

## Nanotechnology Signature Initiative\*

# Nanotechnology for Sensors and Sensors for Nanotechnology: Improving and Protecting Health, Safety, and the Environment

### Overview

Nanotechnology-enabled sensors are providing new solutions in physical, chemical, and biological sensing that enable increased detection sensitivity, specificity, and multiplexing capability in portable devices for a wide variety of health, safety, and environmental assessments. Compelling drivers for the development of nanosensors include the global distribution of agricultural and manufacturing facilities, creating an urgent need for sensors that can rapidly and reliably detect and identify the source of pollutants, adulterants, pathogens, and other threat agents at any point in the supply chain. The increasing burden of chronic diseases such as cancer and diabetes on the aging U.S. population requires improved sensors to identify early-stage disease and inform disease management. Although several new high-performance nanosensors have demonstrated rapid response and increased sensitivity at reduced size, translation of these devices to the commercial market is impeded by issues of reliability, reproducibility, and robustness. Furthermore, the rise in the use of engineered nanomaterials (ENMs) in commercial products and industrial applications has increased the need for sensors to detect, measure, and monitor the presence of ENMs potentially released in diverse environments across the entire nanotechnology-enabled product life cycle.

### Goals

Support research on engineered nanomaterial properties and development of supporting technologies that enable next-generation sensing of biological, chemical, and nanoscale materials.

### Thrust Areas

- Develop and promote adoption of new technologies that employ nanoscale materials and features to overcome technical barriers associated with conventional sensors
- Develop methods and devices to detect and identify engineered materials across their life cycles in order to assess their potential impact on human health and the environment

### Agencies Involved

Consumer Product Safety Commission, Department of Commerce (National Institute of Standards and Technology), Department of Defense, Department of Health and Human Services (Food and Drug Administration, National Institutes of Health, National Institute for Occupational Safety and Health), Environmental Protection Agency, National Aeronautics and Space Administration, National Science Foundation and the U.S. Department of Agriculture (National Institute of Food and Agriculture).

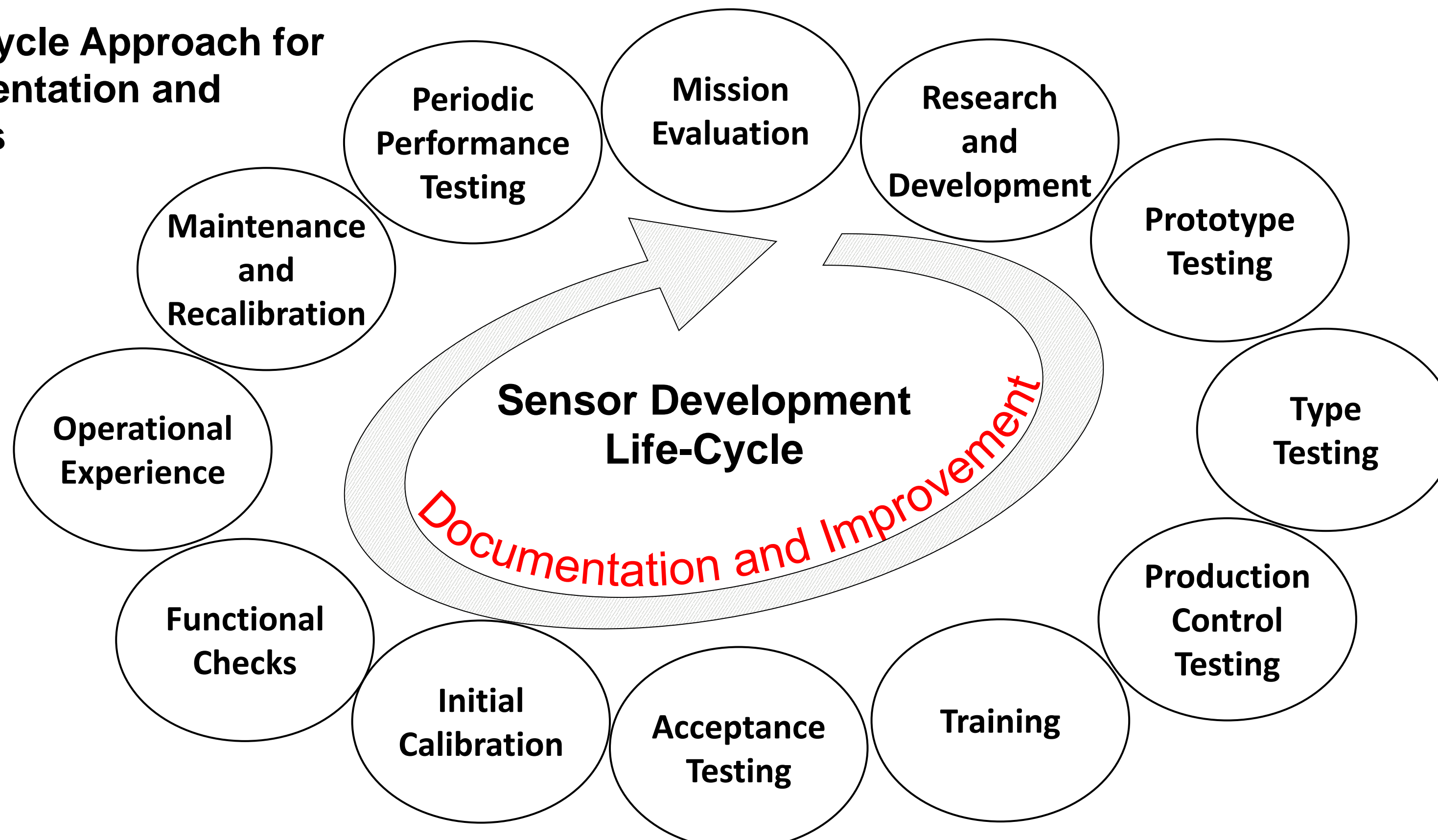
### Examples of Activities that Support the Goals of the Sensors NSI

#### FDA: DNA Barcodes for Regulatory Science

A DNA barcode is a short gene sequence used to identify species taken from a standard position in the genome – nucleotides identify the species

DNA Barcodes Invariable Across Life Stages, Processed Parts, Genders

### A Life-Cycle Approach for Instrumentation and Methods



### Examples of Activities that Support the Goals of the Sensors NSI

#### NIOSH-funded Development of a Practical Particle Collector

**Commercial Prototype (v.4)**

- Li-ion Rechargeable Battery
- Thermo-electric cooling module
- Piezo Micropump: 5-30 mL/min
- Flow Sensor
- TEM Sample Holder
- Resistive Heater
- Integrated circuit with LCD
  - user interface, data storage
  - flow, temperature control

**TPS-100 Prototype (v.4)**

- Smaller, Lighter
  - Wearable, ~315g
- User Flow Control
  - 1 – 10 mL/min
- User Temp. Control
  - Hot: 30 – 120 °C
  - Cold: 0 – 30 °C
- Removable Substrate
- 8 hr battery life
- Memory: T, RH, Q, time

#### NASA Biosensors

Multi-Channel Sensing Chip for Scalability

MWNT array electrode functionalized with DNA/PNA probe

#### NIST Center for Nanoscale Science and Technology (CNST)

- NIST's nanotechnology user facility. Provides rapid access to tools needed to make and measure nanostructures, with emphasis on helping U.S. industry.
- In the **NanoFab**, researchers can use a commercial state-of-the-art tool set at economical hourly rates, along with help from a dedicated, full-time technical support staff.
- In the **NanoLab**, researchers get access to the next generation of tools and processes through collaboration with our multidisciplinary research staff, who are developing new measurement and fabrication methods in response to national nanotechnology needs.
- The CNST serves as a hub linking the external community to the nanotechnology-related measurement expertise at NIST ([nano@nist.gov](mailto:nano@nist.gov)).

Sources of Nanomaterials

- Centers of Cancer Nanotech Excellence (CCNEs)
- Academia
- Big Pharm
- Small Biotech
- NCI, NIH, NSF Grants
- DoD, DoE

**NIH/NCI: Nanotechnology**

NIST Characterization Lab



\* Nanotechnology Signature Initiatives (NSIs) are topical areas identified by the National Nanotechnology Initiative and its agencies as benefiting greatly from close and targeted interagency interactions. The NSIs spotlight key areas of national priority and provide a mechanism for enhanced collaboration to leverage research and development programs across multiple agencies.