The Economic Impacts of *Documentary* Standards: Facilitating Lab-to-Market Breakthroughs and Economic Growth

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• Why do we care?
  ➢ Documentary standards in the U.S. — a little different
  ➢ NIST participation with SDOs
  ➢ Accelerating Lab-to-Market
  ➢ Assessing economic impacts

• How NIST helps accelerate breakthroughs and economic growth through measurement science and standards: 4 studies
  ➢ Early-stage Nanotechnology Standards
  ➢ Market Transition to Solid State Lighting Technology
  ➢ X-Ray Standards for Explosives Detection
  ➢ Flat Panel Display Measurement Standard (FPDM)
Why Do We Care?
Standards Development in the United States

- **Standards Development Organizations (SDOs) in the U.S. are Industry-driven**
  - Approximately 600 private organizations comprising the U.S. standardization system
  - American National Standards Institute (ANSI) serves as administrator and coordinator of the United States private sector, voluntary standardization system

- **NIST plays an important supporting role**
  - The National Technology Transfer and Advancement Act (NTTAA), gives NIST responsibility for coordinating federal role in voluntary standards
  - NIST is responsible for chairing the Interagency Committee on Standards Policy (ICSP) on federal government standards and conformity assessment activities
  - Approximately 400 NIST experts are involved in more than 1300 documentary standards committees
Accelerating Lab-to-Market

- **Key element of the President’s Management Agenda**
  - Accelerating the transfer of Federally funded research from the laboratory to the commercial marketplace.

- **The Federal Government invests more than $130 billion in research and development (R&D) each year.**
  - Conducted primarily at universities and Federal laboratories

- **NIST’s core competencies include:**
  - Development and maintenance of advanced measurement science and technology
  - Coordination of the Federal governments standards development efforts and works with private sector lead standard development organizations (SDOs)
  - Coordination of technology transfer (lab-to-market) policy across Federal agencies
  - Facilitation of technology transfer among small- and medium-sized manufacturers, nation-wide, through the Hollings Manufacturing Extension Partnership
• Assessment of a *documentary standards* using the NIST approach, focused on:

  - Project- and technology-specific sources of value creation, transfer, and diffusion
  - Generation of cumulative social benefits metrics (summation of benefits to individual beneficiaries, private and public)

• NIST has conducted dozens of micro-economic, case-based, economic impact assessments

  - Quantitative and qualitative
  - Retrospective and prospective
    

• NIST partners with others to advance program assessment goals
Breakthroughs and Economic Growth: Communicating the value of standards
Standards Development Accelerates Lab-to-Market Transitions and Widens Markets

Standards & the Innovation Process

Early-Stage Nanotechnology Standards — Background

- **Focus:** Economic significance of early nanotechnology standards to industry — users and developers.

- **Scope:** Standards developed by ASTM’s Subcommittee E56 (E56), the IEC’s Technical Committee 113 (TC113), ISO’s Technical Committee 229 (TC229).
Nanotechnology-related activities would have cost industry almost 50 percent more in the absence of the standards.
Benefits of nanotechnology documentary standards are conceptualized as the dollar value of costs avoided because the industry has access to the standards. Costs are the dollar value of hours Technical Committee members dedicated to the SDO consensus process plus the cost of pulling the information into their organizations. *Preliminary results indicated below.

• **Net Present Value (NPV) in 2005: $21,285,548**
  - The inflation-adjusted (real) value in 2005 of the labor-savings benefits (net of costs) to organizations’ activities with the highest percentage benefits

• **Cumulative Net Benefits (2005-2010): $34,179,393**
  - The discounted value of the net benefits that actually occurred as a result of the SDOs’ efforts (approximately $21 million invested at compound rate of 7%) from the perspective of 2012.

• **Industry Rate of Return: 309%**
  - This measure is similar to an internal rate of return but applied industry-wide: the discount rate that makes NPV 2005 = 0 and makes BCR = 1

• **Benefit-to-Cost Ratio (BCR): 13:1**
  - NPV of benefit stream/NPV of cost stream
Market Transition to Solid State Lighting Technology — Background

• **Focus:** Next-Generation Lighting Initiative to accelerate the development of white-light solid-state lighting (SSL) in support of DOE goal to reduce the total U.S. energy spent for lighting by half.

• **Scope:** NIST collaboration with DOE and SDOs to develop new standards for SSL; conducted research on color quality and measurement methods; and developed new calibration standards to support industry’s measurement needs.
In 2005, existing lighting measurement standards did not allow consistent measurements across all LED producers in the industry.

New chromaticity and photometric measurement standards (2008) began to create a level of homogeneity among SSL products and practices that did not exist prior to the standards.

- Chromaticity of Solid State Lighting Products (ANSI C78.377-2008)
- Electrical and Photometric Measurements of Solid-State Lighting Products (IESNA LM-79-08)
Significant contributions were made in developing the first standard for measurement of SSL products along with the basis for a laboratory accreditation program.

- A common language allowed for a direct 1:1 comparison of different products and helped reduce confusion on the part of the consumers also helped industry drive towards improved quality and lower costs.

- Lamp manufacturers are able to gauge LEDs for compatibility, cost, and color, driving interchangeability and multiple suppliers.

- Fixture or replacement lamp manufacturers see lower cost components, color defined components, and interchangeability.

- OEM or luminaire distributors have lower cost products that allowed their energy efficient SSL products to compete with existing lighting technologies.

- End users see a lower cost, more energy efficient products.
This descriptive case estimates rough-order-of-magnitude (ROM) benefits, not a discounted stream of net benefits typical of NIST’s economic impact estimates.

NIST participation effectively reduced the time-consuming costs of the consensus-making process.

- NIST’s “honest broker” role mediated positions put forward by interested parties in the standards development consensus-making process.
- “Without NIST,” it is estimated that ANSI C78.377-2008 and IESNA LM-79 would have taken 14 additional months to finalize, at a cost to industry committee participants of more than $1 million worth of their time.

The “value added” from sales foregone by a delay in the publication of the new measurement standards is estimated in the tens of millions of dollars.
• **Focus:**
  Air transportation system vulnerabilities in the wake of 9-11
  — Development, renovation, and promulgation of x-ray safety and image performance consensus standards

• **Scope:**
  Benefits to x-ray equipment manufacturers, equipment buyers (public and commercial), and aviation services users from NIST’s engagement in the standards development process
In 2001 the international community found itself with no comprehensive standards for the technical performance of x-ray or gamma-ray security-screening equipment.


Several public laws have driven U.S. agencies to revolutionize the provision of aviation security and caused the development of x-ray security standards for bulk-explosives detection.

New security standards have helped to transform the aviation x-ray screening infrastructure.
In 2005, NIST and DHS launched an effort to develop a suite of national voluntary consensus standards that span the use of x-rays and gamma rays in the screening of carried items, human subjects, at airline checkpoints, airline checked baggage, air cargo, and other venues.

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<thead>
<tr>
<th>Venue</th>
<th>Technical Performance</th>
<th>Radiation Safety</th>
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<tbody>
<tr>
<td>Checkpoint</td>
<td>ANSI N42.44 – 2008&lt;br&gt;ASTM F792 – 2008</td>
<td>ASTM F 1039; W2002&lt;br&gt;(21 CFR 1020.40)</td>
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<td>CT / EDS (Checked Luggage)</td>
<td>ANSI N42.45-2011</td>
<td>ASTM F1039; W2002&lt;br&gt;(21 CFR 1020.40)</td>
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<td>All Venues</td>
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<td>ANSI/HPS N43.3-2008&lt;br&gt;ANSI/ANS 6.1.1-1991; W2001&lt;br&gt;(29 CFR 1910)</td>
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End User Benefits

- If x-ray security standards contribute a fraction of a percent of the increased value airline travelers enjoy (arbitrarily, 0.0025) — what economists call “consumer surplus” or “willingness to pay” — then the economic value attributable to x-ray security standards would be on the order of tens of millions of dollars.

Procurement Agent Benefits

- If x-ray security standards contributed a small fraction to public and private procurement agents’ ability to assess the comparative value of competing x-ray screening equipment vendors, and induced the entry of competing firms, the economic value of that contribution would be estimated, conservatively, in the hundreds of millions of dollars.

Equipment Manufacturer Benefits

- Estimates that x-ray security standards reduce the development, testing, and compliance cost of manufacturing by up to 40%.
- If the average unit acquisition cost of a sophisticated x-ray screening device is on the order of $300,000, and there are 6000 such devices in the public and private inventory, a rough-order-of-magnitude estimate of cost savings would be measured in the hundreds of millions of dollars.
**Focus:**
NIST’s contributions to the Video Electronics Standards Association’s (VESA’s) Flat Panel Display Measurement (FPDM) standard

**Scope:**
FPDMs impact on
- Quality of products
- Technology transfer of measurement device designs

- Acceleration of FPDM’s publication date
- Transfer of codified know-how to ICDM’s new Display Measurement Standard (DMS)
FPDM enabled the transition to “structured dialog” between FPD manufacturers and application OEMs

- Users able to specify tolerances of product attributes
- Technology to measure attributes is available, reliable and unambiguous
- Procurer understands how, when, and why variation will affect system performance

Industry metrology labor-saving (measured)

- Metrology labor saving (net): ~$2.4 million annually (1998-2010)

SDO consensus-making labor saving (measured)

- Consensus labor-savings (net): ~$640,000 annually (1995-2001)

Enhanced quality of products that use FPDs; measurement device designs transferred to industry; codified know-how carried forward into successor SDO (Display Measurement Standard)
FPDM — Measures of Economic Impact

Very conservative estimate of VESA’s/NIST’s return on investment (ROI) in FPDM

- **Net Present Value (NPV) in 1992**: $15,573,930
  - Value, in 1992 dollars, of the eventual outcome of the VESA/NIST investment

- **Net Present Value in 2010**: $56,323,545
  - Value, in 2010 dollars, of the 1992 NPV invested for 19 years at 7% per annum

- **Real Social Rate of Return**: 48%
  - The discount rate that makes NPV 1992 = 0 and makes BCR = 1 (VESA/NIST “breakeven”)

- **Benefit-to-Cost Ratio (BCR)**: 4
  - NPV of benefit stream/NPV of cost stream
Lessons Learned

• *Documentary* standards have significant economic impacts, similar to the economic impacts of artifact standards, intrinsic standards, standard/reference materials, and the supporting know-how and measurement technologies.

• NIST and thus organizations playing a similar role involvement in SDOs improves the efficiency of the SDOs operations by mitigating “specsmanship” (reducing consensus-making time) and speeding standards release dates and product sales tied to standards.

• Measurement know-how typically plays an important role in the dynamics of global, knowledge-driven industries, enabling the “structured dialog” that speeds technology transfer and applications to improved and new products and services.

• Conducting economic impact studies leads to a deeper understanding of the collaborative role of the public sector (generally) in the acceleration of technological breakthroughs and dynamics of economic growth.
Thank You

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Standards with the Greatest Impact of Organization's Activities

<table>
<thead>
<tr>
<th>All Respondents Top 5 (Count)</th>
<th>Industry Respondents Top 5 (Count)</th>
<th>Documentary Standard Title</th>
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<tr>
<td>14</td>
<td>7</td>
<td>ISO/TS 27687:2008 – Nanotechnologies -- Terminology and definitions for nano-objects</td>
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<tr>
<td>7</td>
<td>6</td>
<td>ISO/TR 13121:2011 – Nanotechnologies -- Nanomaterial risk evaluation</td>
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<td>7</td>
<td>5</td>
<td>E2535-07 Standard Guide for Handling Unbound Engineered Nanoscale Particles in Occupational Settings</td>
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<td>7</td>
<td>5</td>
<td>ISO/TR 11360:2010 – Nanotechnologies – Methodology for the classification and categorization of nanomaterials</td>
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<tr>
<td>5</td>
<td></td>
<td>ISO/TR 13014:2012 - Nanotechnologies - Guidance on physicochemical characterization...for toxicologic assessment</td>
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Across industry, university, and government respondent, terminology, health & safety, and risk evaluation standards are of the greatest importance.