The World Is Flat: Making Materials Matter

National Policy Implications

Toni Marechaux
Board on Manufacturing and Engineering Design
National Research Council
Key policy facts

- There is no US "national materials policy"
  - No industrial policy or technology policy, either
- Government programs affect materials R&D in a number of ways
  - R&D funding (amount and direction)
  - Regulations and laws
- The big picture is difficult to understand
  - Data is lacking
  - Interdependencies are not modeled
Technology insertion

- Process Development
- Qualification
- Export Controls
- New Material
- Product Safety
- Environmental Impact
- Verification And Validation
- System Integration
- Scaled Modeling
Situation analysis

- National security is a priority
  - Drivers for both global and homeland applications
  - Warfighters and first providers are increasingly reliant on new technology

- Economic security is a priority
  - Outsourcing, offshoring, and offsets are proliferating
  - Difficult national "make/buy" decisions
    - Competition is the basis of the US economic system
    - Others factors complicate "competition" – subsidized research, currency values, labor rates, etc.

- The interdependence of national security and economic security is not well understood
  - Complexity is a particular concern
Tipping scales

Implications of new materials

- Technology convergence leading to new concerns
- Mounting evidence of negative environmental and health impacts (e.g., nanoparticles)
- Continued flow of new nano/bio-based products into the marketplace (30-50/month)
- Existing regulatory frameworks prove inadequate in addressing risks and boosting public confidence (e.g., MSDSs)
- Continued low trust in government by the public undermines interventions
Where government plays a role

- Materials sources and transactions
  - Raw materials
  - Processed materials
  - Scrap and recycled materials

- Materials uses and technologies
  - Transportation
  - Energy
  - Construction
  - Consumer products (health care, electronics)

- Materials education and workforce
  - Collaborations
  - Transit
Interdependencies

- Tax and Tariff Policies
- Commodity Prices
- Defense Acquisition Policy
- Export Controls
- R&D Funding
- Patent and IP Law
- Data Collection and Analysis

Economic Security

National Security
Interdependencies

- Technology
- Better technology
- Warfighter success
- National security
- Economic security
- Tax dollars
- DoD budget

Better technology leads to Warfighter success, which improves National security, enhancing Economic security, which ultimately reduces Tax dollars. This cycle supports a stable DoD budget.
Traditional policy perceptions

- Progress in materials research, development, and production has been the basis for economic growth and national security for centuries
- Jobs in the materials industries have been the most stable and highest paying
- Many of the largest companies in the world are materials producers and suppliers
Perceptions today

- Progress in materials research and production **nano-, bio- and information technology** is the basis for economic growth and national security.
- Jobs in the materials industries have been the most stable and highest paying; **polluting and unsafe; globalization will reduce wages**.
- Many of the largest companies in the world have been materials producers and suppliers; **but these aren't important to have in the U.S.**
Possible actions

- More "upstream" education
  - General public, public figures, and vocal scientists
  - Tie potential costs to potential benefits
- More funding for research on environmental and health implications
- Global agreements on responsible research, development, and use of new technologies
- Standards for labeling for consumer products, foods, etc.
- Better tools for understanding drivers
What's missing

- Tools to facilitate systems-level decision making
- Tools to evaluate and prioritize design alternatives early in the design process
- Tools that incorporate life-cycle costs and environmental impact
- Tools to validate component effectiveness
More missing links

- Data that is
  - accessible and peer-reviewed for new materials
- Tools that are
  - interoperable and composable, and span multiple fields
- Best practices that
  - define ownership rights to models, simulations, and data
Models for Linking Design, Manufacturing, and Materials

- Coupled models
  - Performance models
  - Component design
  - Process models
    - Manufacturing processes
  - Materials models
    - Materials
Moving forward

Where could the US lead (or not lag)?

- Comprehensive models and methods
- Materials databases
- Implementation and infrastructure
Ultimate goals

- The reward for use of new materials will be clear
- The risk will be mitigated
The National Academies

- What are the National Academies?
  - Not a government agency
  - Established by Congress to ‘advise the nation’ on science, technology and health policy issues
- Academies consist of
  - National Academy of Sciences (NAS)
  - National Academy of Engineering (NAE)
  - Institute of Medicine (IOM)
  - National Research Council (NRC)
Recent reports

- Capturing the Full Power of Biomaterials for Military Medicine (2004)
- New Directions in Manufacturing (2003)