



MNT Education Special Interest Group (MNT<sup>e</sup>SIG)  
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# In Quest of Universal Nanotechnology Standards

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## **Order of Presentation**

- **Exponential Convergence of Nanotechnology, Robotics and Artificial Intelligence: Uncertainty & Risk Management**
- **Importance of Standards in the Global Marketplace**
- **Key issues for Standards Inclusion in Curricula**
- **Need for Universal Nanotechnology Standards**
- **National & International Standards Organizations**
- **Key challenges & Questions for Development of Universal Standards**

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## Exponential Convergence of Nanotechnology, Robotics and Artificial Intelligence (AI)





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JULY 22-25

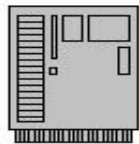
ST LOUIS

Hyatt Regency at the Arch

*Educating America's Technical Workforce*

## Exponential Convergence of Nanotechnology, Robotics and Artificial Intelligence (AI)

### Modern AI Theory of Evolution



Computer

Basic Robot

Programmable Robot

Human-Like

Super Human-Like

Number Cruncher

Special Purpose

Foundational AI

Augmented AI

Strong AI

Computation

Repeated Tasks

Machine Learning

Deep Learning

Conscience?

1950's

1990's

2010's

2030's

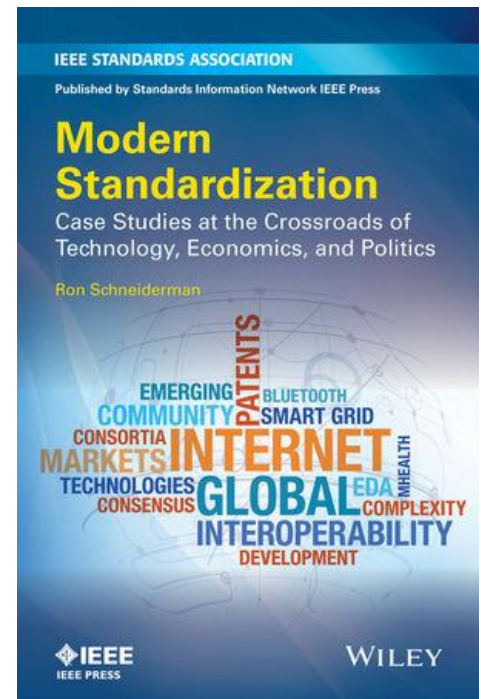
2040's+



In today's global economy, the importance of the formal study of standards has been highlighted by the new demands of international trade.

Politics of standards development and adoption is becoming a complex affair in an era of intellectual property rights. In today's global market place, the major challenges are:

- How do standards development organizations (SDOs) keep pace with the creation and development of products driven by new and emerging technologies?
- How to teach engineering and technology workforce and students the importance and applications of standards?



Book Review: Modern Standardization, Dr. Ahmed S. Khan

<https://www.standardsuniversity.org/e-magazine/june-2016/book-review-modern-standardization-case-studies-crossroads-technology-economics-politics/>



## *What are the fundamental dynamics of standards?*

Students need to develop an understanding of the interplay of three fundamental dynamics of standards: Technology, Economics, and Politics. In this regard students need to learn:

- How standards play a part in their career;
- How to think critically about standards development and technology solutions;
- About the pace of standards development in terms of technical change;
- How standards help drive innovation;
- How standards development process provides good technical solutions;
- Why standards are flexible.





## ***What are practical factors that hinder the inclusion of standards in the curricula?***

Some of the practical factors which hinder the inclusion of standards to the curricula are:

- Institutions are overwhelmed by the quantity of currently required materials;
- Professors believe that they do not know enough about standards to teach the subject effectively or assess student work;
- Required materials for teaching standards do not exist.



## Need for Universal Standards

- **Nanotechnology is remaking the world at an alarmingly fast pace, but presently nanoproducts are being developed in an environment of regulatory vacuum at national and international levels.**
- **The biggest question is how to deal with uncertainty and risk assessment?**
- **All new and emerging technologies pose new challenges and uncertainties; in the domains of science and technology these can be dealt with additional research, but in the realm of law and regulation, immediate answers are sought.**





## Need for Universal Standards

- Because uncertainty must be dealt with in regulation, and in the absence of straightforward regulations, methodologies are used to address uncertainty.
- One such methodology used for dealing with uncertainty in regulation is risk assessment

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## National & International Standards Organizations

Organization	Guideline/ Recommendation/ Standards Publication	Comments
ASTM <a href="http://www.astm.org/Standards/nanotechnology-standards.html">http://www.astm.org/Standards/nanotechnology-standards.html</a>	Provides guidance for nanotechnology and nanomaterials	Focuses on informatics and terminologies, physical and chemical characterization of nanomaterials, and environmental health and safety

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## National & International Standards Organizations

Organization	Guideline/ Recommendation/ Standards Publication	Comments
NIOSH/CDC Department of Health and Human Services Centers for Disease Control and Prevention National Institute for Occupational Safety and Health	Approaches to Safe Nanotechnology Managing the Health and Safety Concerns Associated with Engineered Nanomaterials	This document provides guidelines for managing the Health and Safety Concerns Associated with Engineered Nanomaterials
	General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories	This document provides guidelines for General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories



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## National & International Standards Organizations

Organization	Guideline/ Recommendation/ Standards Publication	Comments
<p>Institute of Environmental Sciences and Technology  <a href="http://www.iest.org">http://www.iest.org</a></p>	<p>EST-RP-NANO200.1:            Planning of Nanoscale Science and Technology Facilities; Guidelines for Design, Construction, and Start-Up.</p>	<p>The overview focuses on the unique 22 considerations related to planning, design, construction, and start-up that typically confront owners, designers, and users of the advanced-technology facilities supporting research or production at the nanometer scale.</p>

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## National & International Standards Organizations

Organization	Guideline/ Recommendation/ Standards Publication	Comments
<p>U.S. Food and Drug Administration <a href="http://www.fda.gov">http://www.fda.gov</a></p>	<ol style="list-style-type: none"> <li>1. Considering Whether an FDA-Regulated Product Involves the Application of Nanotechnology.</li> <li>2. Safety of Nanomaterials in Cosmetic Products.</li> <li>3. Assessing the Effects of Significant Manufacturing Process Changes, Including Emerging Technologies</li> </ol>	<p>The guidance describes FDA's current thinking on determining whether FDA-regulated products involve the application of nanotechnology. This guidance is intended for manufacturers, suppliers, importers, and other stakeholders.</p>

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## National & International Standards Organizations

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<p>IEEE Nanotechnology Standards Working Group</p> <p><a href="http://grouper.ieee.org/groups/1650/">http://grouper.ieee.org/groups/1650/</a></p>	<p>IEEE Standard 1650TM-2005 IEEE Standard Test Methods for Measurement of Electrical Properties of Carbon Nanotubes</p>	<p>This standard describes methods for the electrical characterization of carbon nanotubes. The methods are independent of processing routes used to fabricate the carbon nanotubes.</p>



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- **These national and international organizations have developed guidelines and recommended practices for working with manmade nanostructures.**
- **But there is an urgent need to develop specific universal standards to ensure safety for researchers working with nanomaterials and nanostructures and for consumers using nanotechnology-based products.**
- **These standards would eventually be incorporated into research and manufacturing procedures as the countries around the globe develop their own regulations.**

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**To develop universal standards, the following questions need to be answered by the all stakeholders –consumers, businesses, industries, and national and international regulatory bodies---of nanotechnology:**

- **How should we manage exposure to nano waste by humans and environment?**
- **How can we develop effective risk management strategies dealing with the uncertainties of nanotechnologies?**
- **How should people be educated about the potential benefits and risks of nanotechnology?**
- **How can schools and universities promote best practices in lab safety protocols?**
- **What are some design factors that must be considered in building laboratories that will provide safe environment for researchers?**

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Development of universal Nanotechnology standards, and stakeholder education, are the pivotal factors in effectively dealing with the potential short-term and long-term benefits (**intended consequences**) of nanotechnology together with the limitations and risks (**unintended consequences**).

*Khan, Ahmed S. (2012). Nanotechnology: Ethical and Social Implications, CRC Press, Boca Raton, FL. pp.313-317.*





**Thanks....Any Comments...Questions?**

*To know what you know and what you do not know, that is true knowledge.  
--- Confucius*

*The art of knowing is knowing what to ignore.  
--- Rumi*

