Lowell Center for Sustainable Production
UNIVERSITY OF MASSACHUSETTS LOWELL

Alternatives Assessment Webinar:

Lessons and Insights on the role of alternatives assessment in addressing emerging technologies

JANUARY 25, 2018

FACILITATED BY: JOEL TICKNER, SCD

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LOWELL CENTER FOR SUSTAINABLE PRODUCTION, UMASS LOWELL

** If you would like to ask a question or comment during this webinar please type your question in the Q&A box located in the control panel.*

Goals

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- Continuing education and dialog

- To advance the practice of alternatives assessment for informed substitution across federal, state, and local agencies through networking, sharing of experiences, development of common approaches, tools, datasets and frameworks, and creation of a community of practice.

Purpose of this call

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- This is the second webinar in our series focusing on the role of alternatives assessment in minimizing the impacts of chemicals and materials in the context of emerging technologies.

- Today we're considering emerging technologies broadly and examining common core needs, challenges and opportunities associated with integrating the use alternatives assessment while driving safer chemicals and materials at the design-stage of new technology development.

Webinar questions and questions for discussion:

- How to identify and evaluate potential hazards at the design phase to minimize impacts for human and environmental health?
- What are the data/information needs and challenges?
- How to better connect innovation investment in emerging technologies with the development of safer chemicals and materials?
- What is needed for the broader use of alternatives assessment to inform safer chemical and material choices?

Today's Speakers

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Dr. Treye Thomas, Program Manager Program Manager for Chemicals, Nanotechnology and Emerging Materials, Office of Hazard Identification and Reduction, Consumer Product Safety Commission

Dr. Chuck Geraci, Associate Director for Nanotechnology and Advanced Materials, National Institute for Occupational Safety and Health

Dr. Dave Rejeski, Director of the Technology, Innovation and the Environment Project, Environmental Law Institute

Webinar Discussion Instructions

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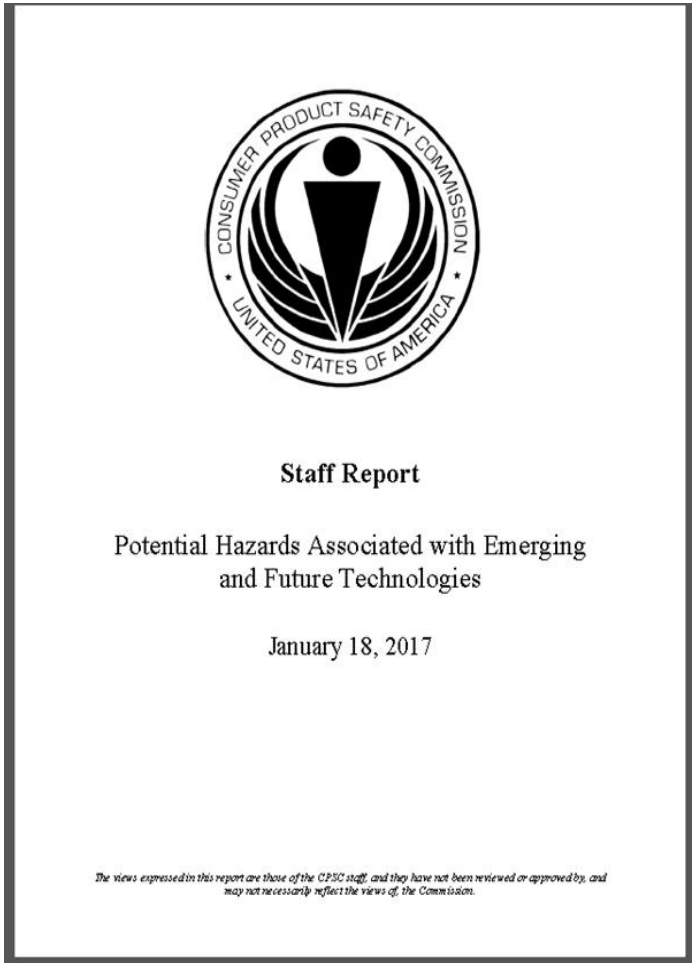
- Due to the number of participants on the Webinar, all lines will be muted
- If you wish to ask a question, please type your question in the Q&A box located in the drop down control panel at the top of the screen
- All questions will be answered at the end of the presentations
- Call is being recorded

Alternatives Assessment and Emerging Products

Treye A. Thomas, Ph.D.
Program Manager
Chemicals, Nanotechnology and Emerging Materials
Office of Hazard Identification and Reduction

CPSC Report on Emerging Consumer Products

- Released January 2017
- Brief overview of potential emerging consumer products and technologies
- Technological and societal trends likely to influence marketplace for consumers
- Potential consumer safety issues
  - Opportunities for enhancing product safety



Staff Report

Potential Hazards Associated with Emerging and Future Technologies

January 18, 2017

The views expressed in this report are those of the CPSC staff, and they have not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

Emerging and Future Products

Emerging and future consumer products and technologies identified in this report include:

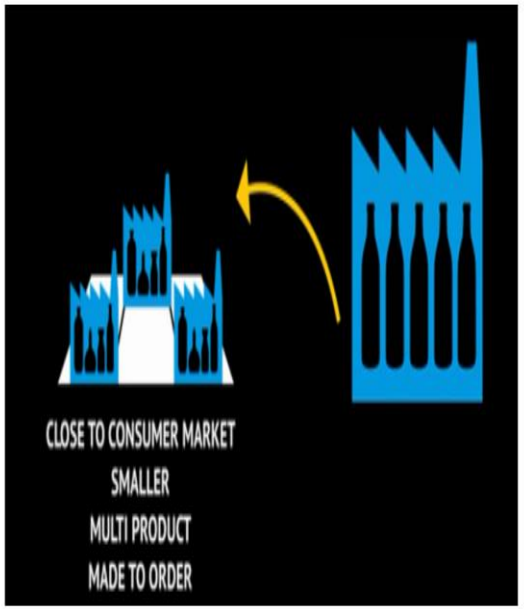
- **3D Printers and the printed products**;
- Internet-home based smart technologies;
- Software as a component part;
- **Wearable products and technologies**;
- **New materials, including nanomaterials**;
- Virtual reality (VR) and augmented reality (AR) games;
- Personal transportation products;
- High capacity energy storage and energy generation;
- Robotics, including robotic products to assist older adults; and
- Brain-machine interface/implantable technologies.

Estimating Exposure and Health Risks From 3D Printing

- Consumer at-home use of 3D printing is increasing rapidly and is expected to reach USD 30 billion by 2022.
  - Adult hobbyists and home-based manufacturers account for most home use
    - Some 3D printers are being marketed for use by children.
- Broad range of filaments available such as:
  - acrylonitrile butadiene styrene (ABS), high impact polystyrene (HIPS), polylactic acid (PLA), thermoplastic elastomer (PCTPE), transparent polycarbonate, nylon
- Consumers can also make their own filaments using blended materials and home filament extruders.
- Nanomaterials may be used in these filaments
  - CNTs

3D Printing of Products

- Distributed manufacturing
  - Business developed in the home environment to “manufacture” products
  - Larger and more advanced devices
  - Multiple printers and products
- Safety
  - Engineering controls
  - Personal protective equipment (PPE)
  - Storage of materials
    - Accessibility to children and pets



Distributed Manufacturing
Micro Factories, Home Factories
Made to Order: Just in time, Just to order, Just next door

Source: C. Geraci, NIOSH

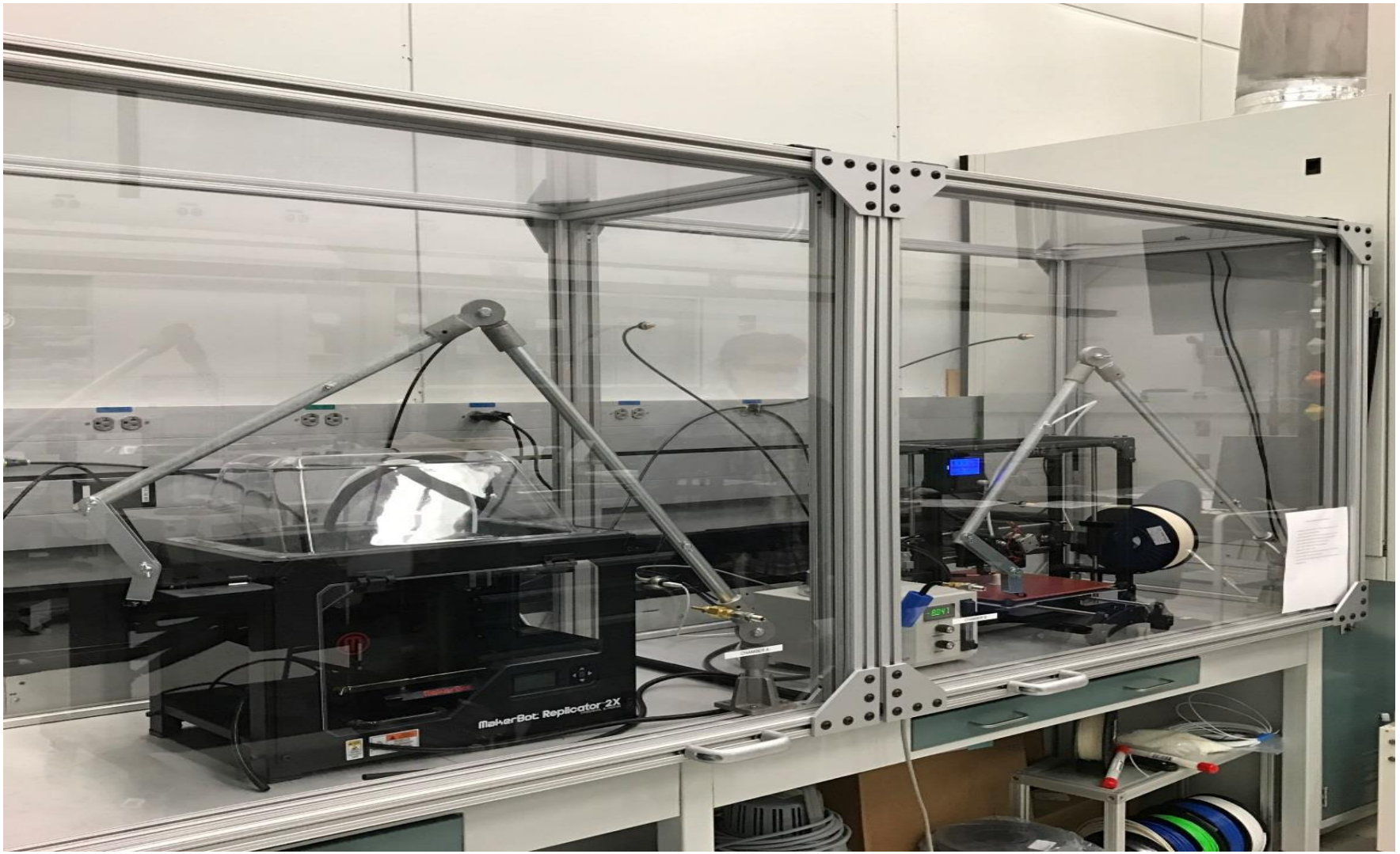
Health Implications 3D Printing

- What is released during 3D printing?
  - Printing may take several hours
  - High heat ~200 – 250 C filament extrusion
  - Minimal to no engineering controls
  - Accumulation in the indoor environment
- Advanced versions of 3D printers involve powders
- Exposures across the lifecycle
  - Durability of 3D printed versus traditionally manufactured products

Assessment of Emerging Materials

- Traditional risk based approaches
  - Availability of toxicity and exposure data?
- Alternative methods
  - Are methods suitable for emerging materials?
  - Can they be used by home manufacturers?
  - Are these methods validated?

CPSC-NIST Chamber Testing - Nanomaterials Releases During 3D Printing



2 separate sampling chambers for 2 different printers

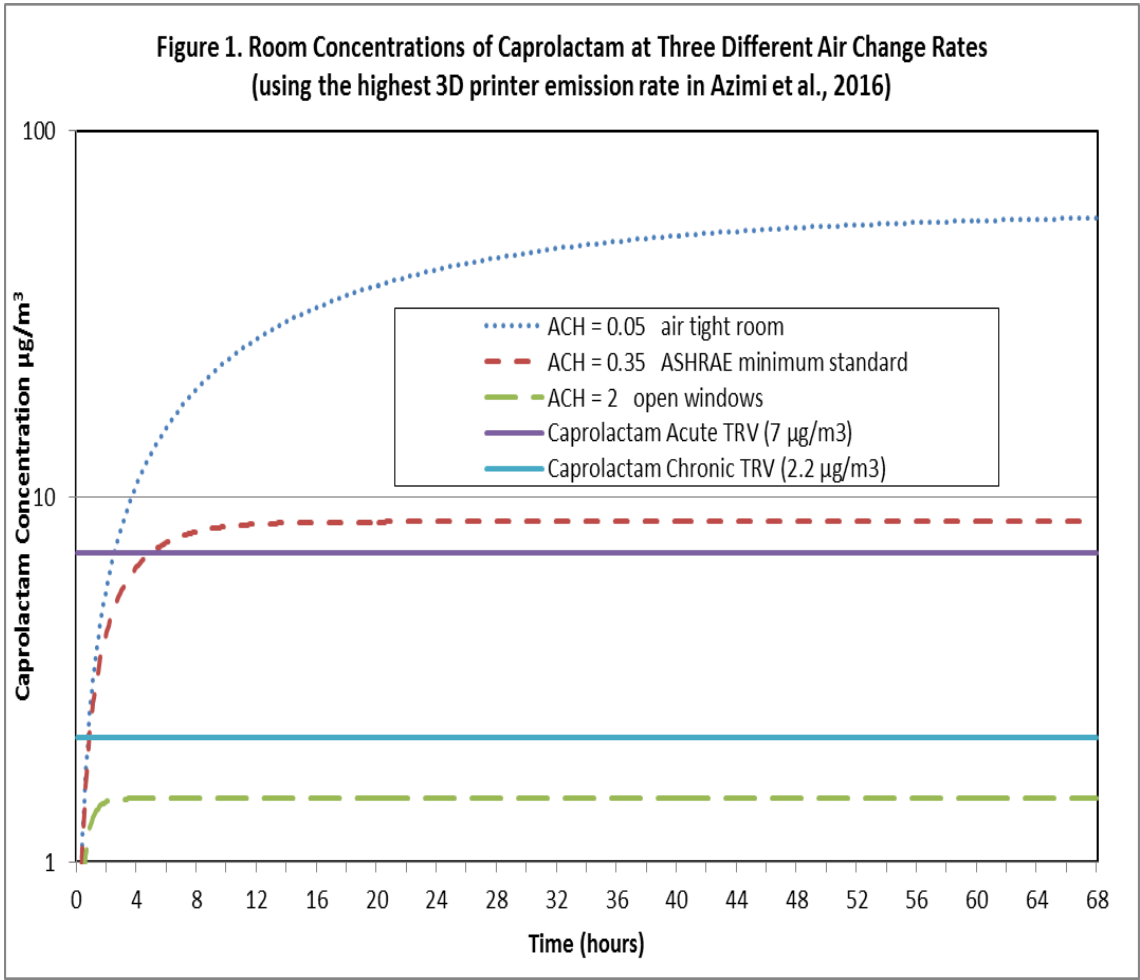
PRELIMINARY HUMAN HEALTH RISK ESTIMATES FROM 3D PRINTER EMISSIONS
CPSC staff SOT Poster #2433

Volume = 18.1 m^3) with variable air change rates (ACH, 0.05, 0.35, and 2 h^{-1}).

Continuous printing for 68H

- Instantaneously mixed air
- No VOCs entering the room with dilution air
- No reactive decay of VOCs, and no VOC sinks.
- VOC room concentrations compared to acute and chronic TRVs

One-Zone Model. VOC emission rates were used to estimate room VOC concentrations in a one-zone model evaluated at time intervals from 0.1 to 68 hours.



Thank You

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CPSC website:
www.cpsc.gov
CPSC New Product Database:
www.saferproducts.gov

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NTRC | NANOTECHNOLOGY RESEARCH CENTER

Moving from Nanotechnology to Advanced Manufacturing

Did We Learn Anything?

Alternatives Assessment Webinar
January 25, 2018

Charles L. Geraci, Jr. PhD, CIH, FAIHA

Associate Director, Nanotechnology and Advanced Materials
National Institute for Occupational Safety and Health

CDC Workplace Safety and Health | NIOSH

Today's Journey

Emerging Technologies

Focus on Manufacturing

Nanotechnology's role

Lessons from the Workplace

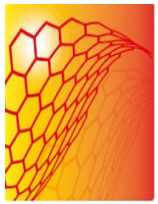
Where does Alternatives Assessment start?

The World Economic Forum 'Top 10" Emerging Technologies

1. Nanosensors and the Internet of Nanothings

2. Next Generation Batteries

3. The Blockchain

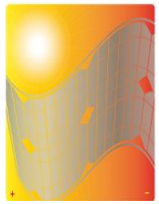


4. 2D Materials

5. Autonomous Vehicles

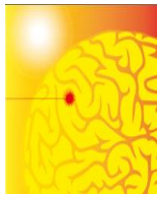
6. Organs-on-chips

7. Perovskite Solar Cells



8. Open AI Ecosystem

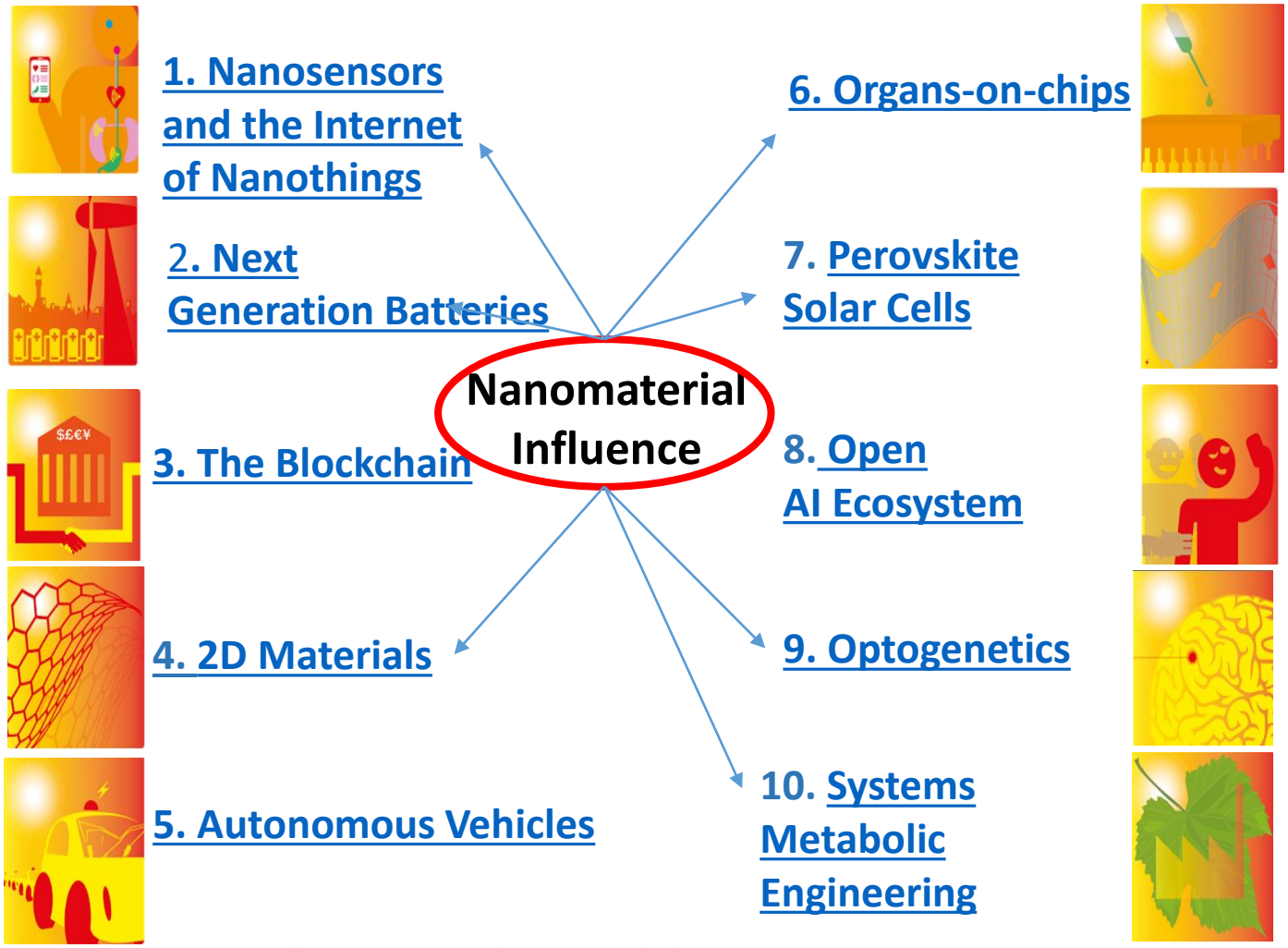
9. Optogenetics



10. Systems Metabolic Engineering

https://www.weforum.org/agenda/2016/06/top-10-emerging-technologies-2016/

The World Economic Forum 'Top 10" Emerging Technologies



https://www.weforum.org/agenda/2016/06/top-10-emerging-technologies-2016/

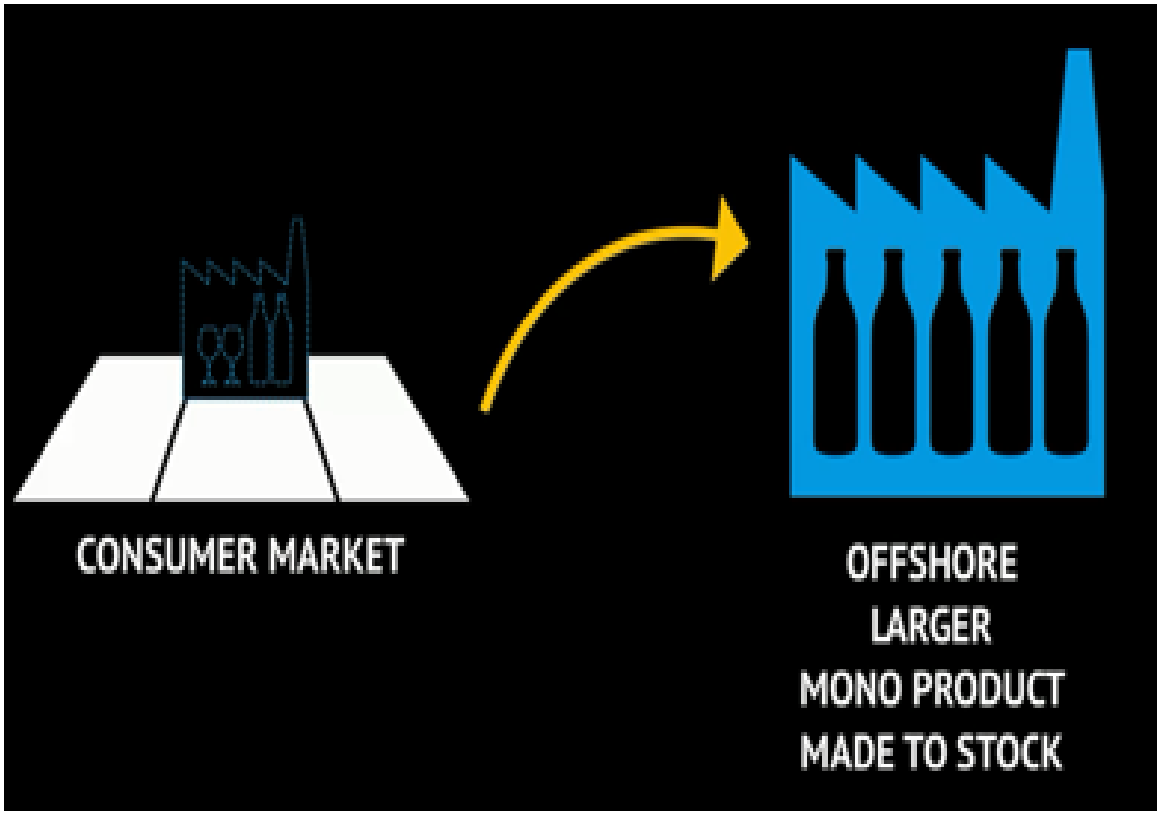
The Manufacturing Model is Changing

How we make things is evolving from mechanical processes to information and technology based processes.

The Drivers are Changing

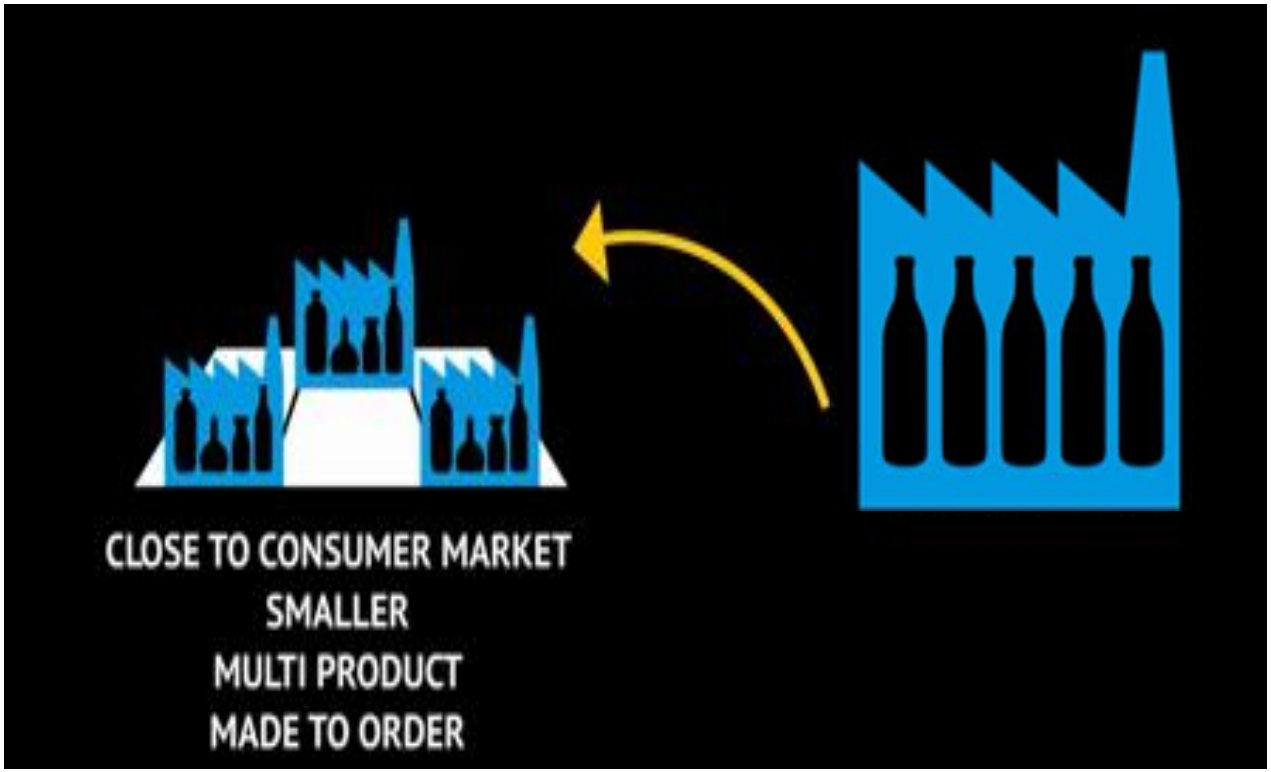
Speed to market, complex designs, mass customization, sustainable processes.

Changing State of Manufacturing
- Current Model, but Fading -



"By 2020 changes in labor, energy, and material costs will cause a rethinking"

- Emerging Manufacturing Model -



Distributed Manufacturing

Micro Factories, Home Factories

Made to Order:

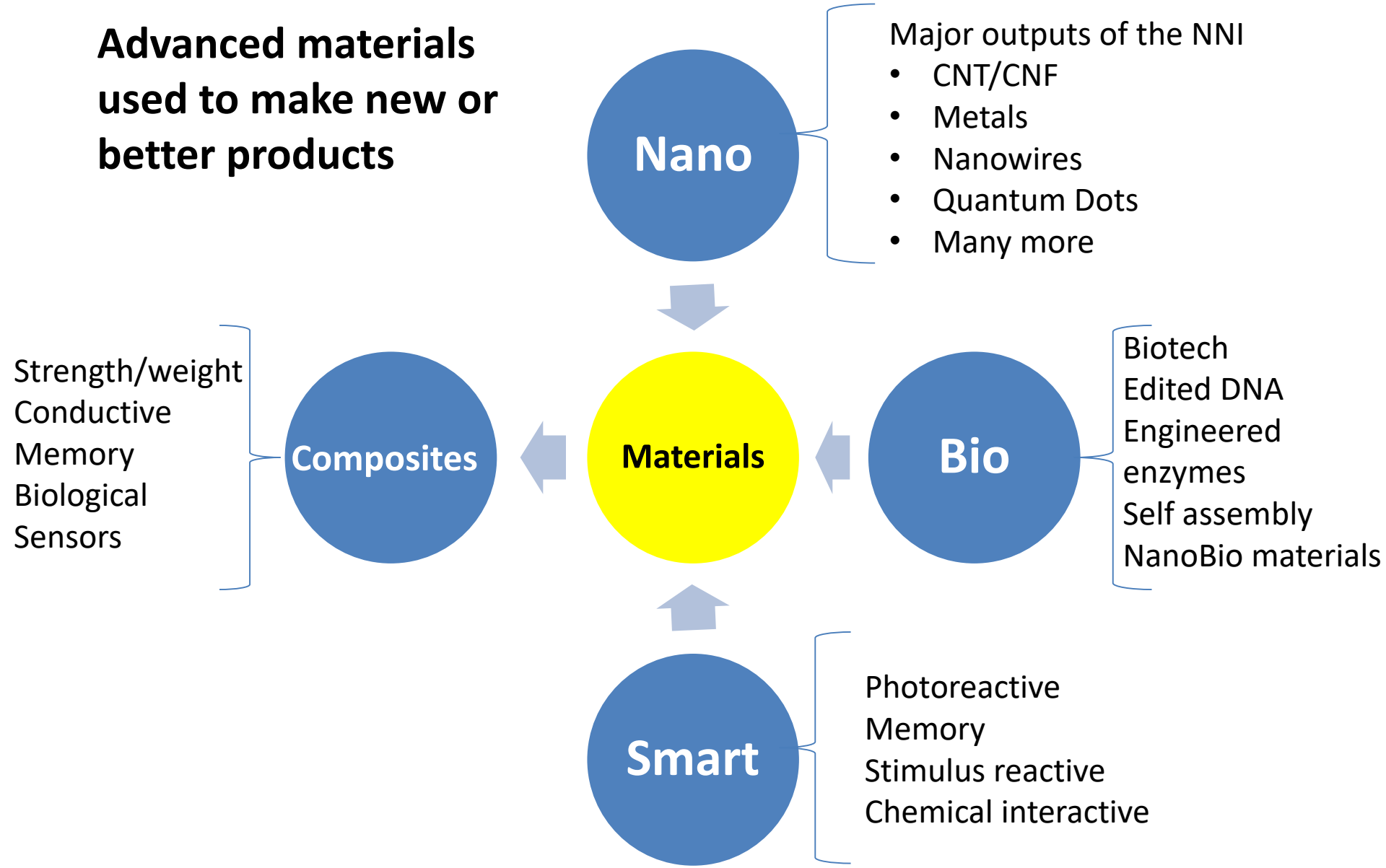
- Just in time, Just for you, Just next door

The Big Shift: ‘Nano to Advanced”

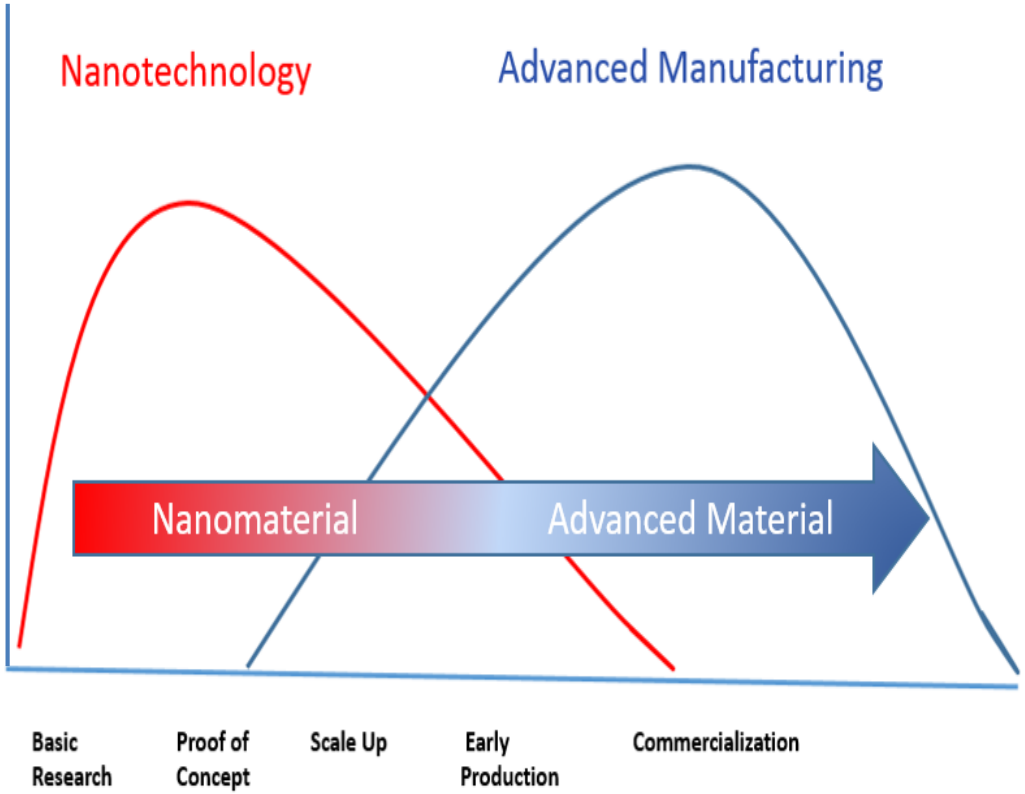
Convergence, convergence, convergence

- Nano manufacturing: focus on commercialization (not new)
- Nano is mainstream and not always a separate theme
- Advanced Materials quickly displacing “Nanomaterial”
- Advanced Manufacturing seen as direct outlet for Nano
- Growth of Advanced Manufacturing
- Nanotech, Biotech, Emerging Tech, Manufacturing Tech

Advanced materials used to make new or better products



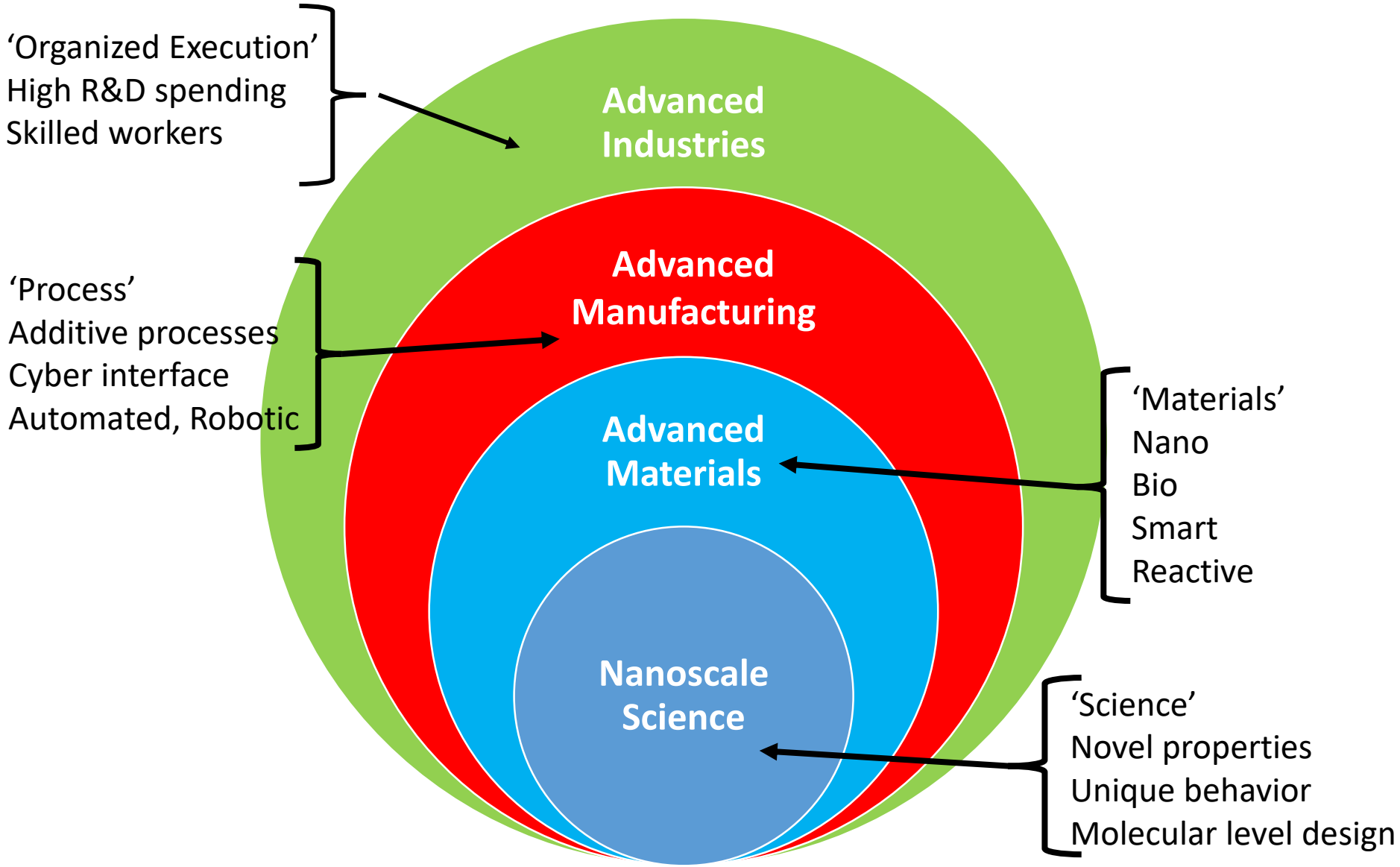
Evolution of Advanced Materials and Manufacturing



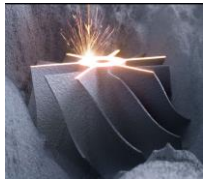
Overall Investment

Material, Process, and Product Life Cycle

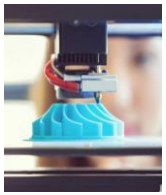
Advanced Industries, Manufacturing, and Materials



Processes & Products

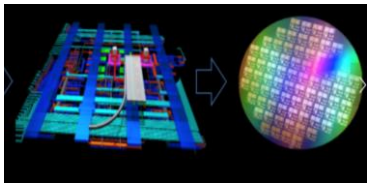


Additive Manufacturing



3D Printing

Functional Fabrics



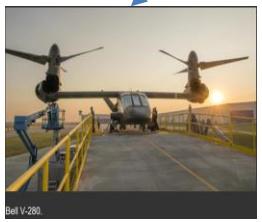
Photonics

"Advanced Manufacturing"

Flexible Sensors

Robotics

Light Weighting



Advanced Composites

Clean Energy

Engineered Biology

CDC Workplace Safety and Health NIOSH

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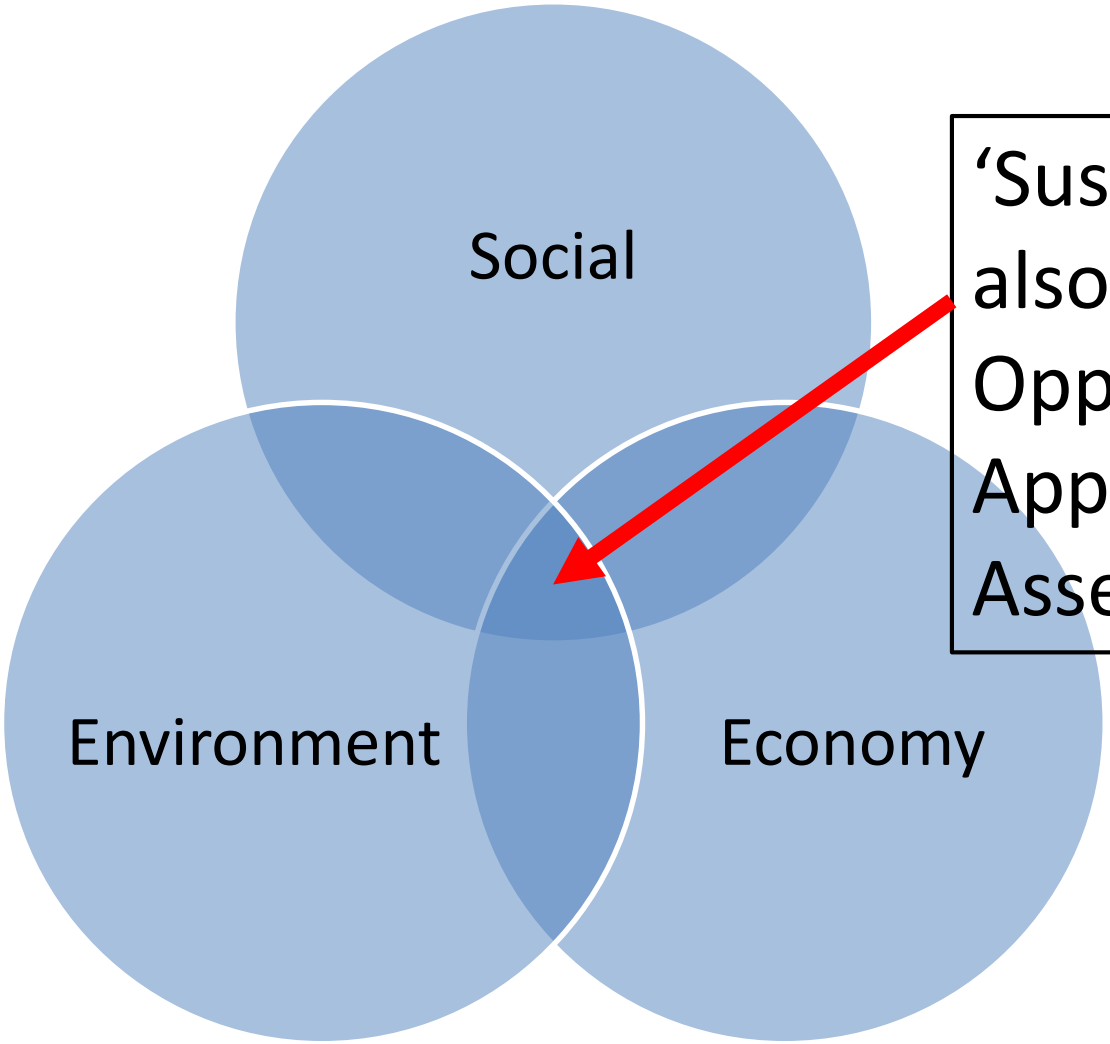
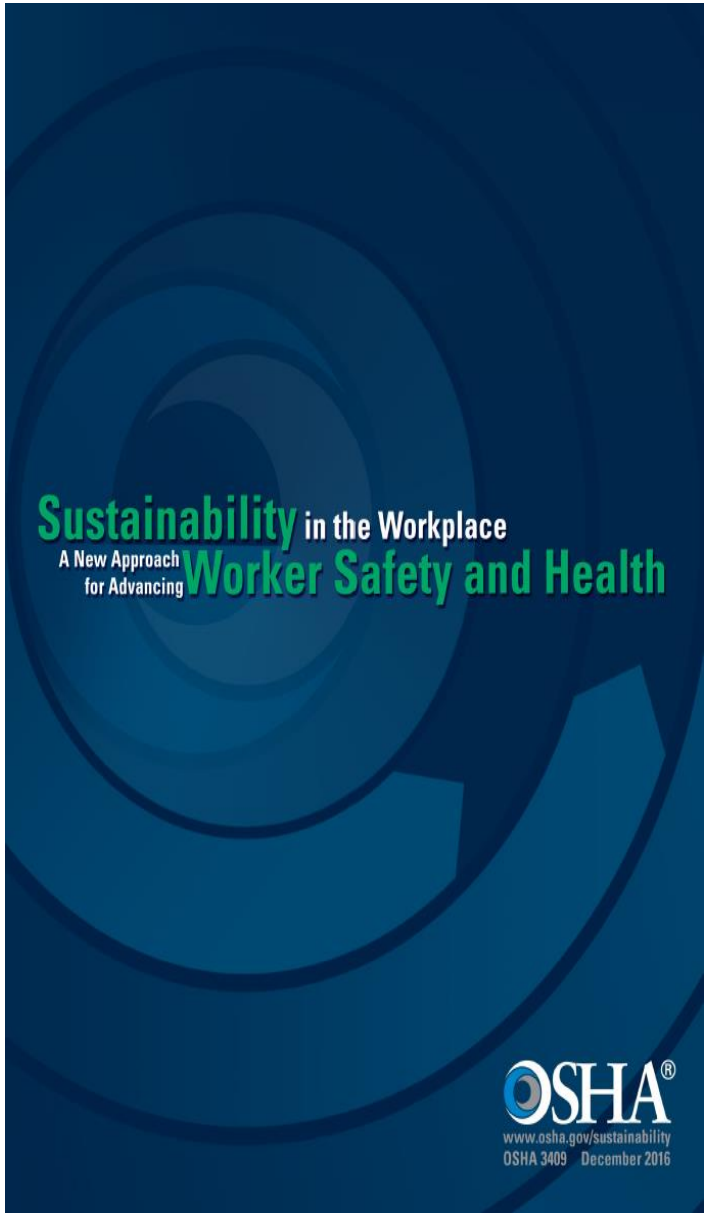


‘Sustainability’ but also an Opportunity to Apply Alternatives Assessment

The Workplace is an important element the Social component



"Sustainability Starts in the Workplace"

- New Technologies are developed in the R&D Workplace
- First human interface
- First opportunity for safer design
- Human health hazard evaluated
- Control of emissions
- Design of safer processes and products

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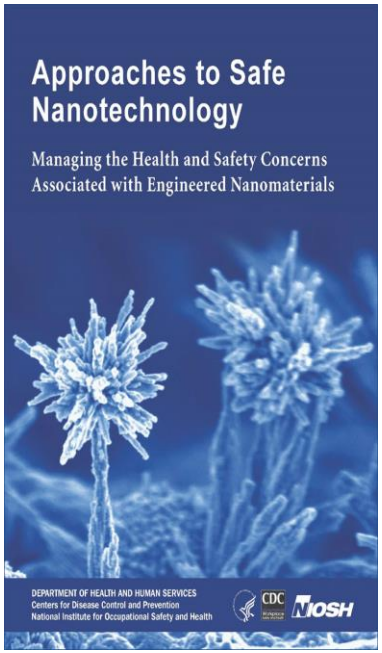
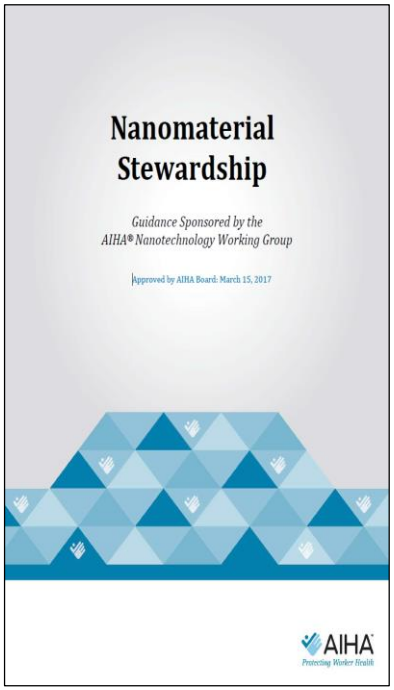
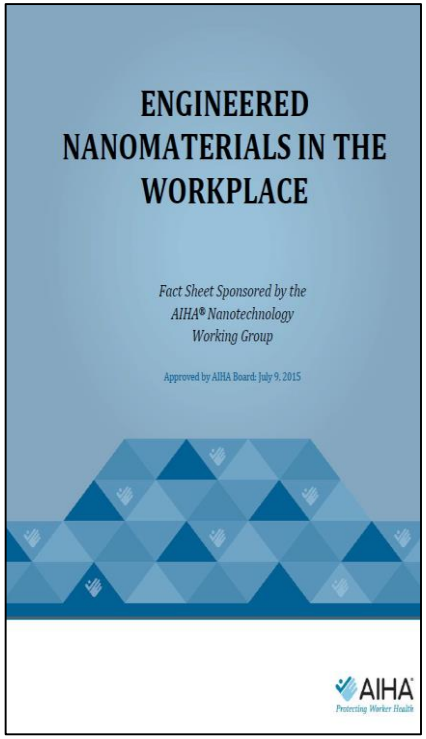
Recognition of the need for good OS&H practices, which support Alternatives Assessment







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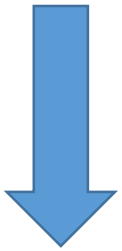
OS&H as a 'Sustainability Translator'

Nanotechnology

Research and guidance that supports responsible development



Translation &
Reapplication

Advanced Materials and Manufacturing

Explore potential implications on worker health

Guidance that supports rapid and responsible development.

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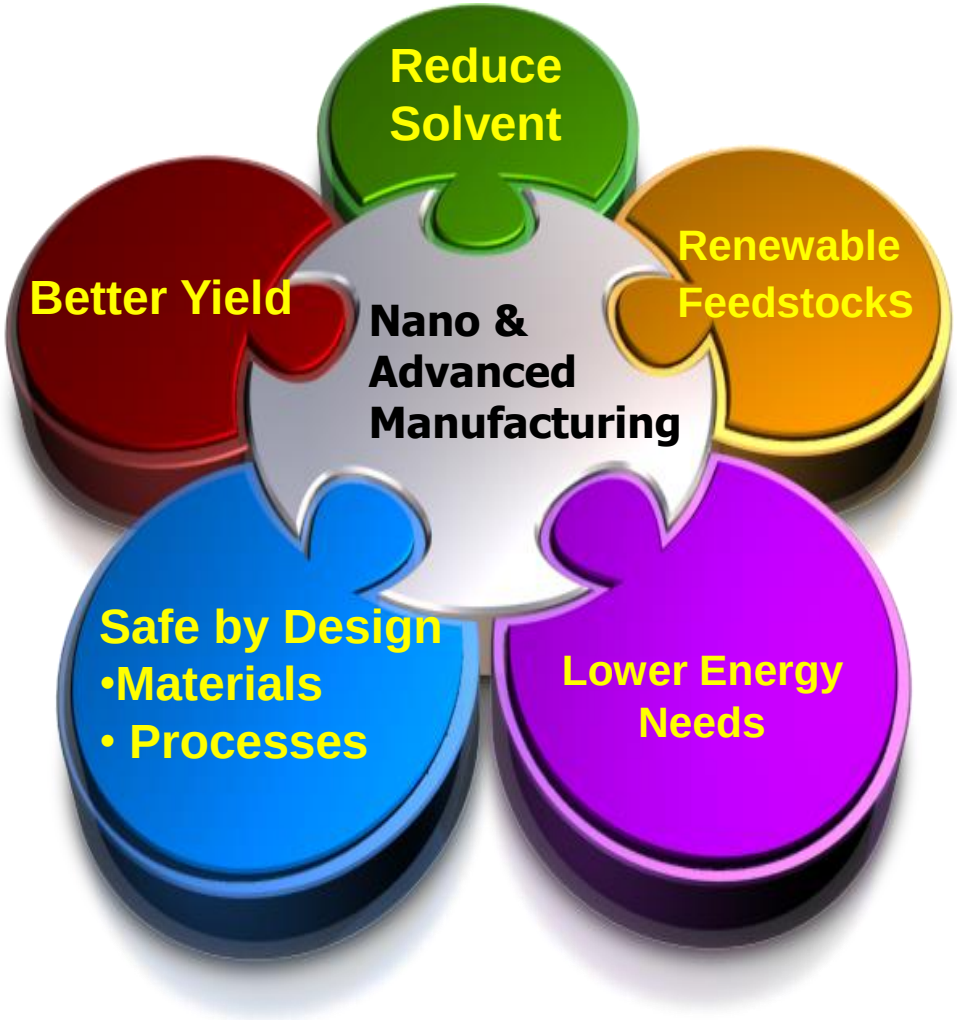
Green Chemistry (AA) Opportunities for Nanotechnology



Nanotechnology: 'Green Impact' on Industry

Agriculture	More efficient, targeted delivery of plant nutrients, pesticides. Newer application techniques and tools
Automotive	Lighter, stronger, self-healing materials: Manufacture and assembly of nano-enabled components
Biomedical	Targeted therapeutics, enhanced detection, new structural materials. Accelerated growth in biologicals and SynBio
Energy	More efficient fuel cells, solar collectors, generation, transmission and storage. Insulation
Environmental	New pollution control and remediation tools, sensors
Food	New safety sensors, food preservatives, nutrient additives
Materials	Self-cleaning glass, stain resistant, stronger materials, body armor, construction
Water	New purification approaches: filtration, treatment

Organized approach in the US

Manufacturing USA℠

Quick case study

Tissue Fabrication

Functional Fabrics

Integrated Photonics

Additive Manufacturing

Advanced Robotics

Digital Manufacturing

Advanced Composites

Lightweight Manufacturing

Flexible Hybrid Electronics

Manufacturing Biopharmaceuticals

SiC and GaN Semiconductors

Molecular Level Process Maximization

Sustainable Manufacturing

Smart Sensors Digital Processes

What is additive manufacturing/3D printing?

Joining materials to make objects from 3D model data, usually layer upon layer (ISO/ASTM 52900:2015….Formerly ASTM F2792).

Subtractive

Photo: Fabricatingandmetalworking.com

Additive

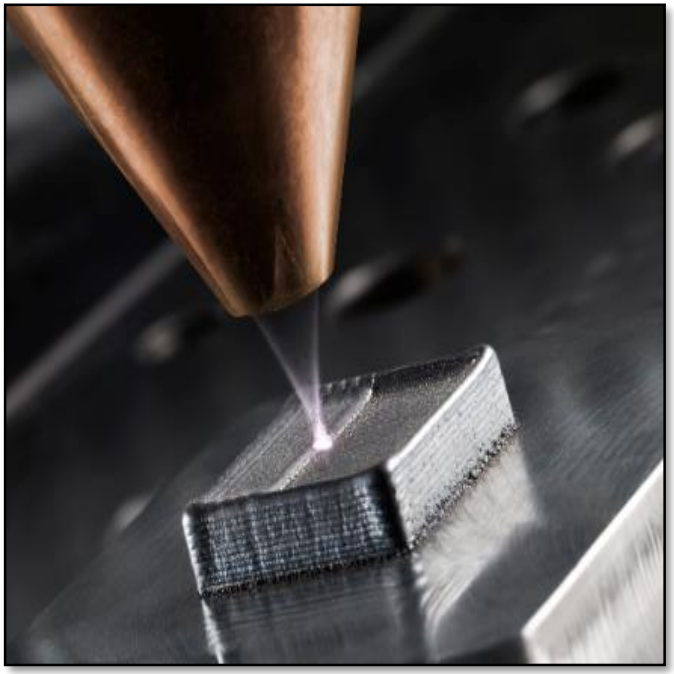
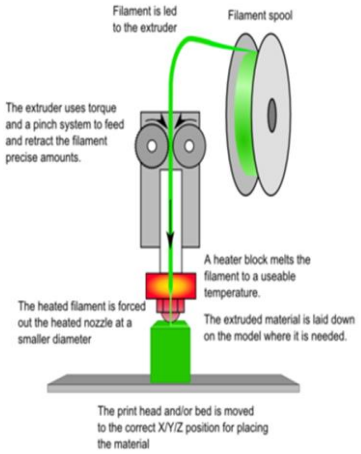


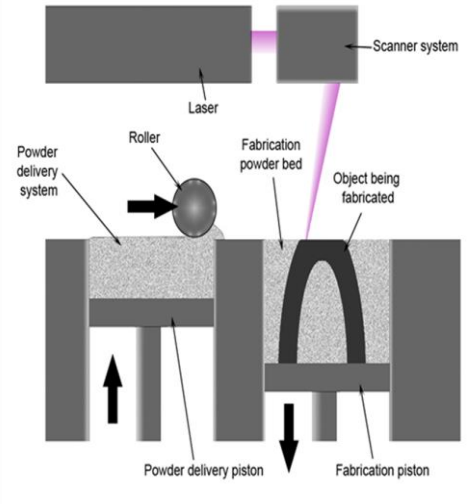
Photo: Canadian metalworking.com

Four Basic Categories of Additive Manufacturing

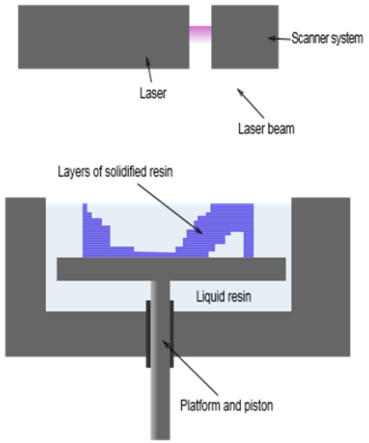
Fused Filament Fabrication (FFF)



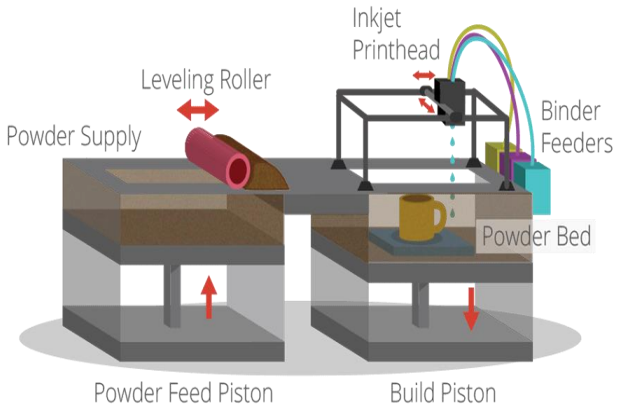
Selective Laser Sintering (SLS)



Stereolithography



Powder Bed Inkjet Binding



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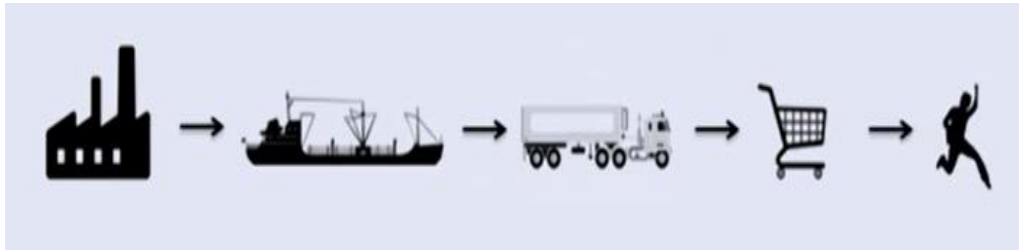
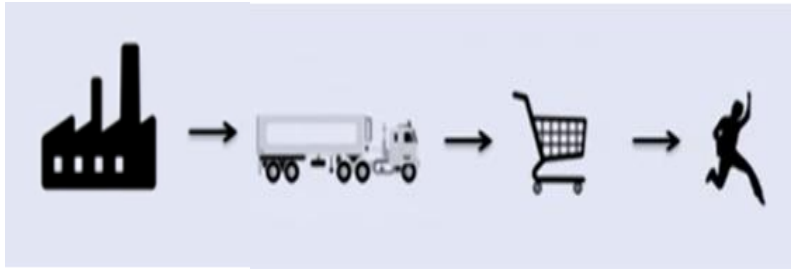
Impact of 3D Printing on the Supply Chain

Production Consumption



Old Model



Evolving Model

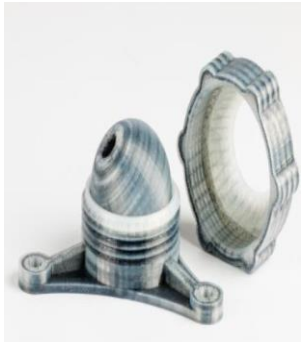
Cottage, Close to Home, Custom Made, Maker Spaces

3D Printing is accelerating this model

Manufacturer as Consumer
Consumer as Manufacturer

More than simple parts or prototypes

Above: The 3D printed nozzle combined all 20 parts into a single unit, but it also weighed 25 percent less. "In the design of jet engines, complexity used to be expensive," Ehteshami says. But additive allows you to get sophisticated and reduces costs at the same time. This is an engineer's dream." Image credit: Adam Senatori for GE Reports



The Blade Supercar

Modern Manufacturing

- Photo credit: 3dprintingindustry.com

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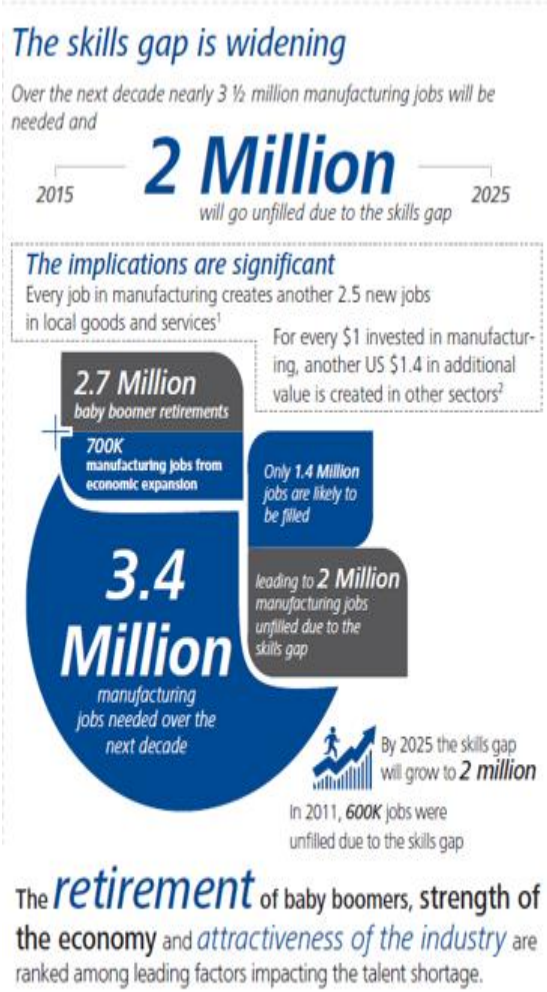
Over the next decade nearly **3 1/2 Million** manufacturing jobs need to be filled
The skills gap will result in **2 Million** of those jobs being unfilled



Deloitte. Institute

Will health, safety, and sustainability be part of workforce development?

CDC Workplace Safety and Health NIOSH

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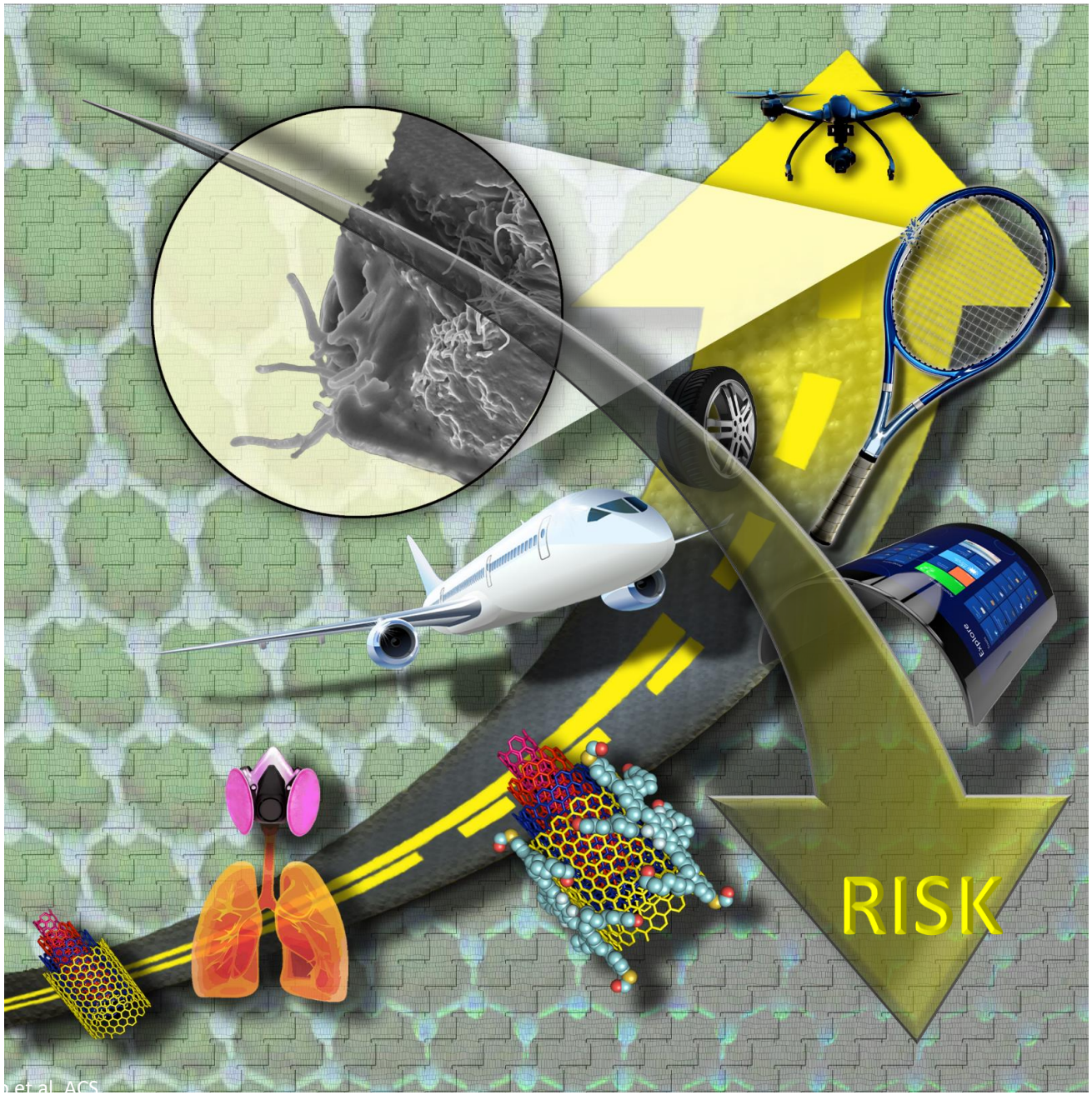


EHS

- Support growth
- Help minimize risk

Thank You!

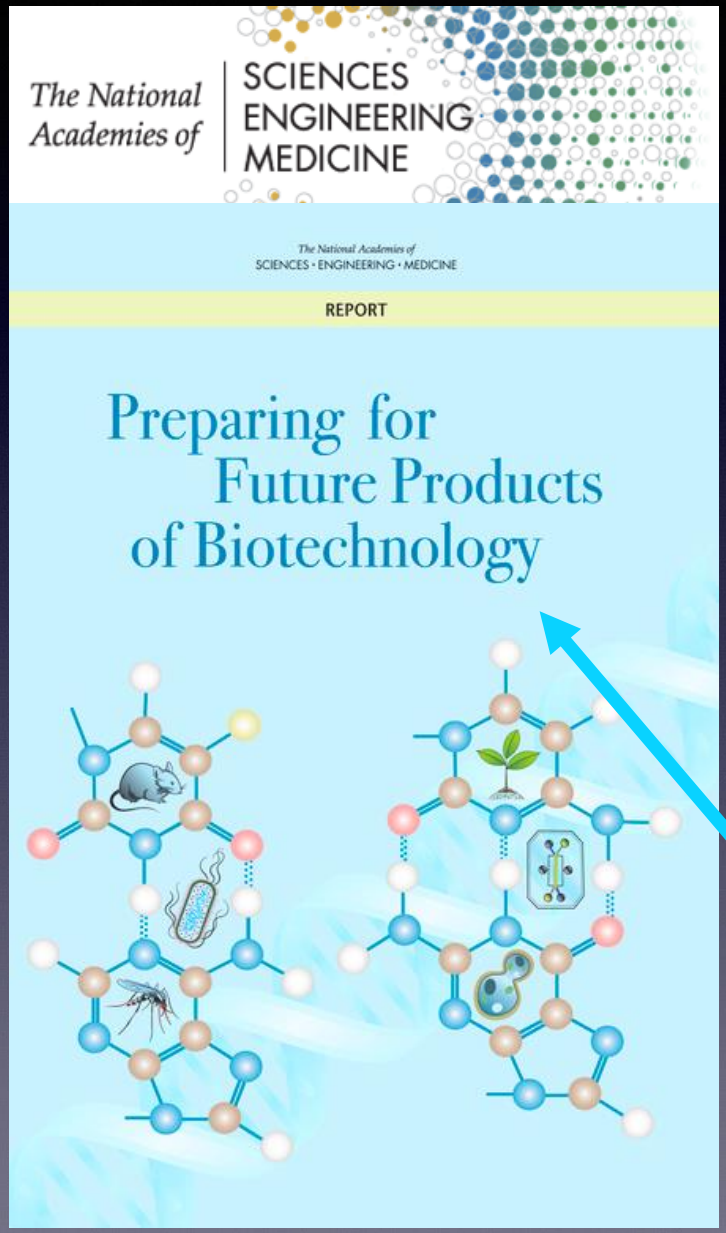
cgeraci@cdc.gov

Emerging Technologies and Anticipatory Governance: Lessons and Insights from Biotechnology

January 25, 2018

David Rejeski
Director, Technology, Innovation & Environment Program
Environmental Law Institute
Washington, DC

July 2015 White House Memo



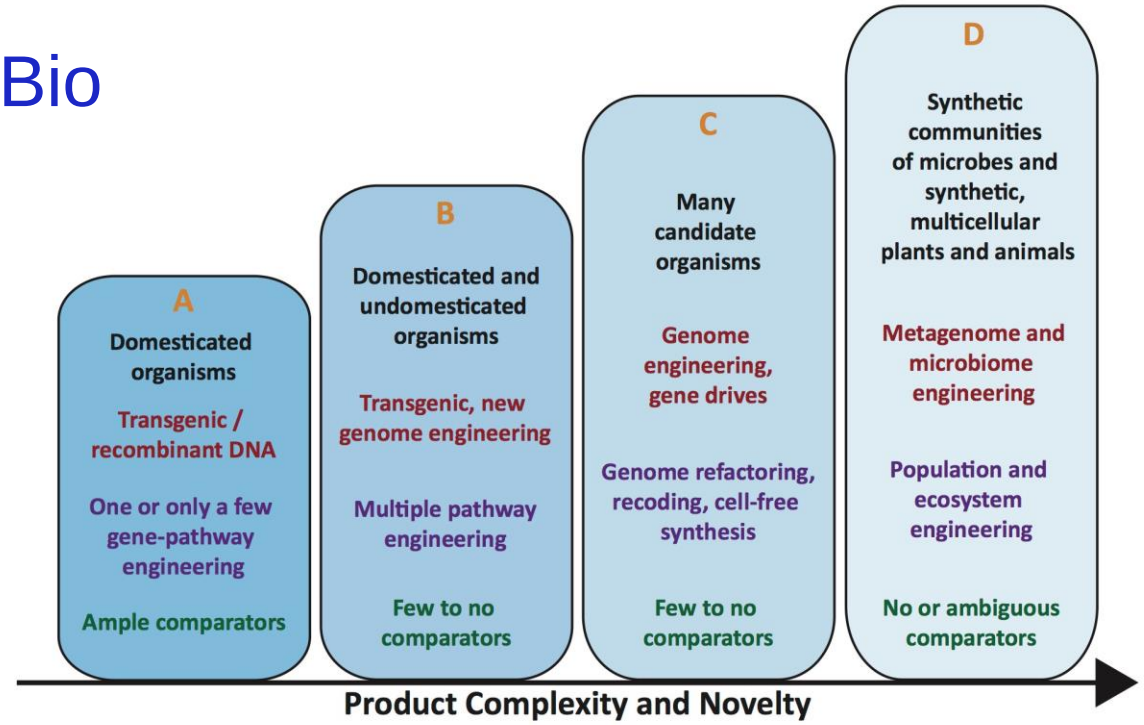
SUBJECT: Modernizing the Regulatory System for Biotechnology Products[1]

1. Development of an **update to the Coordinated Framework** for the Regulation of Biotechnology …to clarify the roles and responsibilities of the agencies that regulate the products of biotechnology;

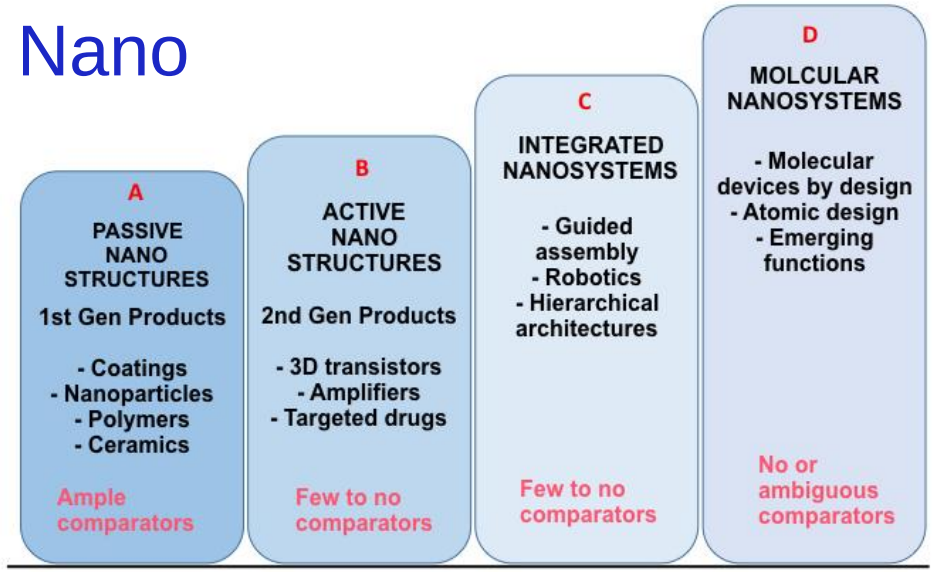
2. **Formulation of a long-term strategy** to ensure that the federal regulatory system is equipped to efficiently assess the risks, if any, associated with future products of biotechnology while supporting innovation, protecting health and the environment, promoting public confidence in the regulatory process, increasing transparency and predictability, and reducing unnecessary costs and burdens;

3. **Commission an external, independent analysis of the future landscape of biotechnology products with a primary focus on potential new risks and risk-assessment frameworks.**

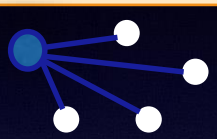
Bio


A
Domesticated organisms
Transgenic / recombinant DNA
One or only a few gene-pathway engineering
Ample comparators
B
Domesticated and undomesticated organisms
Transgenic, new genome engineering
Multiple pathway engineering
Few to no comparators
C
Many candidate organisms
Genome engineering, gene drives
Genome refactoring, recoding, cell-free synthesis
Few to no comparators
D
Synthetic communities of microbes and synthetic, multicellular plants and animals
Metagenome and microbiome engineering
Population and ecosystem engineering
No or ambiguous comparators
Product Complexity and Novelty

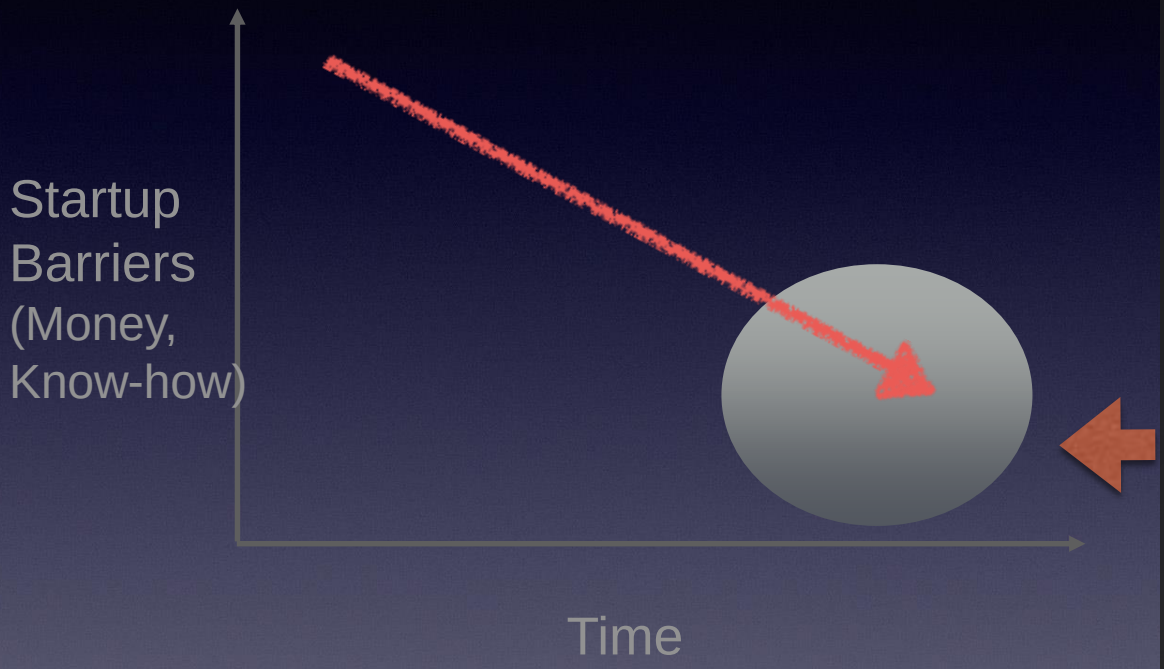
Nano


A
PASSIVE NANO STRUCTURES
1st Gen Products
- Coatings
- Nanoparticles
- Polymers
- Ceramics
Ample comparators
B
ACTIVE NANO STRUCTURES
2nd Gen Products
- 3D transistors
- Amplifiers
- Targeted drugs
Few to no comparators
C
INTEGRATED NANOSYSTEMS
- Guided assembly
- Robotics
- Hierarchical architectures
Few to no comparators
D
MOLCULAR NANOSYSTEMS
- Molecular devices by design
- Atomic design
- Emerging functions
No or ambiguous comparators

New Bioeconomy Business Models

	New B2B	B2C	C2C	C
Structure				
Examples	Ginko Bioworks Zymergen Contract synthesis	Taxa Glowing Plants	Peer-to-peer probiotics	At-home bioreactors, DIY products (for individuals, family & friends)
Analogs	Vertical to horizontal, plug and play	Mass customization, customer driven design	Artisanal products, on-line sales, BioEsty	Cloud-enabled, 3-D printing, anytime/anywhere/ anything
Enabling Tools Drivers	Gene editing, bioinformatics, 1000+ molecules	Gene editing, social media, bioinformatics, 1000+ molecules	Crowdsourced designs	Cloud computing, open-source repositories, standardized parts
Governance Approaches	Existing regulations	Regs, covenants, voluntary agreements, social benefit corporations	Consumer preferences, codes	Codes of conduct, ‘sticky’ norms. watermarking

New Funding Models



Crowdfunded Capital

KICKSTARTER

Crowdfunded Equity

WEFUNDER

Donor Driven

NEW HARVEST

Incubator/ Accelerator

INDIE BIO
ACCELERATING BIOLOGY

Community Lab

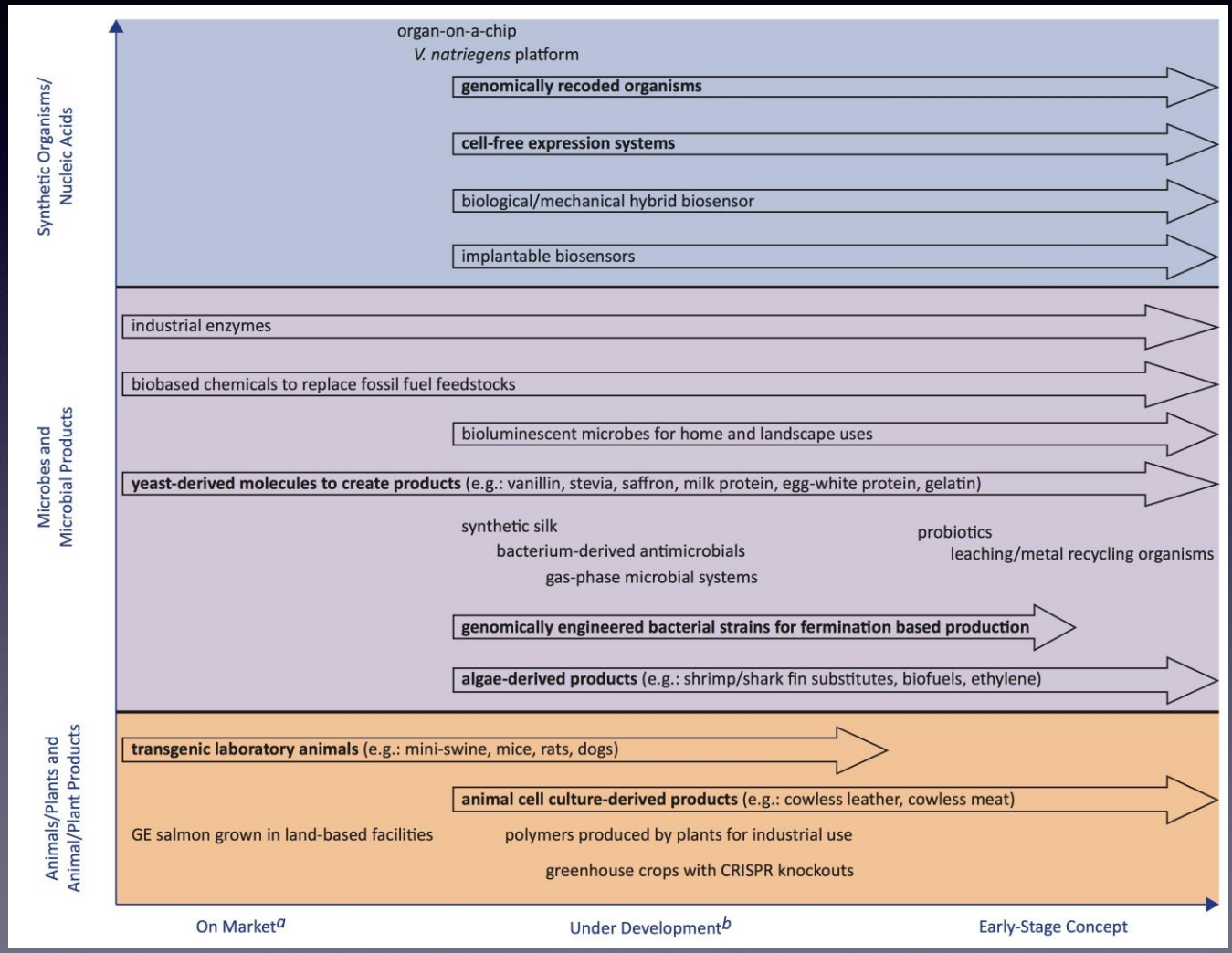
GENSPACE

Historical studies have found that delays in policy or regulatory action in the face of rapid technological change are often due to a lack of effective ‘early warning,’ and/or an inability to search out and identify blind spots. e.g., no situational awareness = Surprise.

Recommendation: In order to inform the regulatory process federal agencies should build capacity to scan the horizon continuously for new products and processes that could present novel risk pathways.

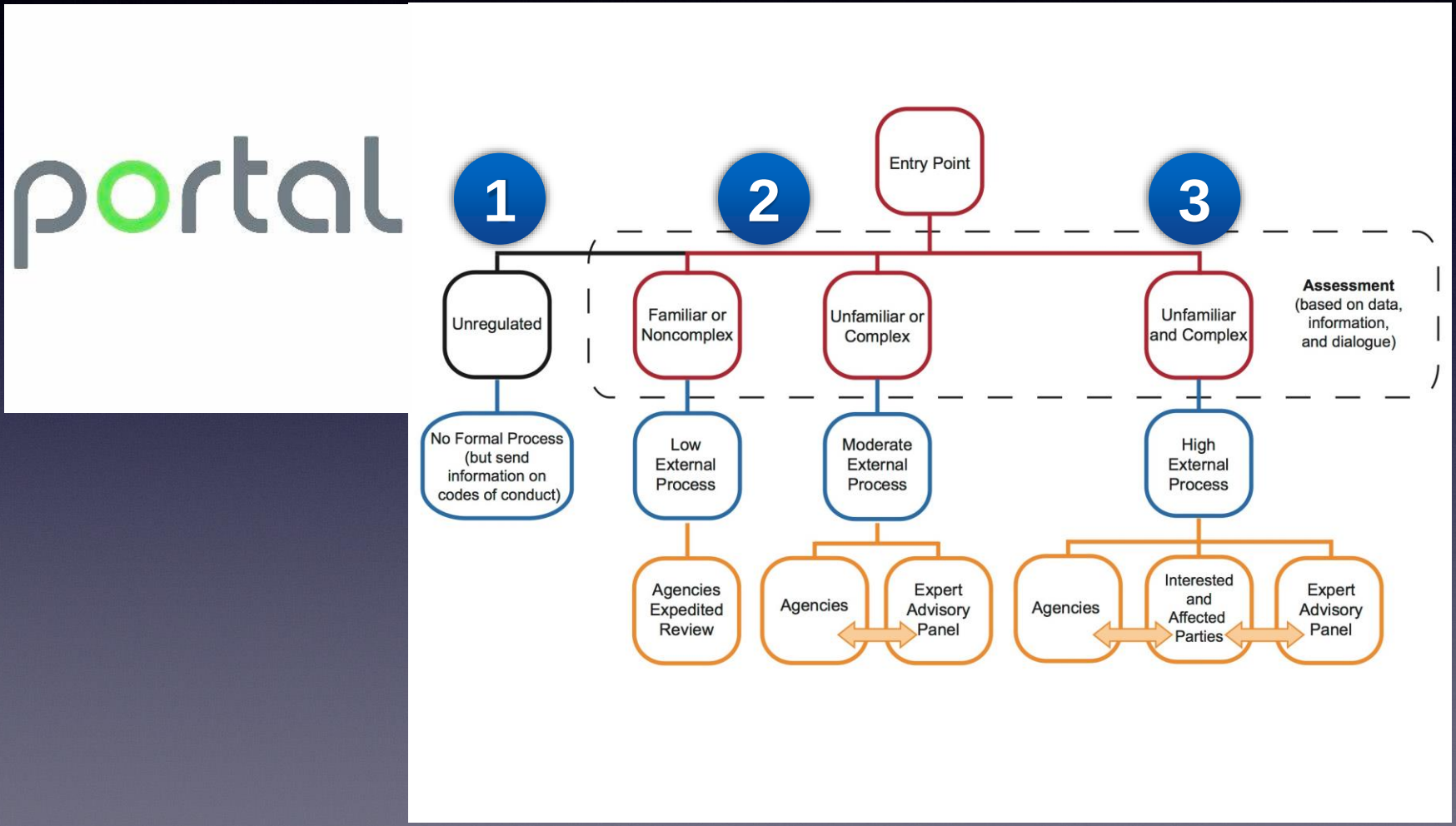
NASEM committee categorized ~300 entities

USDA funded horizon scanning system



Create a Database and Website with Global Reach

Recommendation: Regulatory agencies should build and maintain the capacity to rapidly triage products entering the regulatory system.



Thanks

Contact: rejeski@eli.org

Discussion Questions:

- How to identify and evaluate potential hazards at the design phase to minimize impacts for human and environmental health?
- What are the data/information needs and challenges?
  - Particular challenges for your agency?
- How to better connect innovation investment in emerging technologies with the development of safer chemicals and materials?
- What is needed for the broader use of alternatives assessment to inform safer chemical and material choices?

Next Webinar TBD
In-person convening in early April

Stay tuned:

- Announcement for our next webinar, planned for March 2018
- “Save the Date” announcement for an in-person Interagency Alternatives Assessment meeting in DC – envisioned for early April 2018