Nano & Society:

Making nano relevant by making connections to societal impacts and everyday life

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Making nano relevant by making connections to societal impacts and everyday life

- **Brad Herring, Museum of Life and Science**
- **Ira Bennett and Andrew Maynard, Arizona State University and University of Michigan**
- **Liz Kunz-Kollmann and Gina Svarosky, Museum of Science, Boston and Notre Dame**
- **Kristi Jean, North Dakota State College of Science**
- **Kevin Jones, Sophia Acord, and Pamela Hupp - Materials Research Society**
- **David Sittenfeld, Museum of Science, Boston**

Nano & Society Workshops

ARIZONA SCIENCE CENTER

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Children's Museum of Houston

Science Museum of Minnesota

OMSI
OREGON MUSEUM OF SCIENCE AND INDUSTRY

Engaging Visitors in Nano & Society

Overarching goal

To empower educators and visitors to reflect on the relevance of nanotechnology to their lives.

Goals for Engaging Visitors in Conversations

1. Educators and visitors participate in open-ended, engaging conversations.
2. Educators and visitors have distinct, equally important roles in the conversation.
3. Participating in a conversation is a meaningful learning experience for visitors.
4. Facilitating a conversation is a valuable interpretive method for facilitators.

Two Approaches to Engaging Visitors

Demonstration

- Scientist/educator has knowledge and expertise to share
- Visitors discover phenomena and laws of nature
- The facilitator communicates facts
- Visitors ask questions and receive answers
- Promotes basic goal public understanding

Use this approach to explain the Bernoulli Principle to visitors

Conversation

- Everyone has their own values and perspective to share
- Facilitators and visitors consider facts and values
- Facilitators and visitors ask questions and receive responses
- Visitors form opinions and explore ideas
- Promotes basic goal of public engagement

Try this approach to engage visitors in nano and society

Nano & Society Big Ideas

Engaging in conversations about what nanotechnology means to us and our future.

Values

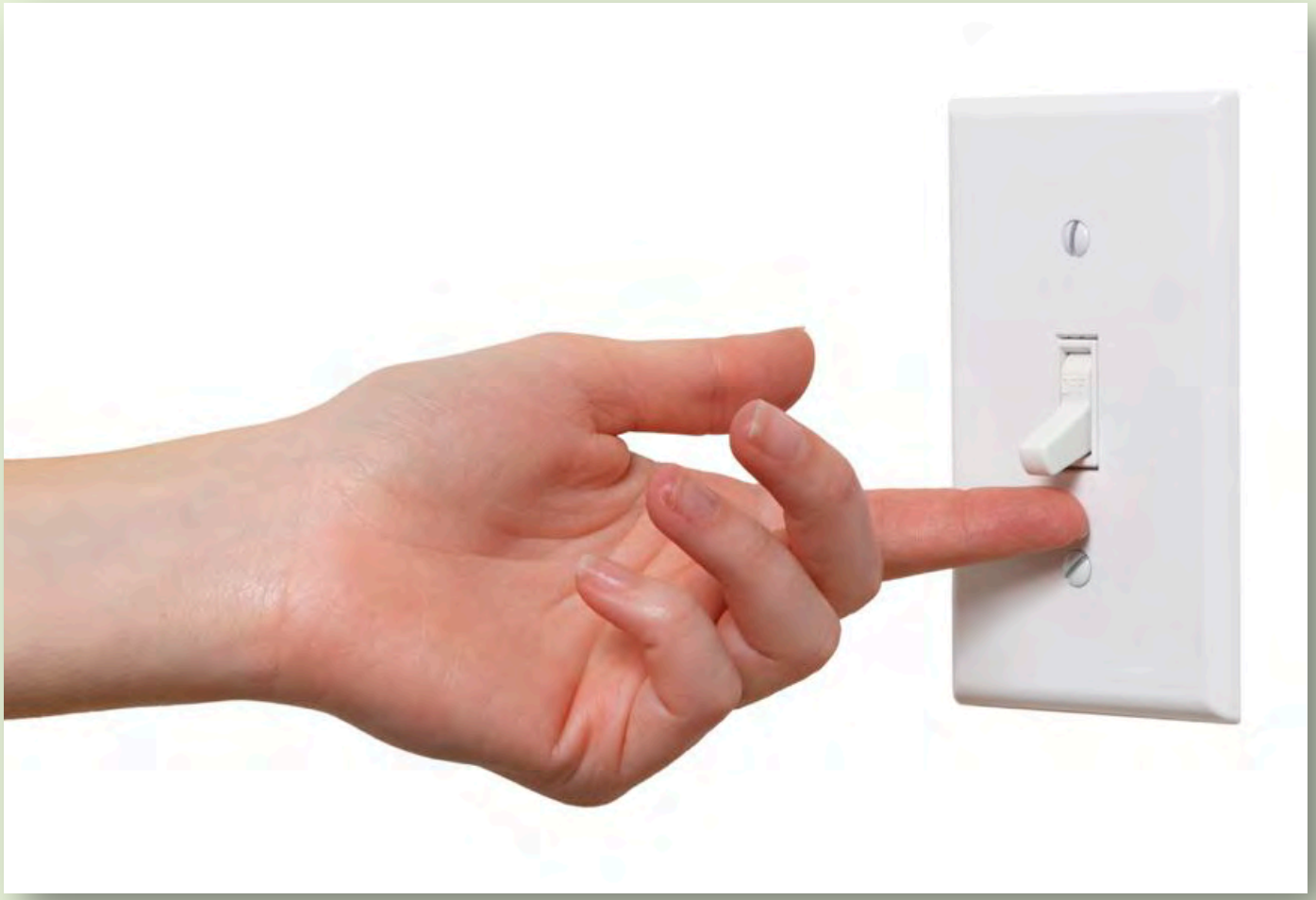
Values shape how technologies are developed and adopted.

Relationships

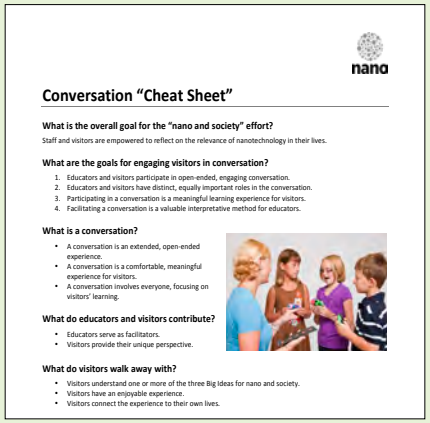
Technologies affect social relationships.

Systems

Technologies work because they're part of systems.



Nano & Society Tools


nano

Conversation "Cheat Sheet"

What is the overall goal for the "nano and society" effort?

Staff and visitors are empowered to reflect on the relevance of nanotechnology in their lives.

What are the goals for engaging visitors in conversation?

1. Educators and visitors participate in open-ended, engaging conversation.
2. Educators and visitors have distinct, equally important roles in the conversation.
3. Participating in a conversation is a meaningful learning experience for visitors.
4. Facilitating a conversation is a valuable interpretative method for educators.

What is a conversation?

- A conversation is an extended, open-ended experience.
- A conversation is a comfortable, meaningful experience for visitors.
- A conversation involves everyone, focusing on visitors' learning.

What do educators and visitors contribute?

- Educators serve as facilitators.
- Visitors provide their unique perspective.

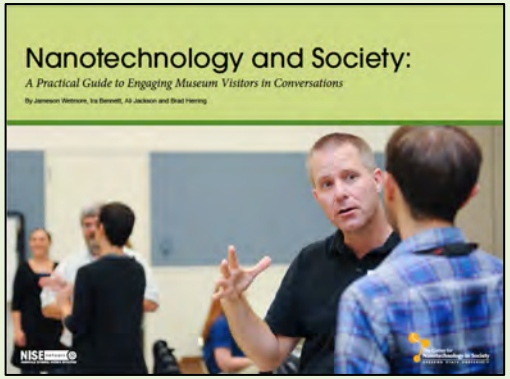
What do visitors walk away with?

- Visitors understand one or more of the three Big Ideas for nano and society.
- Visitors have an enjoyable experience.
- Visitors connect the experience to their own lives.

Nano & Society training materials

- slideshows
- videos
- tip sheets
- team-based inquiry sheets

Improv Exercises for staff and volunteers



Technology & Society Guide

More info: www.nisenet.org/catalog/tools_guides/nano_society_training_materials

Educational Products in Catalog

Nano Around the World card game

Exploring Nano & Society – Invisibility Cloak

Exploring Properties – Capillary Action

Exploring Nano & Society – Space Elevator

Exploring Nano & Society – Tippy Table

Exploring Nano & Society – You Decide!

More info: nisenet.org/catalog

IRA BENNETT & ANDREW MAYNARD

Arizona State University
University of Michigan

Values and Risk

Ira Bennett & Andrew Maynard

School for the Future of
Innovation in Society
Arizona State University

Values are more than a set of morals

What we find desirable

The most perfect tomato on the internet

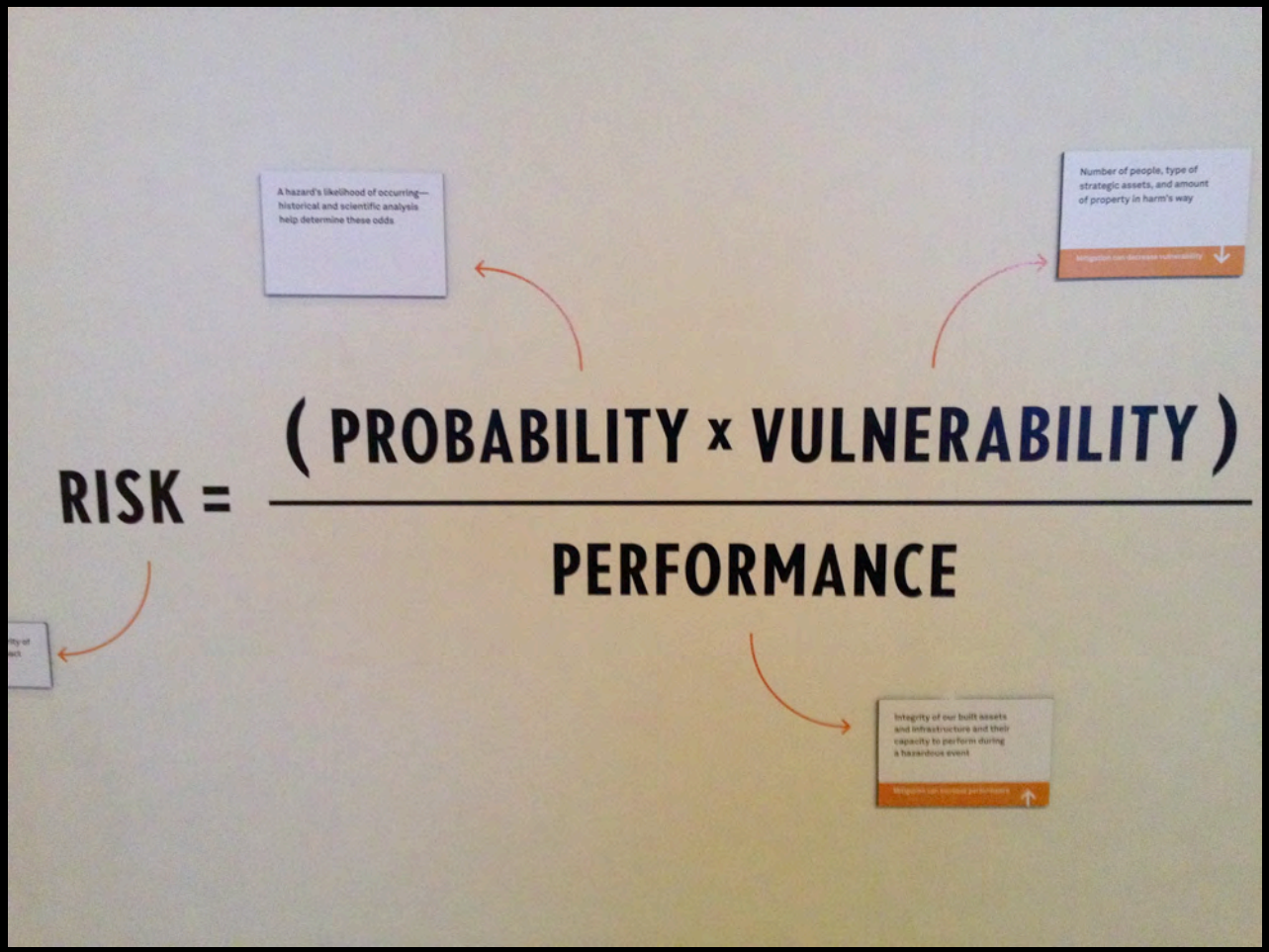
What we find undesirable

The worst tomato on the internet

Risk is the idea that things we find undesirable could happen.

And we can fit more than scientific data or toxicological screens into this conception of risk.

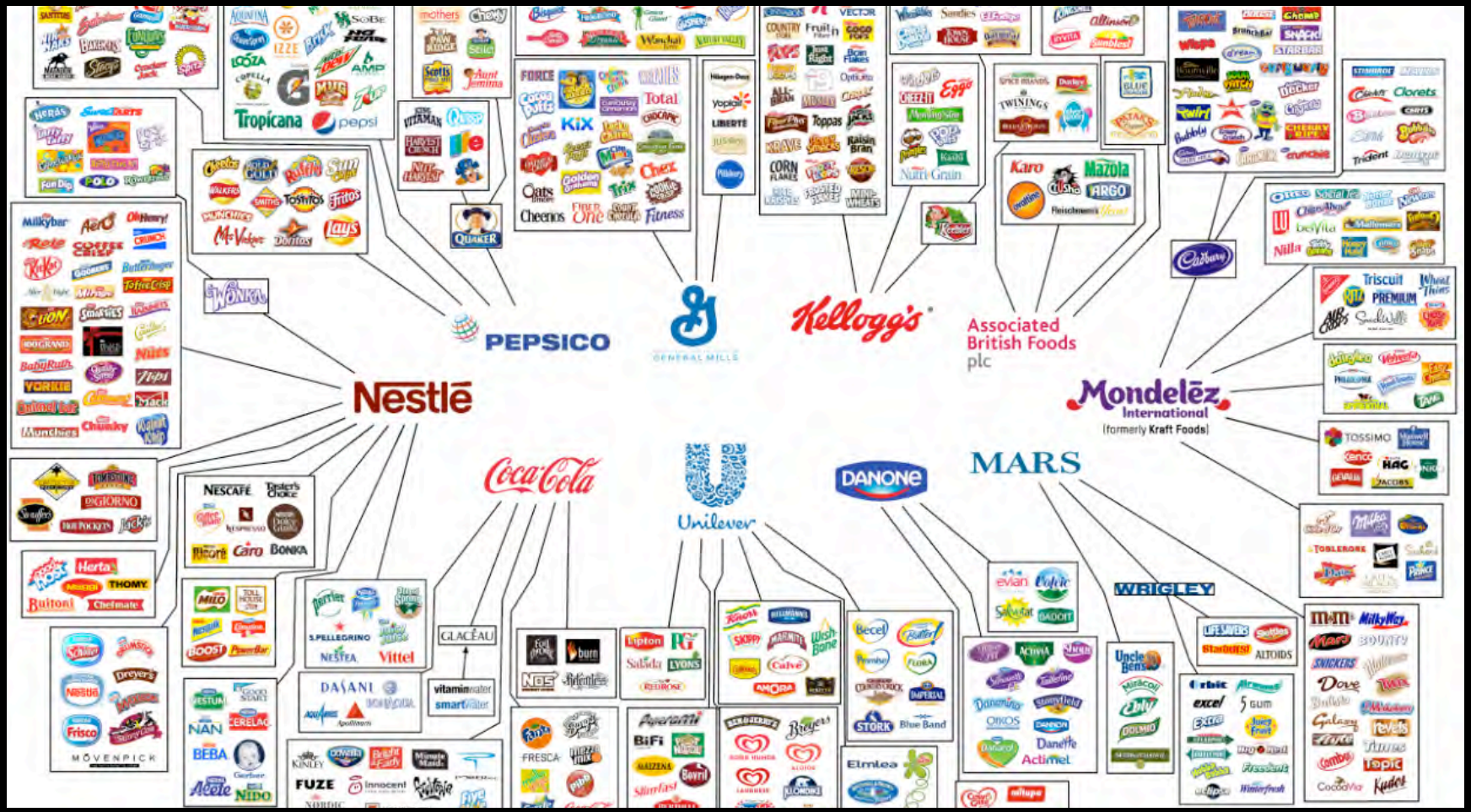
Risk is represented in many ways



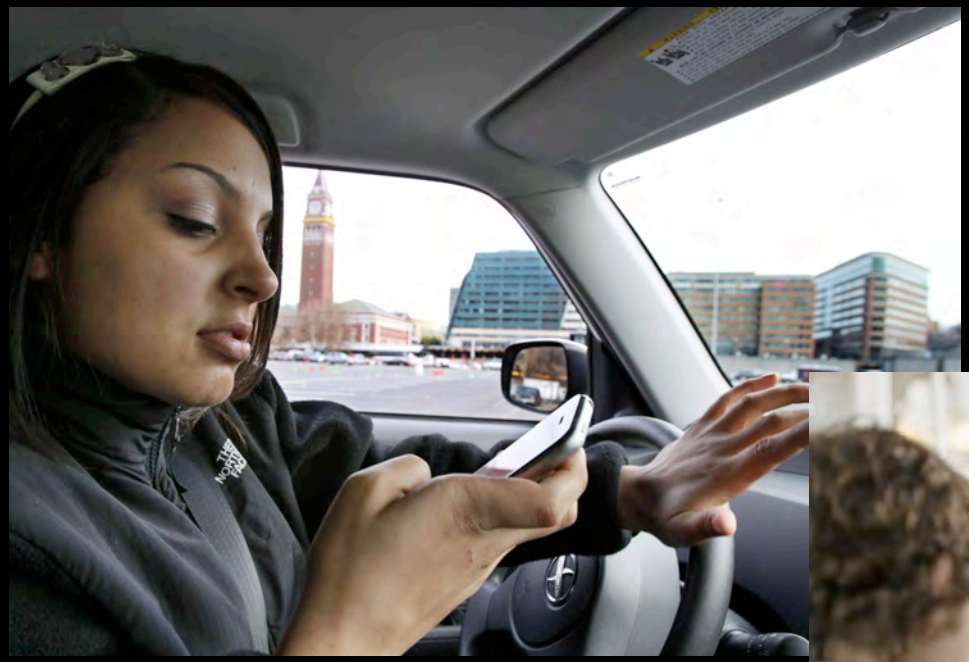
Designing for Disaster, National Building Museum

GMO Agriculture

GMO Agriculture



Distractions caused by mobile phones



Distracted Driving

Distracted Dining

As we figure out what we value, we can decide what we find risky and then decide if we want choices about that risk to be an individual or societal one.

LIZ KUNZ-KOLLMANN & GINA SVAROSKY

Museum of Science, Boston
Notre Dame

Research on connections between *Nano* and relevance

NISE network™
NANOSCALE INFORMAL SCIENCE EDUCATION

JUNE 2015
NETWORK-WIDE MEETING

NISENET.ORG

NSF

Nano Summative Evaluation

59% of visitors reported finding connections between the mini-exhibition experiences and their daily lives

(Svarovsky et al., 2013)

Nano Mini-Exhibition

Nano Mini-Exhibition

Nano Mini-Exhibition

Study Methods

Data collection:

- 33 visitor groups
- Audio and video recording
- Reflective interview

Coding:

- 29 groups completed
- Relevance content (Kember, Ho, & Hong, 2008)

Study Findings

All the groups in our sample made some connection between the *Nano* Mini-Exhibition and their everyday lives or experiences

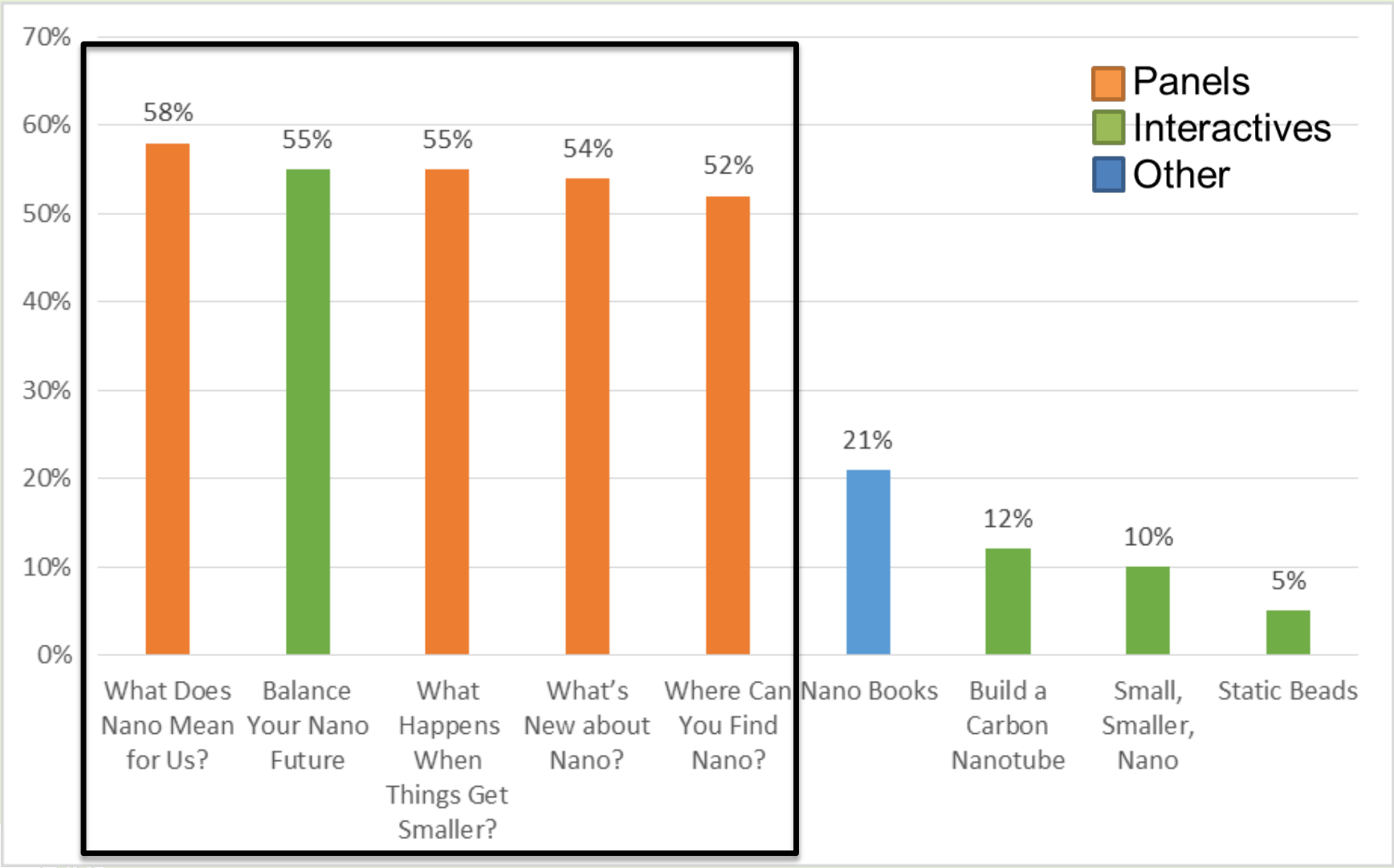
Study Findings: Relevance Content

29 of 29 groups talked about current societal topics

"Like the thing with the water, the water filtration thing, that could save lives."

"That solar panel thing because I've heard a lot of talk about how they're going to develop that more and more in our country to replace the energy crisis thing..."

Study Findings: % of Groups discussing Current Topics



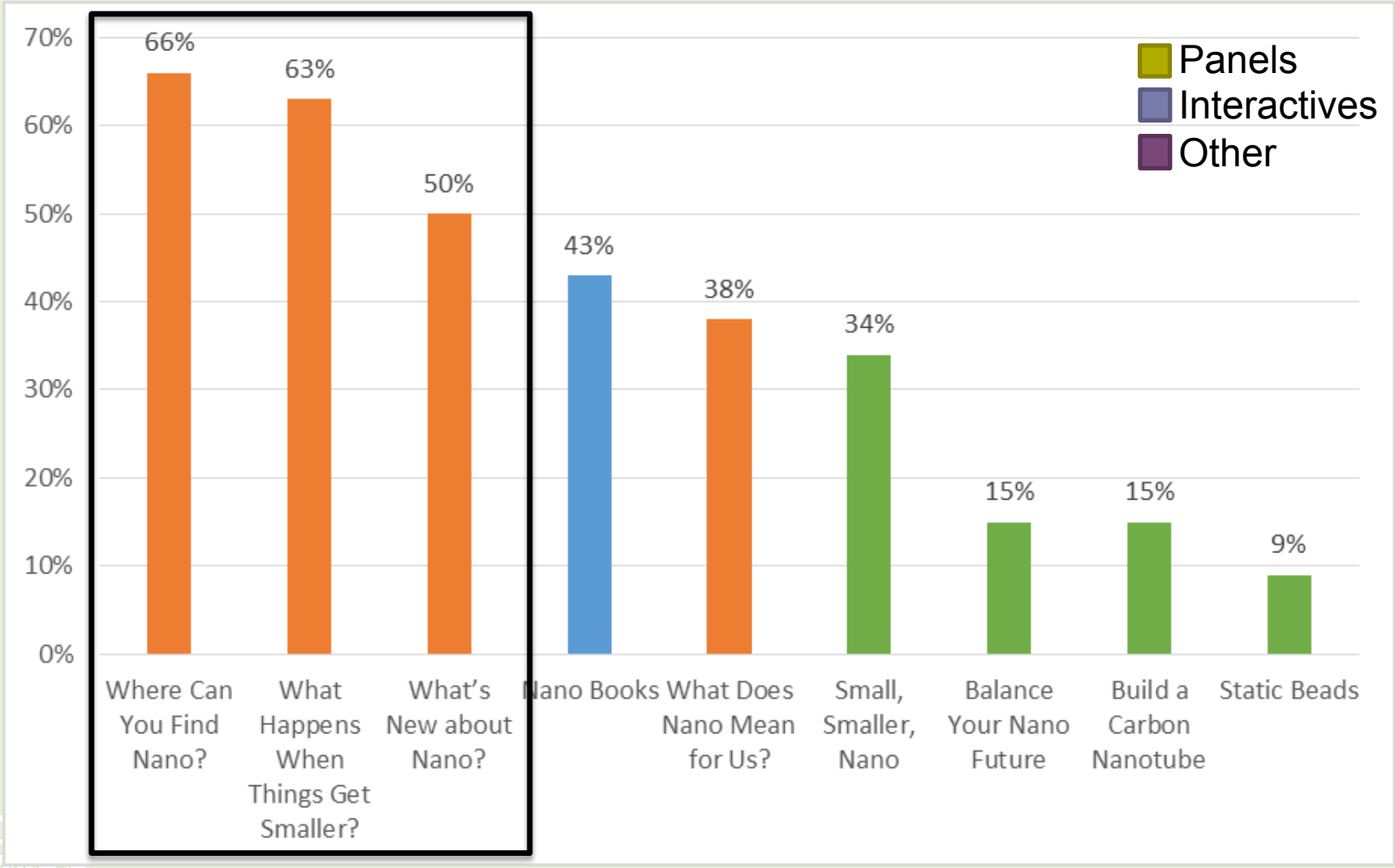
Study Findings: Relevance Content

28 of 29 groups talked about everyday applications / personal connections

"This is what you need! They say that nanotechnology can keep germs at bay. So when we're in the boundary waters we could, we could get some nano socks…"

"Okay Mark. Here's the scientific evidence that my Norwex gloves are anti-bacterial. 'A little bit of nano-sized silver can keep a lot of germs at bay!'"

Study Findings: % of Groups discussing Everyday Applications



In Conclusion

- All groups were able to make some kind of relevance connection to the exhibition either at a societal or personal/ everyday level
- Although more study is needed, it seems that purposefully adding content about applications and societal implications can lead people to feel a connection between STEM and their lives

References

Kember, D., Ho, A., & Hong, C. (2008). The importance of establishing relevance in motivating student learning. *Active Learning in Higher Education, 9*(3), 249 - 263.

Svarovsky, G., Goss, J., Ostgaard, G., Reyes, N., Cahill, C., Auster, R., et al. (2013). *Summative study of the Nano mini-exhibition.* Saint Paul, MN: NISE Network.

KRISTI JEAN

North Dakota State College of Science

KEVIN JONES, SOPHIA ACORD, & PAMELA HUPP

Materials Research Society

IMPACT OF MATERIALS ON SOCIETY

Kevin S. Jones
Materials Science and Engineering UF
&
Sophia Krzys Acord
Sociology and Humanities Center UF
&
Pamela Hupp
Materials Research Society

University of Florida Faculty Participants

Kevin Jones (Materials Science and Engineering)

Sophia K. Acord (Sociology)

Sean Adams (History)

Marsha Bryant (English)

Florin Curta (History)

Mary Ann Eaverly (Classics)

Bonnie Effros (History)

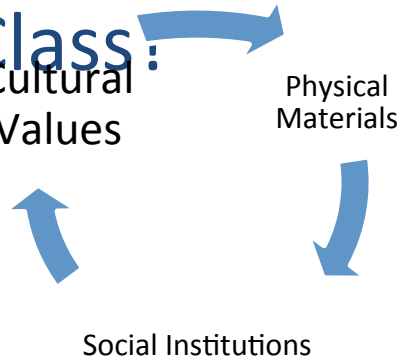
Susan D. Gillespie (Anthropology/Archeology)

Ken Sassaman (Anthropology)

In collaboration with over 30 other members of the

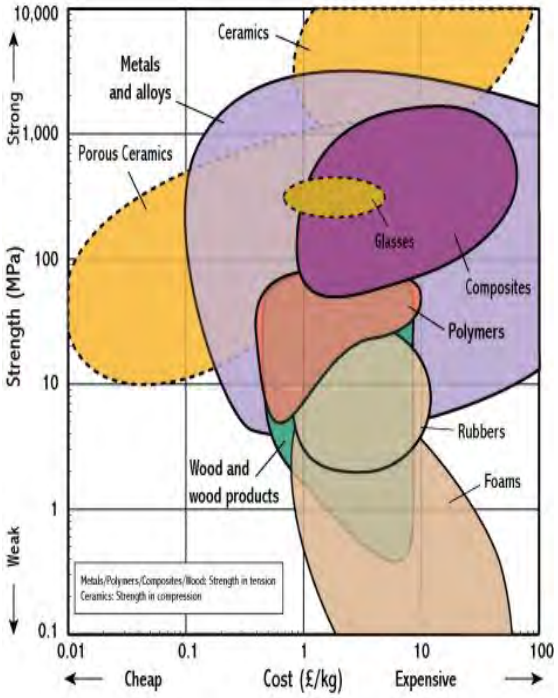
Materials Research Society.

What is the Impact of Materials on Society (IMOS) Class?



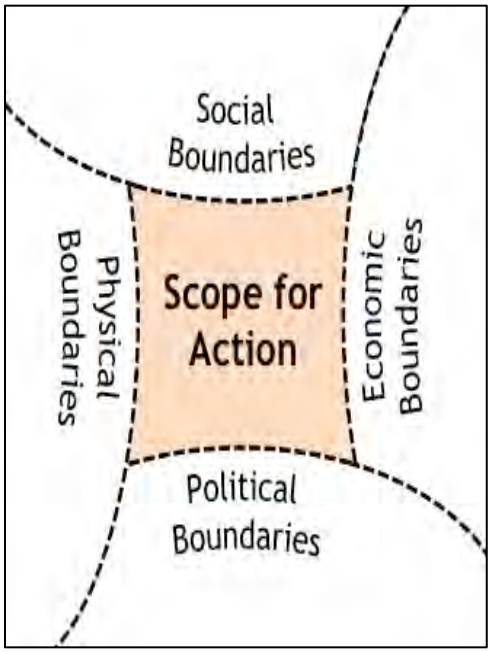
- IMOS is a freshman level class that explores how materials discoveries (metals, polymers, etc.) have shaped society from the past to the future.
- The class demonstrates that (1) society is dependent upon materials innovations **AND** (2) how those innovations are influenced by society.
- Goal: Increase science and social literacies

Materials have physical properties

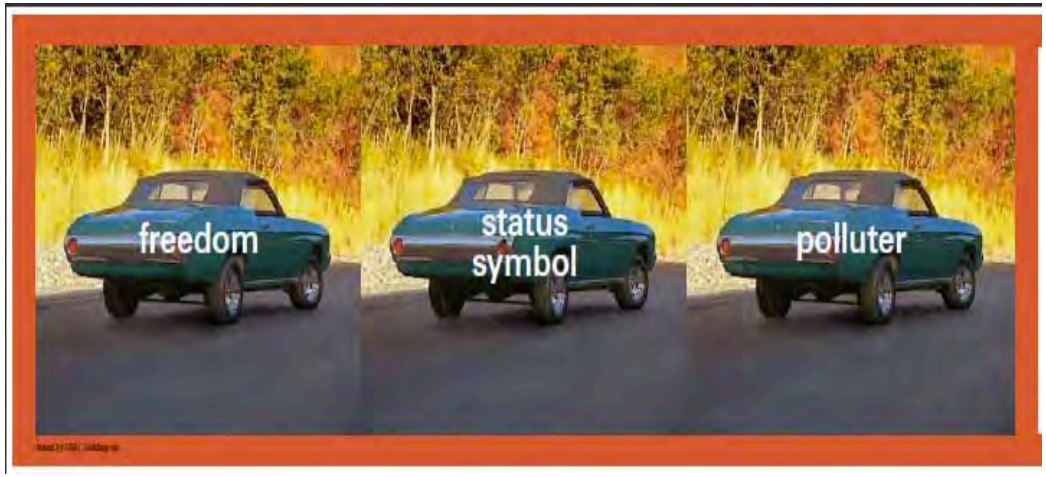


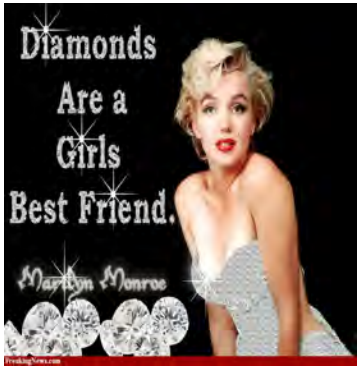
The selection of certain materials involves a cost/benefit analysis of durability, safety, aesthetics, cost, capabilities, human lives, legality, all weighed alongside their properties

Materials have social lives

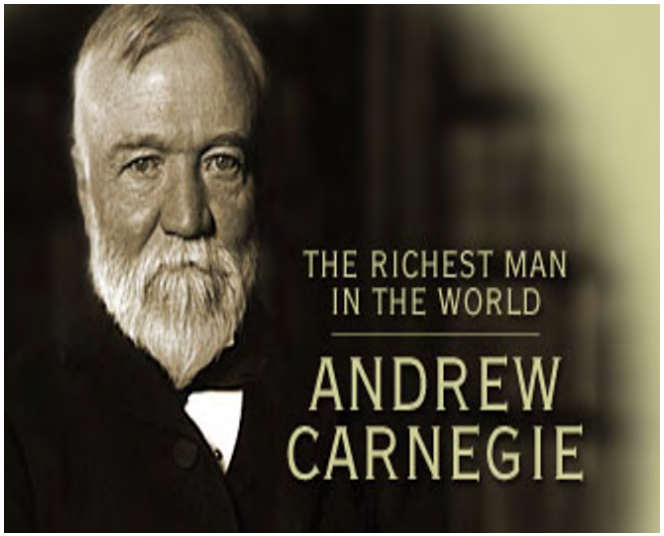


Materials have cultural meanings





What we can do with materials is shaped by human mediators



Some materials are more appropriate than others

Materials affect how we think and interact

Materials have relationships to other materials

Many factors shape materials innovation

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Ancient Roman glass inspires modern science

Posted on November 21, 2013

A 1700-year-old Roman glass cup is inspiring University of Adelaide researchers in their search for new ways to exploit nanoparticles and their interactions with

Researchers in the University's Institute for Photonics investigating how to best embed nanoparticles in glass – inst nanoparticles it contains.

"Nanoparticles and nanocrystals are the focus of research a properties that have the potential to bring great advances electronic fields," says Associate Professor Heike Ebendorff- the University's School of Chemistry and Physics. "A nanoparticles into glass, will open the way for applications efficient solar cells or advanced sensors that can see inside th

"We will be able to more readily harness these nanoscale pro a tangible material with nanoparticle properties that we ca applications. And the unique properties are actually enhance

The Lycurgus Cup, a 4th century cup held by the British Mu changes colour from red to green depending on whether ligh off it. It gets this property from gold and silver nanoparticles

Read more at: Phys.org

theguardian

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News › Science

Five wonder materials that could change the world

Materials such as graphene and shrilk are so new that the scientists who discovered them hardly know what to do with them – they only know they might yet transform our lives

Ian Sample

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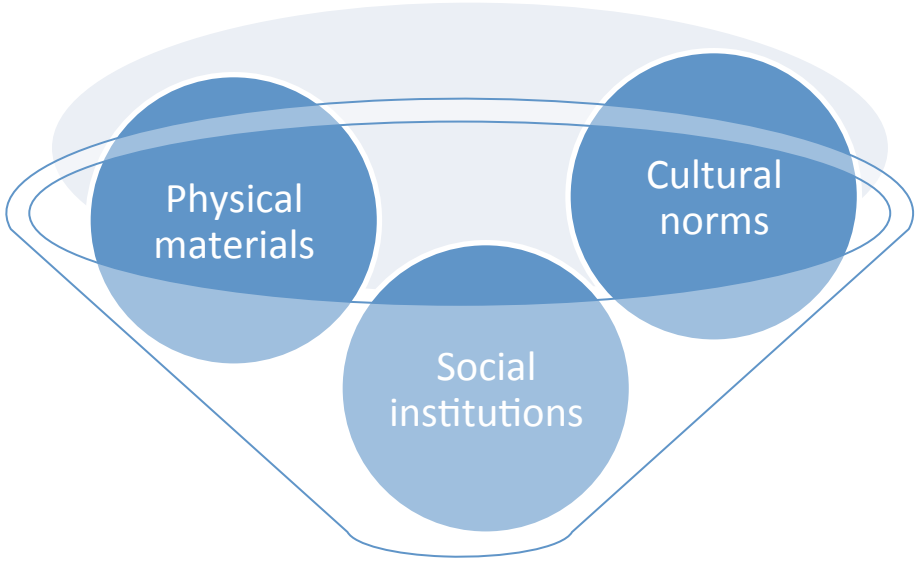
The Guardian, Tuesday 15 April 2014 12.14 EDT

Jump to comments (45)

Fritz Vollrath leads a team of scientists at the Oxford Silk Project who are exploring the biological, chemical and mechanical properties of spider silk. Photograph: Andy Hall

"The history of materials is a history of mistakes," says Mark Miodownik, a materials scientist at University College London, who traces his own fascination with materials to the moment he was stabbed in the back with a razor while ambling to school one day.

Engineering can be a diverse field



Impact of Materials on Society

Class Description

- There is one instructor of record in engineering and nine instructors in liberal arts
- Class structure
  - **Monday: Engineering lecture** on a specific material
    - E.g. Iron and steel
  - **Wednesday: HSS lecture** on material case study
    - E.g. Andrew Carnegie and creative destruction
  - **Thursday: Watch video** on new material
    - E.g. Magnesium (Mg) alloys that are replacing steel
  - **Friday: Flip the classroom and work in groups**
    - E.g. Create a future product with magnesium and discuss its anticipated creative destruction

IMOS Lessons I

Each week is a new material!

Week 2 Clay - Team with Susan Gillespie (Anthropology)
- The Entanglement of Earth: The Age of Clay versus the Age of Rare Earths

Week 3 Glass - Team with Ken Sassaman (Anthropology)
- Molding Clay, Breaking Glass, and the Past Futures of Ceramics

Week 4 Concrete - Team with Mary Ann Eaverly (Classics)
- Engineering Society through Social Spaces

Week 6 Copper and Bronze – Team with Florin Curta (History)
- Trading Material Resources and Knowledge

Week 7 Iron - Team with Sean Adams (History)
- Steel and Magnesium: Technology, Markets, and Creative Destruction

IMOS Lessons II

Each week is a new material!

Week 9 Aluminum - Team with Sean Adams (History)
- Aluminum, Amorphous Metals and the Structuring of Markets

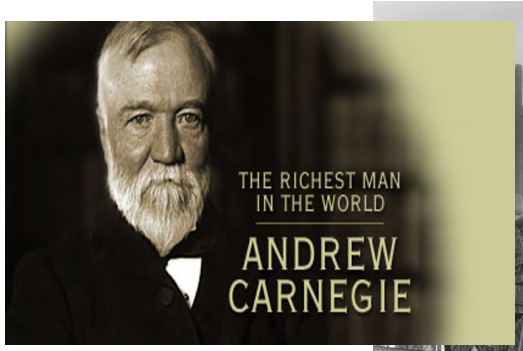
Week 10 Writing Materials - Team with Bonnie Effros (History)
- The Politics and Preservation of Knowledge

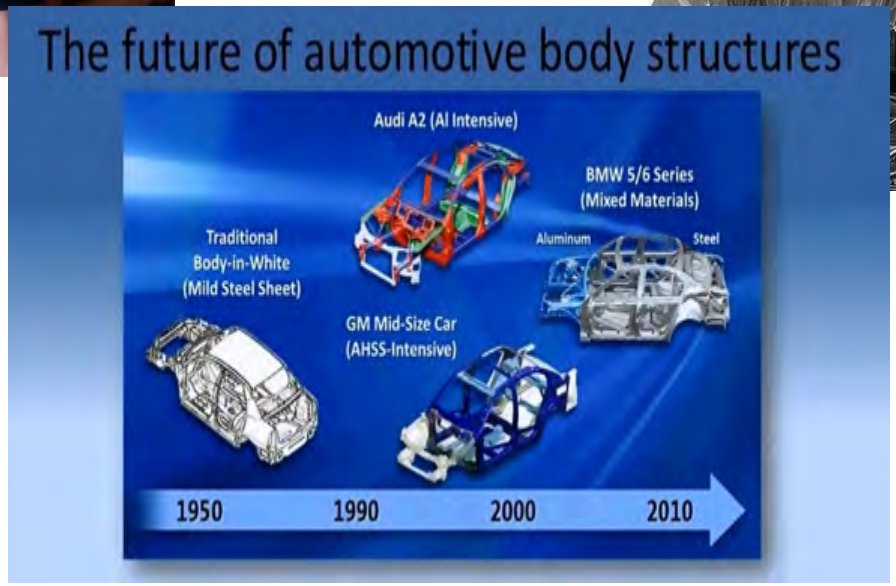
Week 11 Gold and Silver - Team with Florin Curta (History)
- Gold, Silver, and the Creation of Value

Week 12 Plastics - Team with Marsha Bryant (English)
- Earl Tupper, Brownie Wise and Materials Marketing (Tupperware)

Week 13 Semiconductors - Team with Sophia Acord (Sociology)
- Semiconductors & Cyborgs: Human-Material Relations in the Networked Society

Iron, Steel and Creative Destruction (Sean Adams, history)





Mg Alloys

Quotes 1-2 years later

- **Undecided => MSE: YES I LOVED THE CLASS! It was a major factor in determining my major, which is now MSE.**
- Biomed => MSE: The class helped me land my first internship offer, it was my favorite class at UF.
- **MSE Major: I feel that I reaped the most benefit from the historical implications and technological insights to research and development of new materials.**
- History Major: I feel like it gave me an advantage in my future history classes.
- **MSE Major: I feel that EMA1004 covers very important and some seldom considered information that should indeed be shared with other institutions.**
- Environmental Major: Great class, I recommend it to all my friends

Overview of Status

Class taught 3 times at UF with great success (size ~120)

Goal: Increase science and social literacy of students and publics.

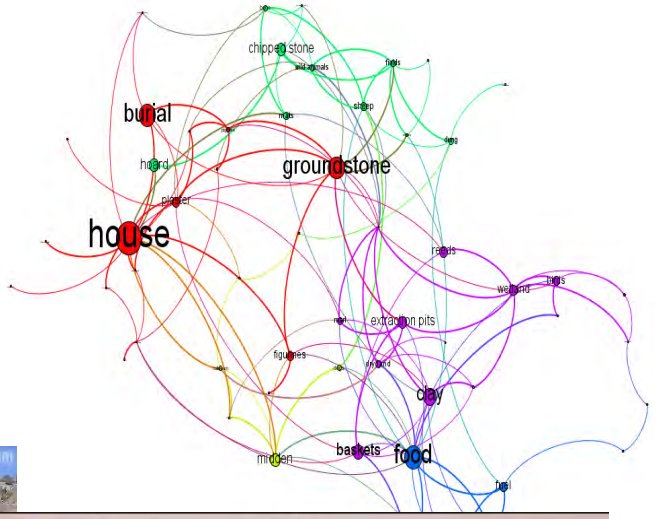
Next Steps:

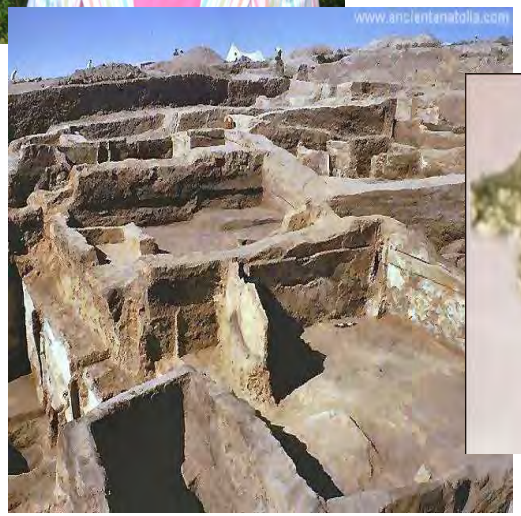
- UF Faculty producing an Open Textbook (Orange Grove Press)
- DoD grant to produce videos of new materials
- Planning to disseminate the course nationally starting Fall of 2015

IMPACT

OF MATERIALS ON SOCIETY

The Entanglement of Earth (Susan Gillespie, anthropology)

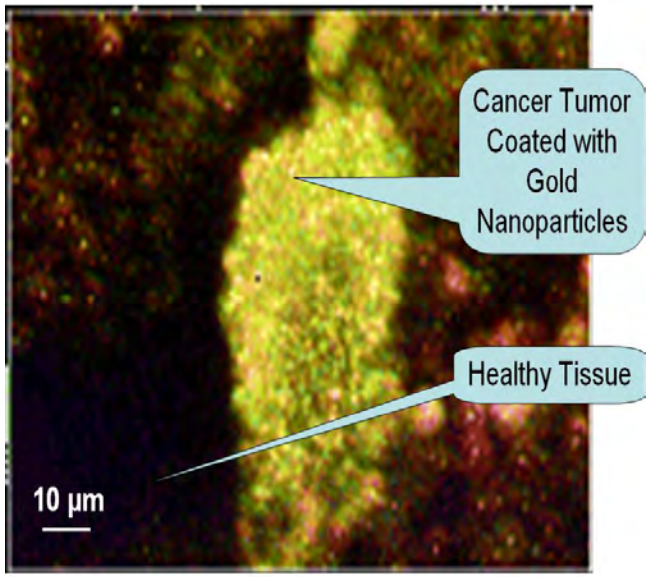




Engineering Society through Social Spaces (Mary Ann Eaverly, classics)

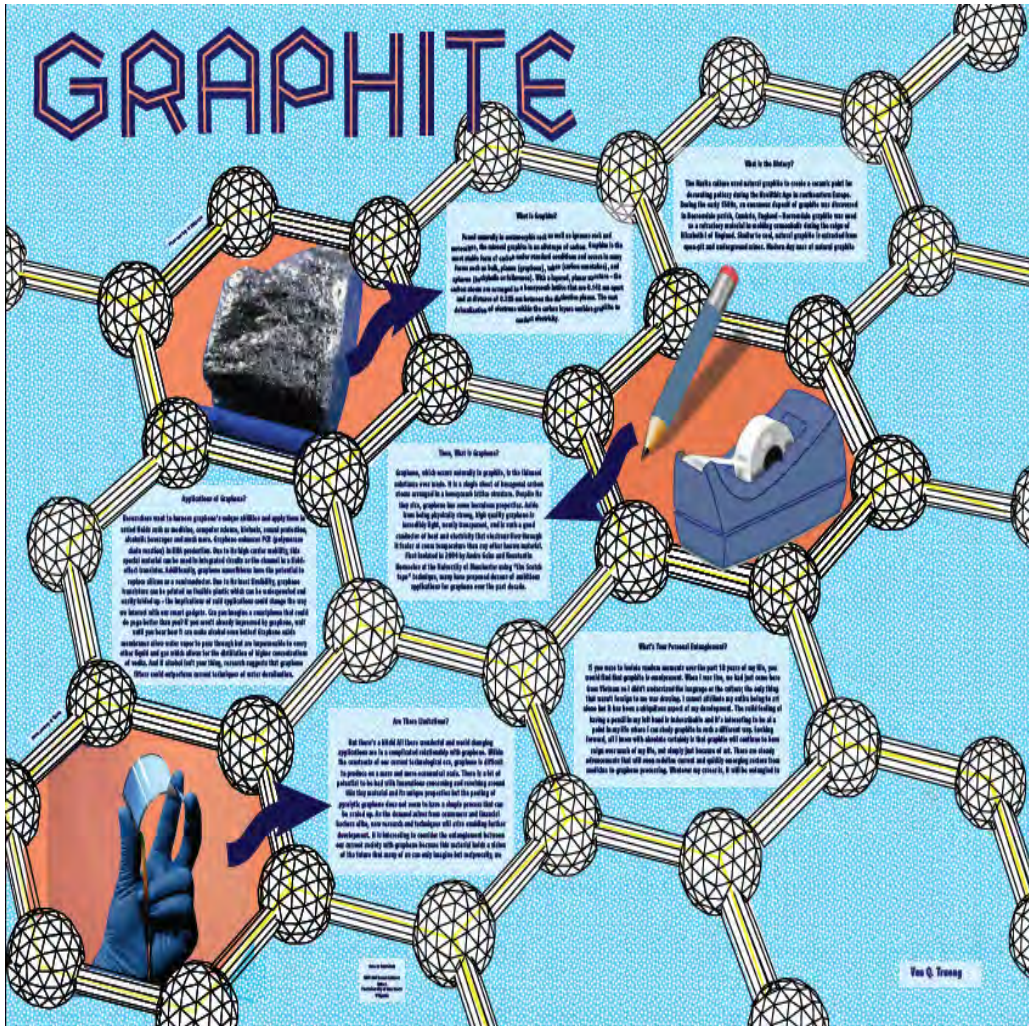
Department

Gold, Silver, and the Creation of Value (Florin Curta, history)



Impact Testing Concrete

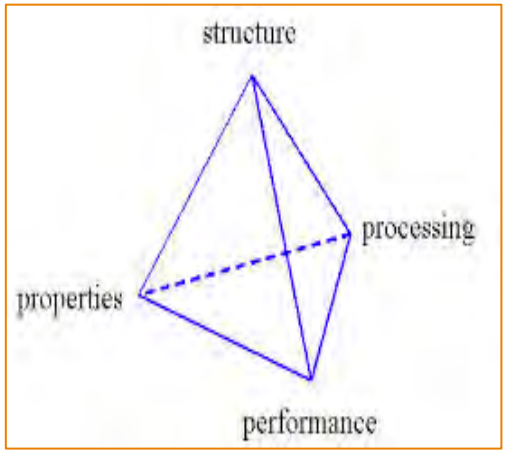
Final Posters

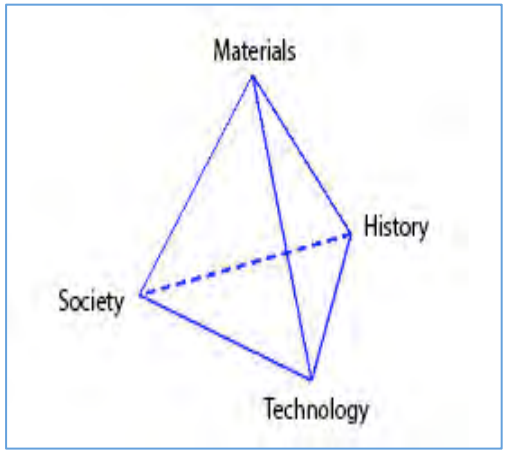


Survey Results

- 90.1% felt the course would make them a more effective engineer.
- 92.6% felt that the course made them a more aware decision-maker as a consumer or voter.
- 70.4% reported that the course had changed their impression of what an engineer did.
- 92.6% would recommend the course to engineers.
- 72.8% would recommend the course to non-engineers.
- 65.4% were more likely to major in engineering as a result of taking the course.

The Impact Paradigm





What is the impact of this material on society?

- *Is a society willing to accept it?*
- *How sustainable is it?*
- *What impacts does it have on health?*

DAVID SITTENFELD

Museum of Science, Boston

Building with Biology

Activities and Conversations about Synthetic Biology

David Sittenfeld

Program Manager, Forum

Museum of Science, Boston

Building with Biology

AAAS

ADVANCING SCIENCE, SERVING SOCIETY

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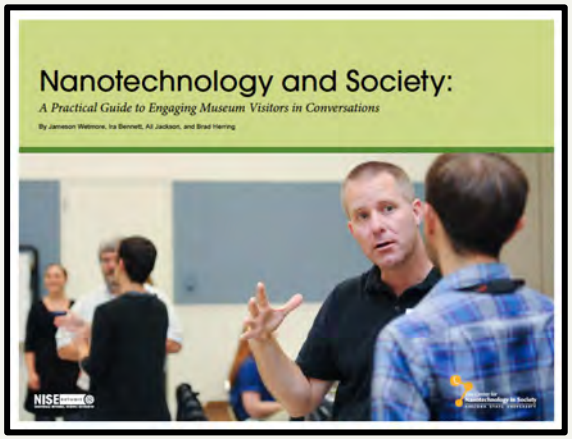


synberc

Building the Future with Biology

NISE network

NANOSCALE INFORMAL SCIENCE EDUCATION

ECAST

EXPERT AND CITIZEN ASSESSMENT OF SCIENCE AND TECHNOLOGY

Current Research

BioBuilder

Educational Foundation

In Teachable Form

The Center for Nanotechnology in Society

ARIZONA STATE UNIVERSITY

NSF

Building with Biology

The aim of this project is to foster activities in science museums through which public audiences can engage with scientists and engineers in conversations about what synthetic biology is, how research in the field is carried out, and the potential products, outcomes, and implications for society of this work. Researchers and publics will explore personal and societal values and priorities as well as research outcomes so that both groups can learn from each other.

This project is funded by the Advancing Informal STEM Learning (AISL) program in the Education and Human Resources Directorate of the National Science Foundation through award no. DRL-1421179

Building with Biology

Dimensions of PUS to PES

More PUS-like

Focus

- Natural and human made world
- Processes of science
- Societal & environmental impacts
- Relevant personal, community, and societal values
- Institutional priority or public policy

Public

- Watch and read
- Ask questions or interact
- Talk and share views
- Deliberate and problem solve together
- Produce recommendations

Experts

- Advise the ISE folks
- Make presentations to the public
- Work to improve communication skills
- Welcome and value public input
- Act on public input

More PES-like

SynBio Big Ideas

Synthetic biology builds biological systems as a way to explore how principles of engineering apply to the life sciences.

Synthetic biology welcomes participation of communities with diverse training to foster creativity and growth of the field.

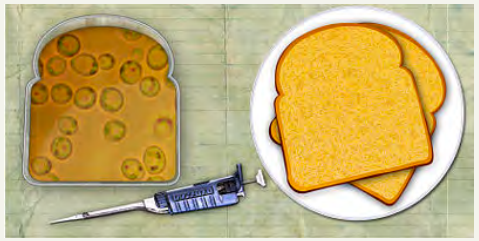
Synthetic biology generates new tools and knowledge to enable biology-based solutions to societal challenges.

Synthetic biology is interconnected with human values through the uses, costs, benefits, and risks of science and technology.

Building with Biology

Which method of Vitamin A production would you support? Place a poker chip in the appropriate box:

Atlantic Cod image from NOAA



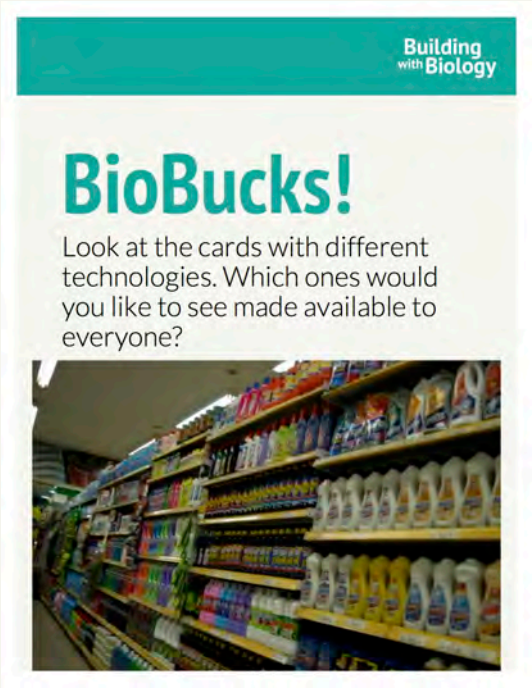
Credit BioBuilder.org

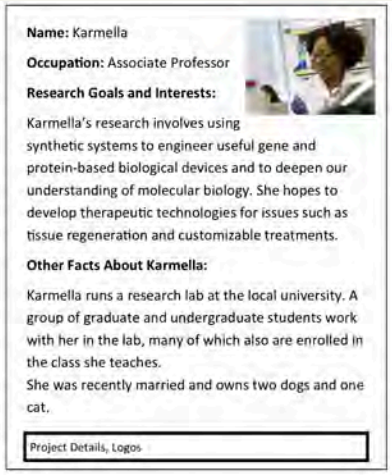
From non-living sources?	From (once) living sources?	From biologically engineered yeast?

What info would you want to know before deciding?
How do you think these items should be labeled?

Building with Biology

Co-created engagement activities





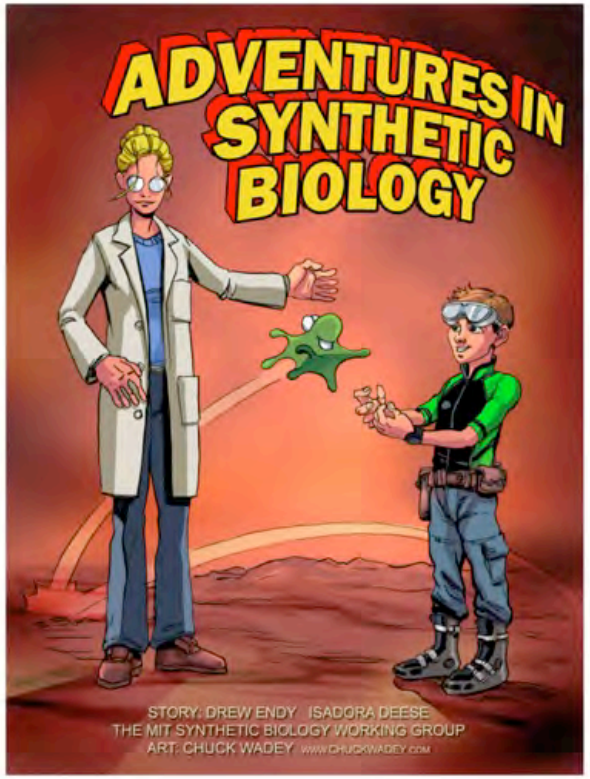
Building with Biology

- Forums are dialogue programs
- They usually focus on societal and ethical issues related to science and technology
- They dig into science content but also into personal experiences and social values
- They provide an opportunity to learn from publics that are informed and engaged in a deliberative process

BwB Forums

Thank you!

http://buildingwithbiology.org



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This presentation is based on work supported by the National Science Foundation under Grant No. 0940143.
Any opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Foundation.

Questions & Discussion