and simulation tools
  - Reference materials (e.g. data sets)
  - Artifacts
  - Protocols
  - Technical data
  - Knowledge modeling
- Conduct inter-comparison studies and calibrations
- Evaluation of technologies, systems, and practices
- Development of the technical basis for standards, codes, guidelines, and/or practices

Image Courtesy of Adobe Stock

NIST Laboratory Programs

Material Measurement Laboratory

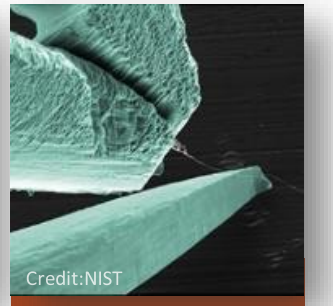


Physical Measurement Laboratory

Engineering Laboratory

Information Technology Laboratory

Communication Technology Laboratory



Center for Nanoscale Science and Technology

NIST Center for Neutron Research

Engineering Laboratory Goal Areas

Resilience

Smart Manufacturing

Cyber Physical Systems

Energy

https://www.nist.gov/el

Smart Manufacturing Enables…

- Make what you want, where you want it, and when you want it.
- Respond in real time to meet changing demands and conditions
- Easily and rapidly reconfigure factory production to optimize performance
- Deal with uncertainty and anomalies to enable continuous improvement
- Maintain seamless interoperability

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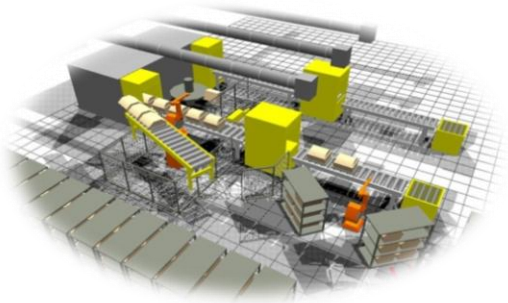
Smart Manufacturing



Objective: **To enable the next generation of innovative and competitive manufacturing through dynamic production systems and rapid design-to-production transformation**

- Measurement Science for Additive Manufacturing
- Measurement Science for Manufacturing Robotics
- Model-based Enterprise
- Trustworthy Systems, Components, and Data for Smart Manufacturing

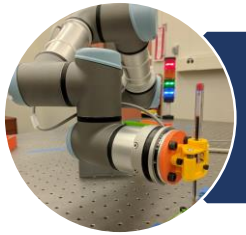
https://www.nist.gov/el/goals-programs/smart-manufacturing

Embodied AI and Data Generation for Manufacturing Robotics Research

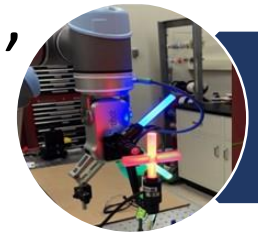
- Provides structured artificial intelligence (AI) and machine learning (ML) training datasets, and proven, trained, and applied AI/ML models, to improve the performance and autonomy of manufacturing robotic applications.
- Allows manufacturers to gain more value from their robots by allowing the robot to “learn” new tasks, and how to better perform existing tasks, without the need for human intervention.
- Initial area of focus are applying AI to:
  - Characterizing training data features
  - Human-robot interaction
  - Object pose recognition
  - Rapid robot task re-planning

Prognostics and Health Management for Reliable Operations in Smart Manufacturing Research

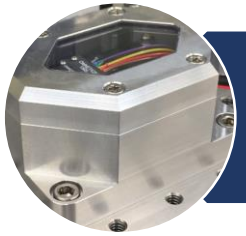
To develop and deploy measurement science to promote the implementation, verification, and validation of advanced monitoring, diagnostic, and prognostic technologies to increase reliability and decrease downtime in smart manufacturing systems



Identification and Isolation of Robot Workcell Degradation



Assessment of Robot Accuracy Degradation



Smart Machine Tools – Linear Axes Diagnostics and Prognostics

Smart Machine Tools – Spindle Health Monitoring

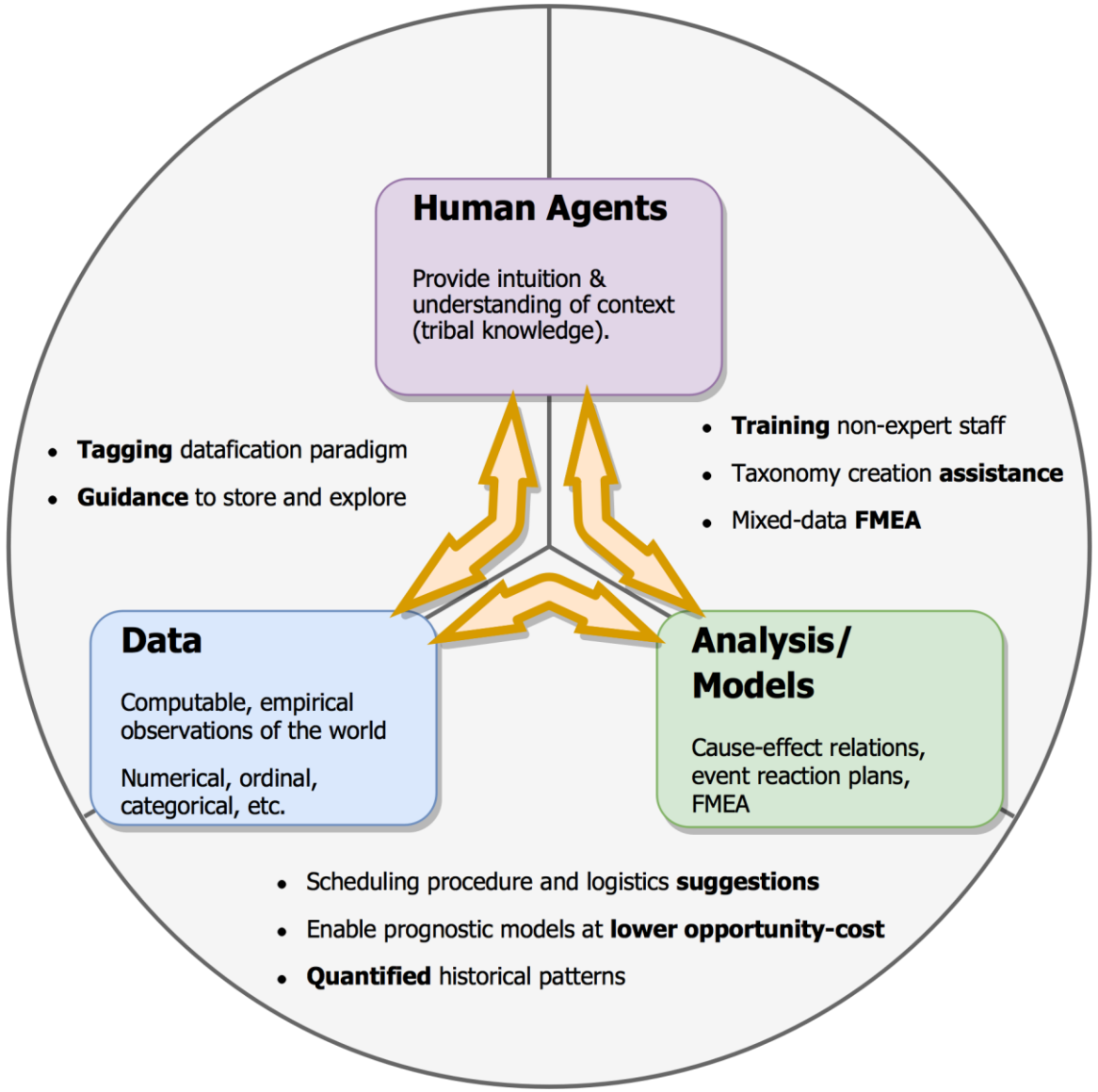
Bottom Image – Courtesy of Adobe Stock

Knowledge Extraction and Application for Manufacturing Operations

- Develop and deploy advances in standards, measurement science, and software tools using actionable, computable, domain knowledge stemming from **informal text-based data** to augment a manufacturers' ability to perform model-based and data-driven analyses.

- Explore hybridized Artificial Intelligence (AI) and expert-driven methodologies for **quantifying human knowledge**.

- Assist in labelling and analyzing text-based documents to **enable decision making and continuous improvement**.



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