Nanotechnology Standardization: Sweating the Small Stuff

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Discussion

What is nanotechnology

Standardization

Nanotechnology standardization

Issues coming up

Why should we care

Nanotechnology – is it new?

Lycurgus Cup – a 4th century Roman glass cage cup

Nanotechnology related phenomenon observed depending upon lighting conditions

Credit: Brit_Mus_13sept10_brooches_etc_044.jpg: Johnbod Wikimedia Commons

Credit: Sailko, Wikimedia Commons, CC-BY-SA 3.0

Nanotechnology – applied

The development of Damascene steel in medieval time resulted in very strong steel – attributed to presence of carbon nanotubes and nanowires

Credit: Ralf Pfeifer, Messer aus Damaszener Stahl von Herbertz
Wikipedia: Damascus_steel#mediaviewer/File:DamaszenerKlinge.JPG
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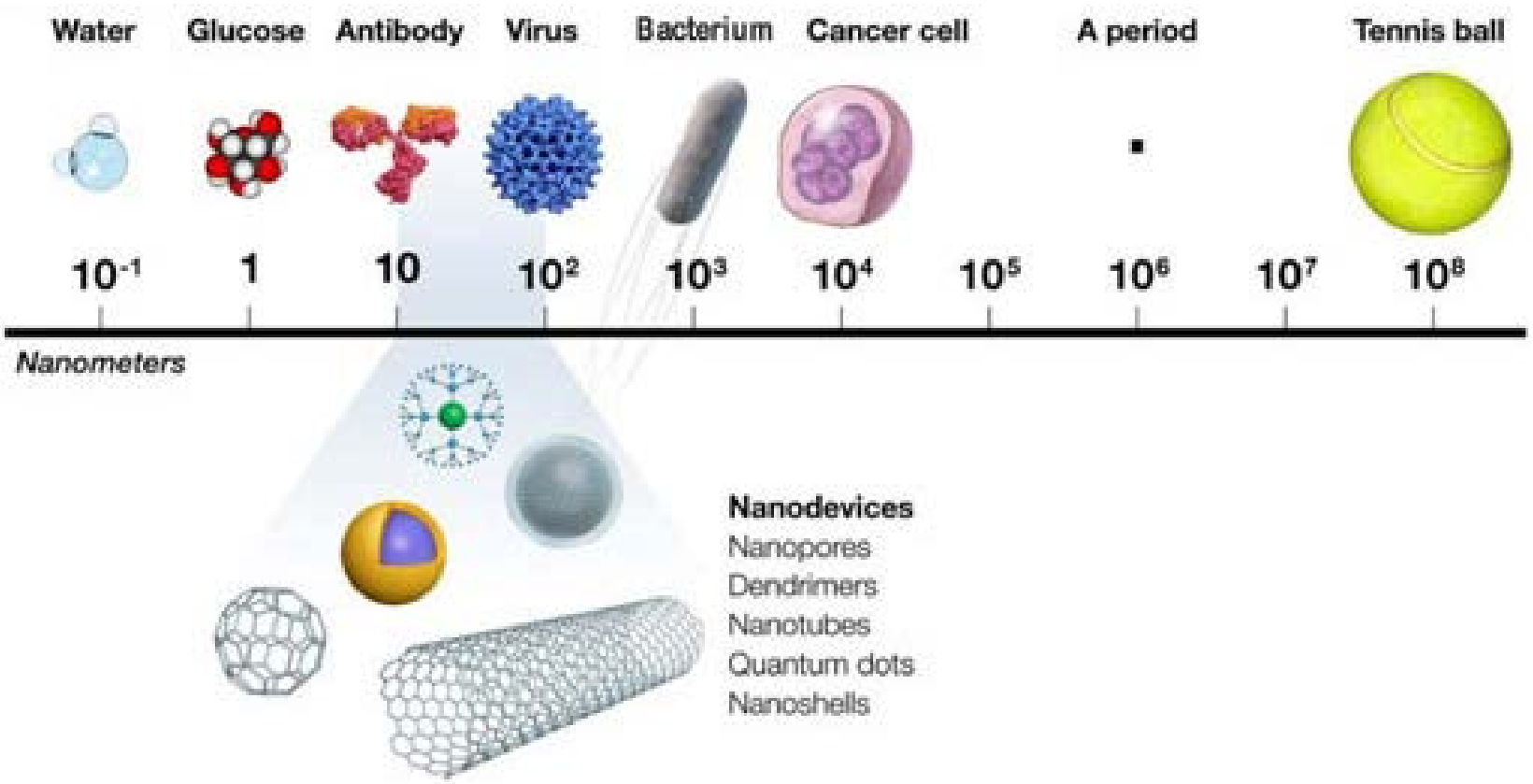
What is nanotechnology

*Nanotechnology is the **understanding and control of matter** at the nanoscale, at dimensions between **approximately 1 and 100 nanometers**, where **unique phenomena** enable novel applications.**

- U.S. National Nanotechnology Initiative 2000

Deconstructing nanotechnology

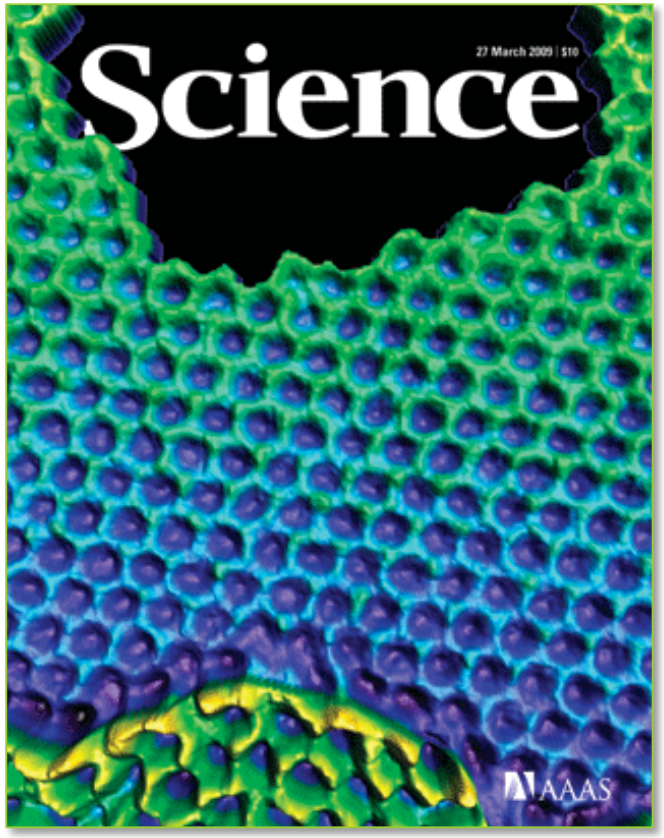
What is “between approximately 1 and 100 nm”?



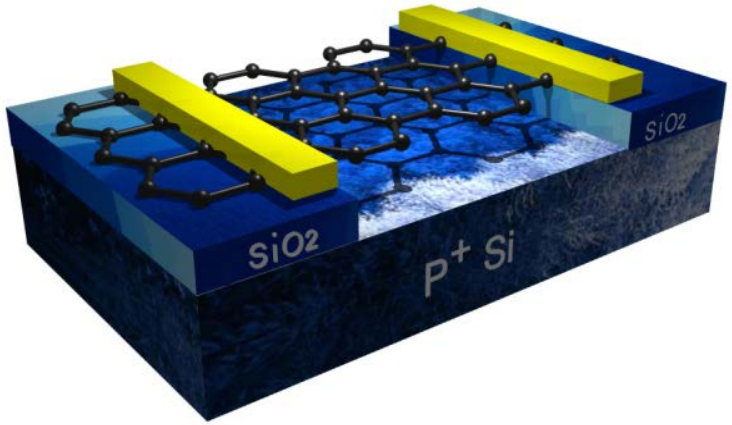
Credit: http://publications.nigms.nih.gov/chemhealth/cool.htm

Deconstructing nanotechnology

"understanding and control of matter"



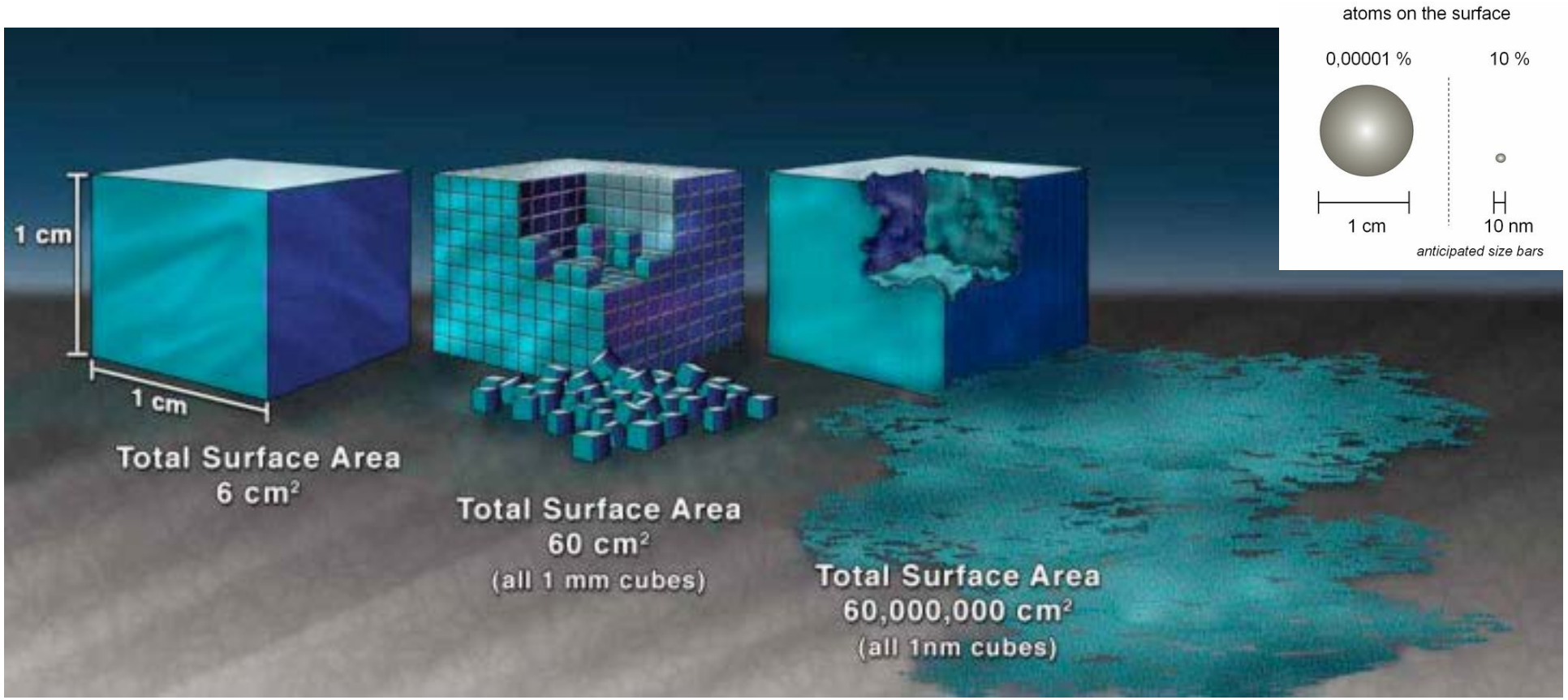
Credit: hScience 27 March 2009: Vol. 323 no. 5922 pp. 1705-1708 ; http://news.cnet.com/8301-17938_105-20004710-1.html



Graphene layer attached to a metal heat sink and suspended across a trench in the silicon wafer.

Deconstructing Nanotechnology

"Unique phenomena"



Credit: http://www.nano.gov/nanotech-101/special; http://www.micronano.ethz.ch/opportunities_and_risks/opportunities

USG interest in nanotechnology

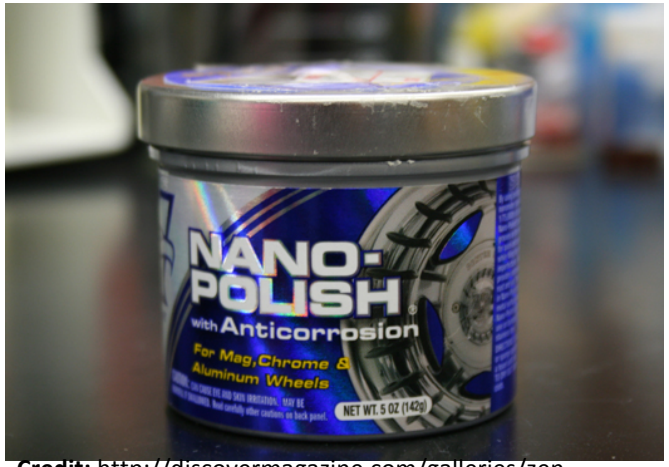
"My budget supports a major new ***National Nanotechnology Initiative***, worth $500 million. … the ability to manipulate matter at the atomic and molecular level. Imagine the possibilities: materials with ten times the strength of steel and only a small fraction of the weight -- shrinking all the information housed at the Library of Congress into a device the size of a sugar cube -- detecting cancerous tumors when they are only a few cells in size. Some of our research goals may take 20 or more years to achieve, but that is precisely why there is an important role for the federal government."

--President William J. Clinton
January 21, 2000
California Institute Of Technology

Nanotechnology applied

Credit: 3M

Credit: http://nanoparticle6.wikispaces.com/nanoparticle+superstars



Credit: http://discovermagazine.com/galleries/zen-photo/n/nanotech-products

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Nanotechnology markets – some numbers & estimates

From Lux Research's State of the Market Report, Feb. 17, 2014

Investments in nanotechnology in 2012: $ 18.5 B

US contribution to global nanotechnology investment: 36%

US (Federal + State) funding for nanotech in 2012: $ 2.1 B

US private sector investment for nanotech in 2012: $ 4 B

Growth in revenue from nano-enabled products: $339B (2010) to $ $731B (2012)

Estimated global value of nanotech value chain: $ 4.4 T by 2018!

SOURCE: https://portal.luxresearchinc.com/research/report_excerpt/16215

The promise of nanotechnology

Cross cutting technologies with broad impact

Some illustrative examples:

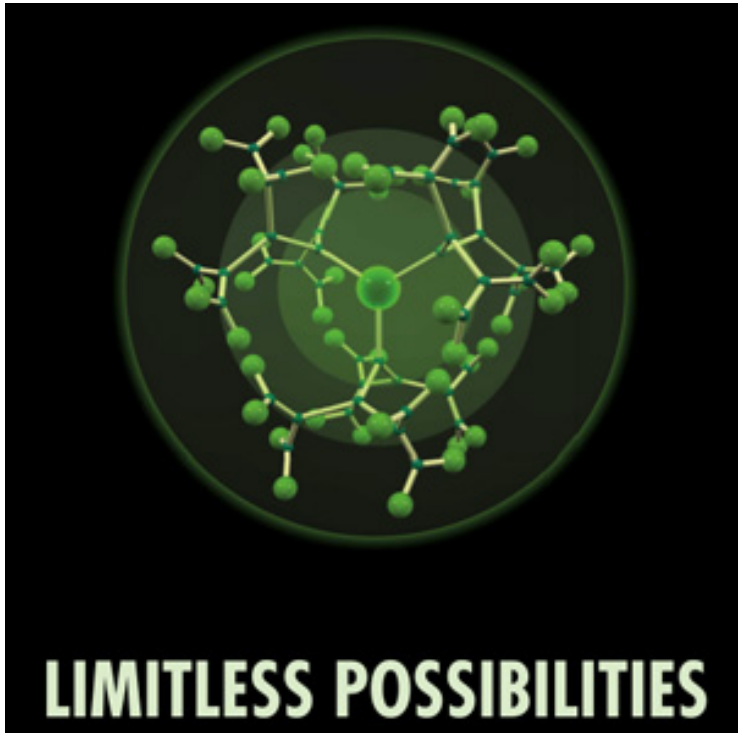
Societal: water purification, waste remediation

Energy: lighter batteries, more efficient solar pantls

Structural materials: stronger and lighter, greater impact resistance

Medical: advanced therapeutics, targeted drug delivery

Consumer: improved food packing materials, faster electronics



Credit: http://www.cosmosmagazine.com/files/imagecache/news/files/20071126_nano.jpg

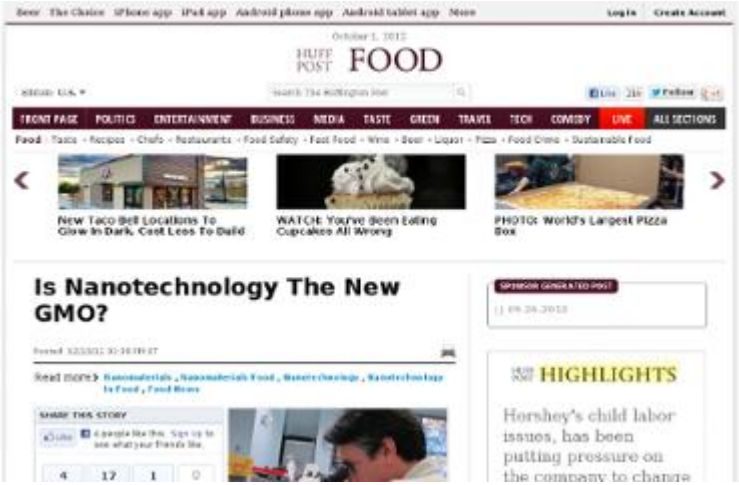
The unanswered question

Great promise, but important questions remain:

Are there risks associated with nanotechnology ?

What are the potential risks related to nanomaterials?

Credit: www.safenano.org



Credit:Huffington Post, Food Section, December 13, 2011

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ON THE FASTRACK BILL HOLBROOK
RUSTY AND COOKIE SURE ARE ENJOYING THAT SANDBOX.
FUNNY... THEY WERE NEVER INTERESTED IN IT BEFORE.
YOU JUST GOTTA KNOW HOW TO MARKET IT!
PATINA SAID THESE TINY PARTICLES ARE WHAT?
NANOTECHNOLOGY!
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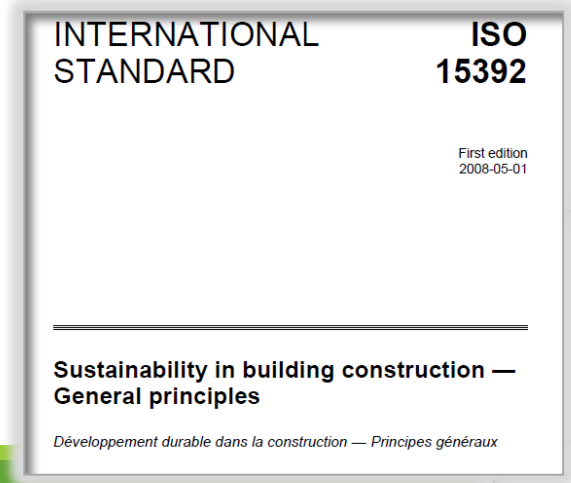
So, what about standards

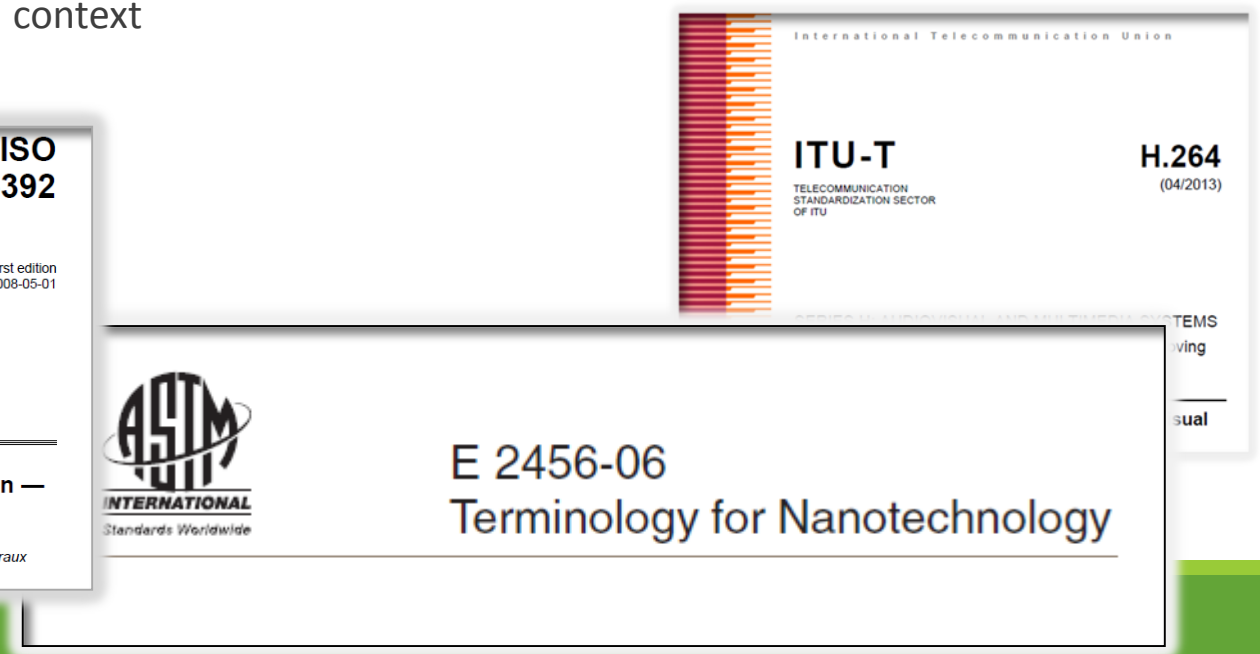
Standards – multiple meanings (physical standards, documentary standards, measurement protocols, specifications, guidelines, best practices, etc.)

Focus on documentary standards for this discussion

ISO/IEC definition *(emphasis added)*: document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context

[Ref: ISO/IEC Guide 2:2004, definition 3.2]





Yes, standards do matter

Courtesy: www.treehugger.com

Why standards matter

Common language for communication

Enable protection of health, safety and environment

Reflect state of technology

Foundation for technological innovation

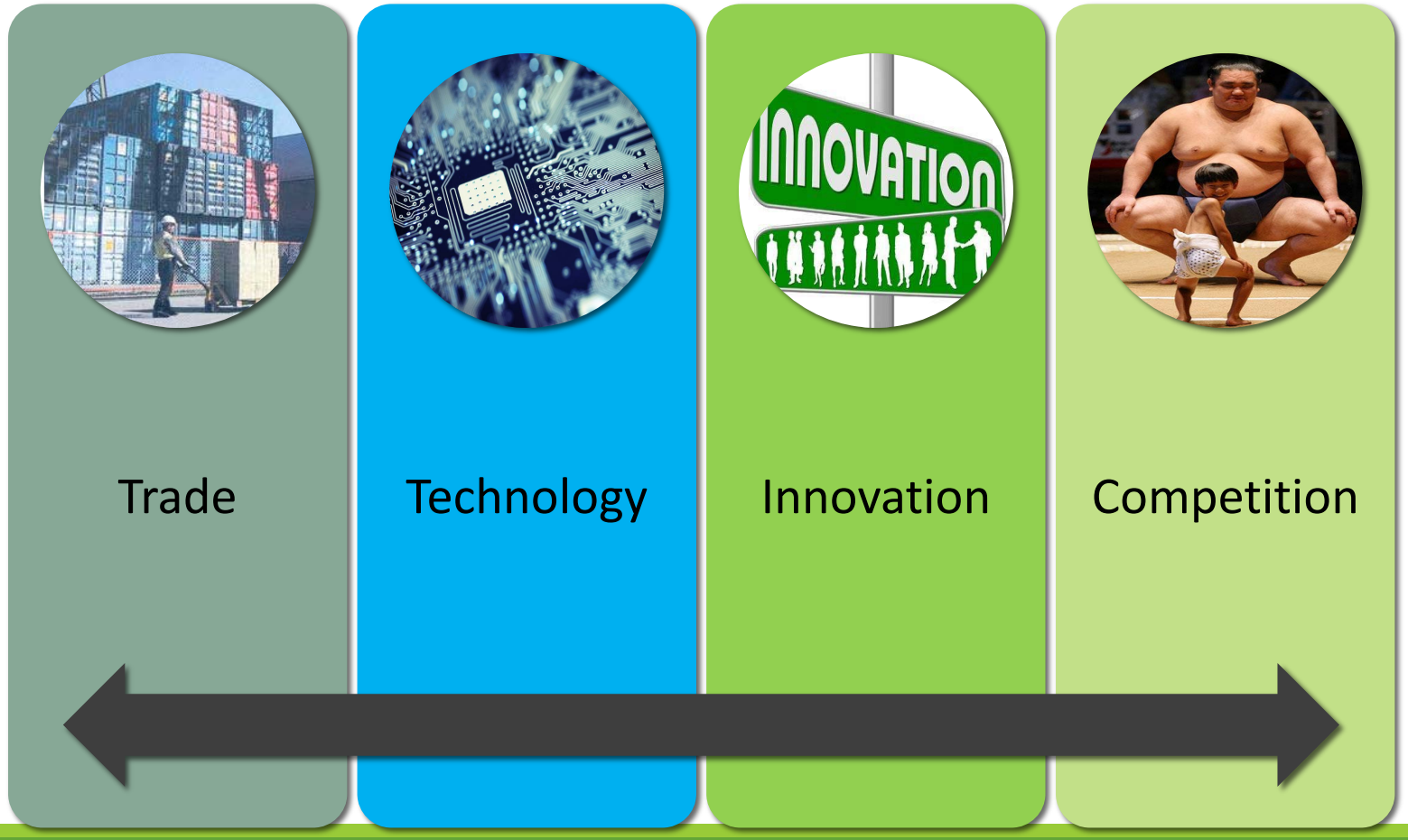
Enable economies of scale

© Geoffrey Wheeler

Courtesy: www.axeleration.com

Courtesy: www.boeingcapital.com

Impact of standardization



http://www.technologyed.com/courses/c160/index.ph
http://econintersect.com/wordpress/?p=17696
http://www.guzer.com/pictures/sumo_mismatch.php

Standardization in emerging tech

Standards play a key role in emerging technologies:

- Tools for data that enables technology development
- Create foundational platforms for product and technology innovation
- Define key points for interoperability, safety and/or functionality

Nanotechnology standardization

Development of international standards started around 2004-2005

Activities underway in a range of bodies – developers of international standards, regional standards organizations and national standards bodies

Different trajectories for standardization in different bodies

International standards efforts have some common features:

- Strong industry participation
- Standards to enable trade and growth of nanotechnology
- Development of tools and techniques to address many fundamental questions
- Extensive international participation

Drivers for nanotech standardization

Ubiquity of nanotechnology and nanotechnology enabled products

- Are they safe
- Consumer confidence
- Regulations – use of standards can ease implementation and compliance

Trade

- Business to business communication
- Global supply chains and global markets

Innovation

- Measurements for new processes and techniques or new applications of existing processes and techniques
- New product and process development

Areas of interest in nanotech standardization

Terminology

- “What is it called”

Measurement

- “How is it measured”

EHS

- “What effect it may have on health, safety and environment”

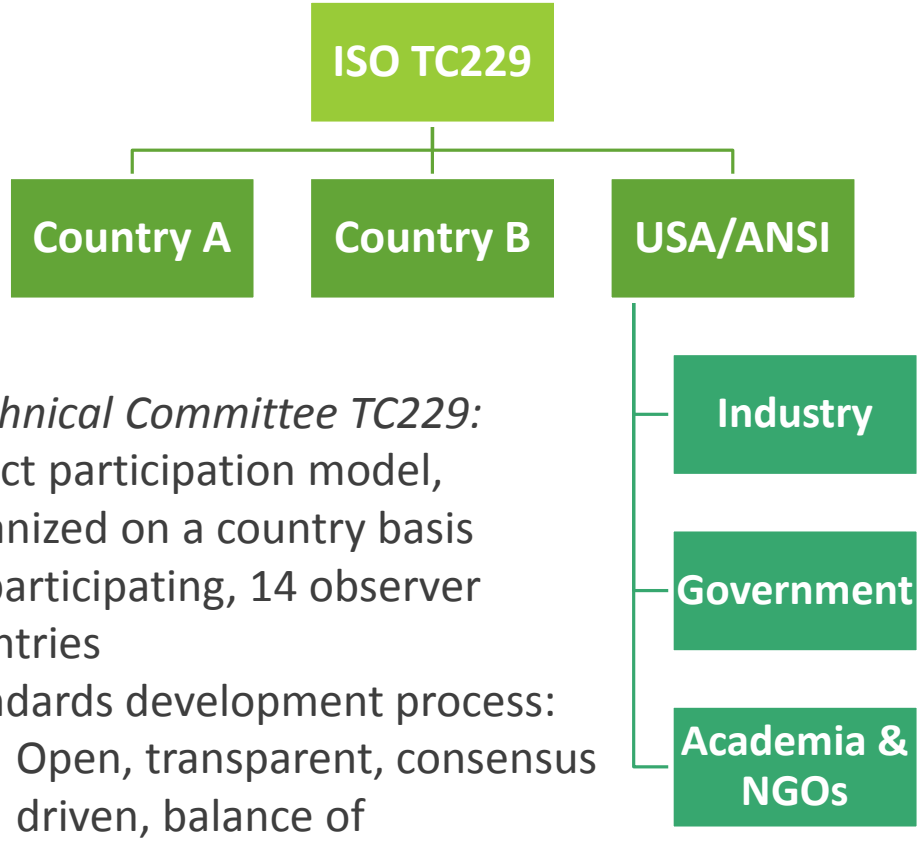
Specifications

- “What needs to measured ”

Illustrative standards development structures

ASTM Intl. Committee E 56 –

- Direct participation model
- 170 participants from 20 countries
- Standards development process:
  - Open, transparent, consensus driven, balance of participation, due processes



ISO Technical Committee TC229:

- Direct participation model, organized on a country basis
- 34 participating, 14 observer countries
- Standards development process:
  - Open, transparent, consensus driven, balance of participation, due processes

Examples of nanotech standards

ISO/TS 80004-1:2010 Nanotechnologies -- Vocabulary -- Part 1: Core terms

ASTM 2578-07 (2012) Standard Practice for Calculation of Mean Diameters and Standard Deviations of Particle Size Distributions

ISO/TS 12901-1:2012 Occupational risk management applied to engineered nanomaterials – Part 1. Principles and approaches

IEC/TS 62565-4-2 Ed. 1.0 Nanomanufacturing - Material specifications - Part 4-2: Luminescent nanomaterials - Detail specification for general lighting and display applications

ASTM WK46489 New Practice for Standard Practice for Workforce Education in Nanotechnology Characterization

ISO/TS 13830:2013 Nanotechnologies -- Guidance on voluntary labelling for consumer products containing manufactured nano-objects

Trends in nanotech standardization

Continued focus on addressing technical issues

Increasing interest in related issues that have non-technical impacts:

- Consumer and societal considerations
- Policy implications
- Range of issues many of which standards organizations are not equipped to address

Increased participation of non-technical experts

- Common understanding of standards development process
- Shared end goal
- Alignment of priorities

Drivers for these trends

Convergence of technologies

Immediate impact of many emerging technologies on the average citizen

Perceptions or fear about technology misuse

Greater awareness about the role of standards and how standards can be a powerful tool

Standards as proxy for regulations

Greater ease of access to standardization and standards

Intersection of tech and societal issues

ISO/TS 13830:2013 Nanotechnologies -- Guidance on voluntary labelling for consumer products containing manufactured nano-objects

CEN Proposal: “Guidance for responsible development of nanotechnologies”

Taking into account:

- Board Accountability
- Stakeholder Involvement
- Worker Health and Safety
- Benefits to and Risks for Public Health, Safety and the Environment
- Wider Social and Ethical Implications and Impacts
- Engagement with Business Partners
- Transparency and Disclosure

CEN discussion about possible future work on B2B labelling– to complement B2C labeling above.

CEN discussion about possible future work on labelling of nanoparticles with stable isotopes to ensure traceability of nanoparticles.

Information presented by Patrice Conner, Secretary of CEN/TC352 at European Conference on Standardization for Nanotechnologies and Nanomaterials: Opportunities and Challenges, Dec. 2014, Brussels

Considerations and implications

Technical standards activities will have to consider or address non-technical aspects

Availability of expertise

Merging both aspects while delivering standards in a timely manner

Increased possibility of friction or conflict

Impact on quality of standards

Alternative paths or venues for standardization

Effectiveness when US industry or USG is unable to participate

Maintaining leadership roles

Consideration as DOC employees

Or “Why should we care”:

Nanotechnology and emerging technologies touch every bureau

Cross-bureau collaborations and information sharing

- Assisting US industry
- Engaging foreign counterparts
- Early identification of issues
- Coordinating responses

Increased participation – internationally, domestically or inter-agency

Developing DOC and USG positions

2nd order implications

Conclusions

Nanotechnology offers many promises but some significant questions need to be addresses

Standardization provides a very effective forum for developing tools to support technology development and address these questions

Cross-cutting and cross-disciplinary nature of emerging technologies is imposing new demands on traditional standardization processes

Standardization processes will have to figure out a way to balance technical work with associated non-technical issues that impact the technical work

Awareness of these developments and their global impact

Thanks!

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H. Benko, ANSI