70 YEARS OF CREATING TOMORROW

Los Alamos NATIONAL LABORATORY

Opportunities / Challenges / Perspectives for Careers in Materials Science and Technology

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Outline

- One Career Path example
- Science or Engineering – ?
- Which career path appeals ?
- What defines success ?
- One example of a National Lab -- LANL
- Networking – the importance / maximizing attending conferences
- Summary

Career path ? – One example

- ? Industry / University / National Labs
  - One path
    - BS, MS – South Dakota School of Mines (Metallurgical Engineering) (1976, 1977)
    - Ph.D. – Carnegie-Mellon Univ. (Metallurgical Engineering) (1981)
    - Post-Doctoral Fellowship – Technical University – Hamburg-Harburg, Germany (1982-1984)
    - Los Alamos National Laboratory
      - Technical staff member (1985-87)
      - Team Leader (1987- 2003)
      - Laboratory Fellow (2003-present)
      - Scientist 6 – (2012-present)

      Fellow (ASM International(ASM), American Physical Society(APS), and The Minerals, Metals, and Materials Society (TMS)

      • President TMS – 2010
      • Chair of Acta Materialia, Inc. (2012-present)

Science or Engineering

- "Engineering is quite different from science. Scientists try to understand nature. Engineers try to make things that do not exist in nature. Engineers stress invention. To embody an invention the engineer must put his idea in concrete terms, and design something that people can use. That something can be a device, a gadget, a material, a method, a computing program, an innovative experiment, a new solution to a problem, or an improvement on what is existing. Since a design has to be concrete, it must have its geometry, dimensions, and characteristic numbers. Almost all engineers working on new designs find that they do not have all the needed information. Most often, they are limited by insufficient scientific knowledge. Thus they study mathematics, physics, chemistry, biology and mechanics. Often they have to add to the sciences relevant to their profession. Thus engineering sciences are born."
- *Classical and Computational Solid Mechanics, YC Fung and P. Tong*. World Scientific. 2001

What Appeals ?

1. ***Science* Top 10 Questions**
2. What is the universe made of?
3. Can the laws of physics be unified?
4. How does earth's interior work?
5. Are we alone in the universe?
6. How far can we push chemical self-assembly?
7. What can replace cheap oil—and when?
8. Do deeper principles underlie quantum uncertainty and non-locality?
9. What are the limits of conventional computing?
10. How hot will the greenhouse world be?

NAE Grand Challenges for Engineering

1. Make solar energy economical.
2. Provide energy from fusion.
3. Develop carbon sequestration methods.
4. Manage the nitrogen cycle.
5. Provide access to clean water.
6. Restore and improve urban infrastructure.
7. Advance health informatics
8. Engineer better medicines.
9. Reverse-engineer the brain.
10. Prevent nuclear terror.
11. Secure cyberspace.
12. Enhance virtual reality.
13. Advance personalized learning.
14. Engineer the tools of scientific discovery.

Challenges in Materials Science and Engineering

• 10 NRC studies and workshops since 1989 dealing with Science and Engineering (status and paths forward) i.e., (MSE for the 1990's; Rising Above the Gathering Storm --- sadly MOSTLY minimal impact / ignored by Congress !

• Lack of an established U.S. materials science and engineering strategy

• Success in Japan / Germany / China – education strongly focused on engineering rather than on science – innovation driven by application of science to technology development – unsupported by Federal funding / nor the mainstream of US – MSE educational programs

• Erosion of MSE education in materials science and engineering disciplines supporting structural materials; in particular solidification, mechanical behavior, fatigue, corrosion – unsupported by Federal Funding (chicken and egg problem)

• Lack of coordinated targeted Federal Funding / Industrial thrusts to foster competitiveness of private sector

• Recognition of Excellence in Engineering / Science – Probably NOT only publications !

MSE Metrics – Probably NOT Publications

Kelly Johnson (H=1)

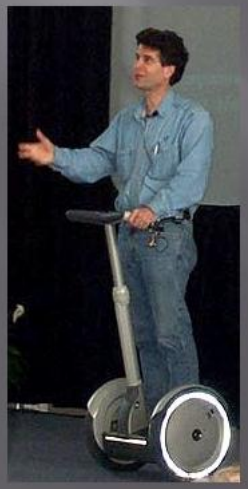
Skunk Works
SR71 Designer

Burt Rutan (H = 1)

Aviation Pioneer
Voyager Designer

Steve Jobs (H=2)

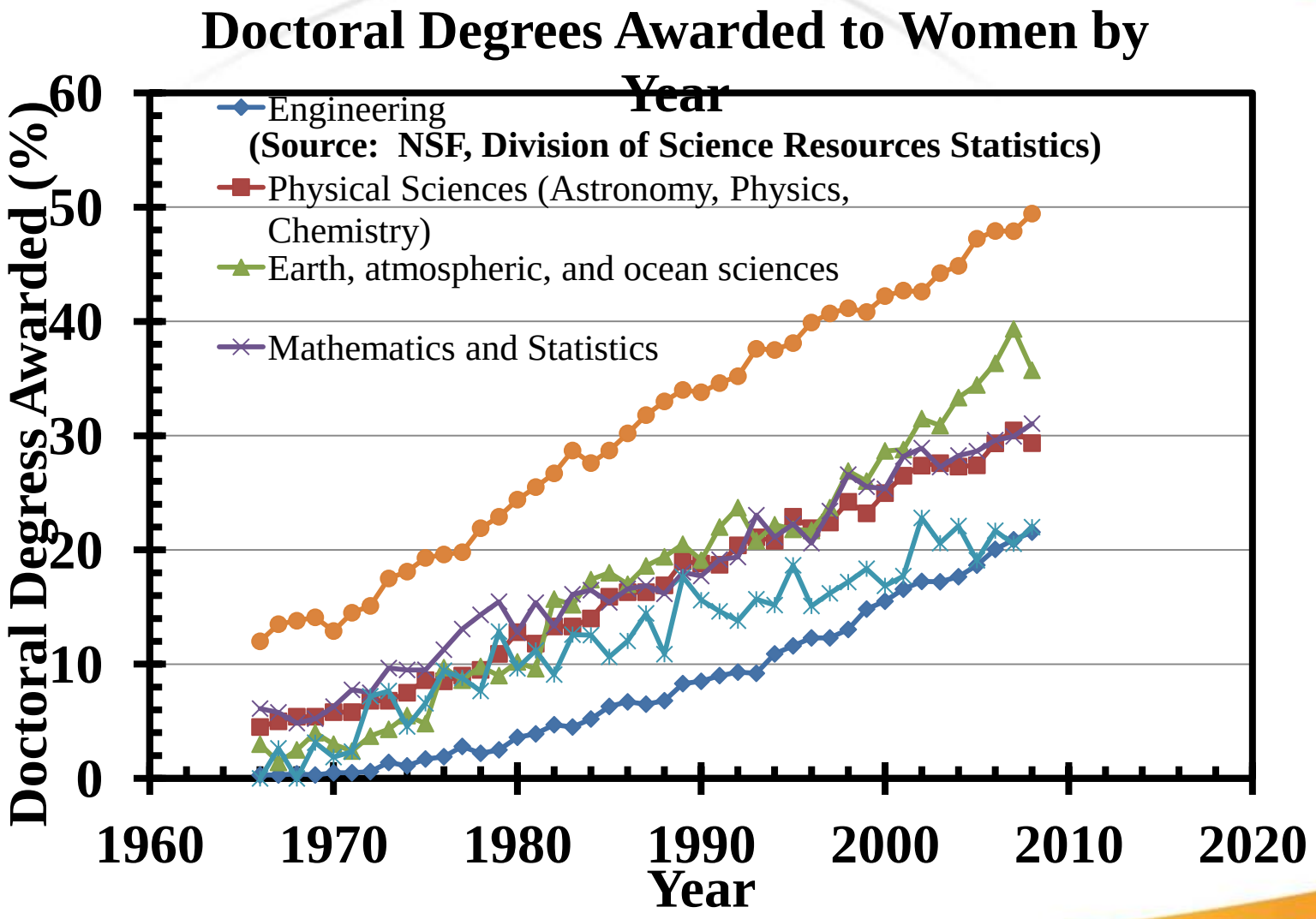
Co-founder
Apple, Inc.



Biomedical Devices
Water Purification
Segway Designer

Dean Kamen (H = 0)

The Diversity Challenge in MSE



Opportunities in Materials Science and Engineering

- Embrace the need / develop lifelong learning infrastructure / content / programs to support the lifelong learning imperative in engineering toward sustainment of American Competitiveness / Innovation in Materials Science and Engineering

- Aggressively engage with K-12 education in promoting Engineering Education as a catalyst for reforming / promoting STEM

- Promote ICME in undergraduate curriculum – in particular in connection with engineering education

  – thereafter tie ICME with Lifelong Learning Initiatives

- Curriculum – Ethics / Safety / Quality Assurance -- needed !!

MSE within the National Laboratories

- Diverse spectrum of employment opportunities spanning discovery science to applied engineering
- Products:
  - Universities – student education / research
  - Industry – products & research (some companies)
  - National Labs – fundamental /applied research & engineering
- Career options diverse:
  - national defense
  - Energy security
  - Industrial partnerships
  - Fundamental research and design
- Science / Engineering --- management

Los Alamos National Laboratory

Our mission as a DOE national security science laboratory is to develop and apply science, technology, and engineering solutions that

- Ensure the safety, security, and reliability of the US nuclear deterrent
- Reduce global threats
- Solve Energy Security and other emerging national security challenges

Our vision is to be the premier National Security Science Laboratory

People → Capability → Mission Impact

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LANL is a large, multi-program, multi-disciplinary, capability-based National Laboratory

New Missions: Global Security & Energy Security

Unique Mission

e.g., Stockpile Stewardship, Nuclear Nonproliferation

Spin-Off Innovations

- Global Climate Modeling
- Computational Co-Design
- Robotic telescopes
- Advanced Biofuels …

Special Blend of Capabilities and Facilities

- Computational Fluid Dynamics
- Proton Radiography
- Nuclear Materials & Chemistry
- Space Sciences …

Outstanding Application to Programs

- Uncertainty Quantification
- Nuclear Forensics
- Predicting Materials Properties
- Systems Biology …

Strong Partnerships: Unique external capabilities

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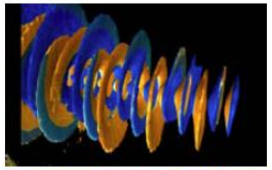
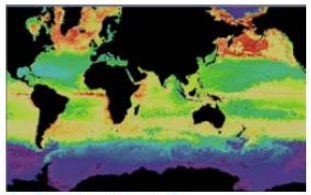
Capabilities serve Programs

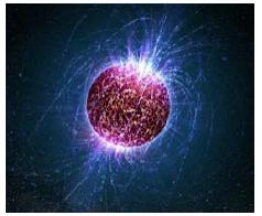


Computational Physics & Applied Mathematics

Accelerators & Electrodynamics



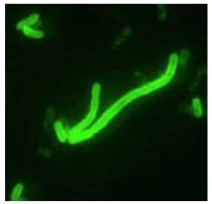
Information & Knowledge Science



Nuclear Physics, Astrophysics & Cosmology

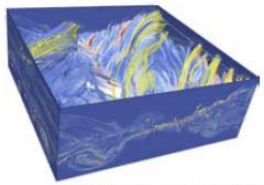
Weapons Science & Engineering

Sensors, Remote Sensing & Sensor Systems

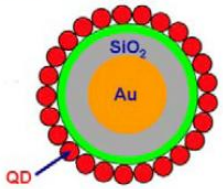


Biosciences

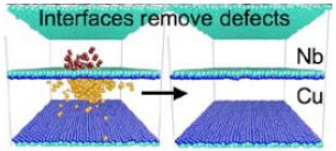
Computer & Computational Sciences



High-Energy Density Plasmas & Fluids

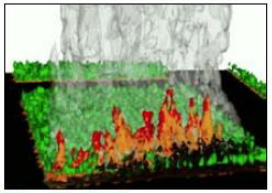


Chemical Science



Materials

Nuclear Engineering and Technology



Earth & Space Sciences

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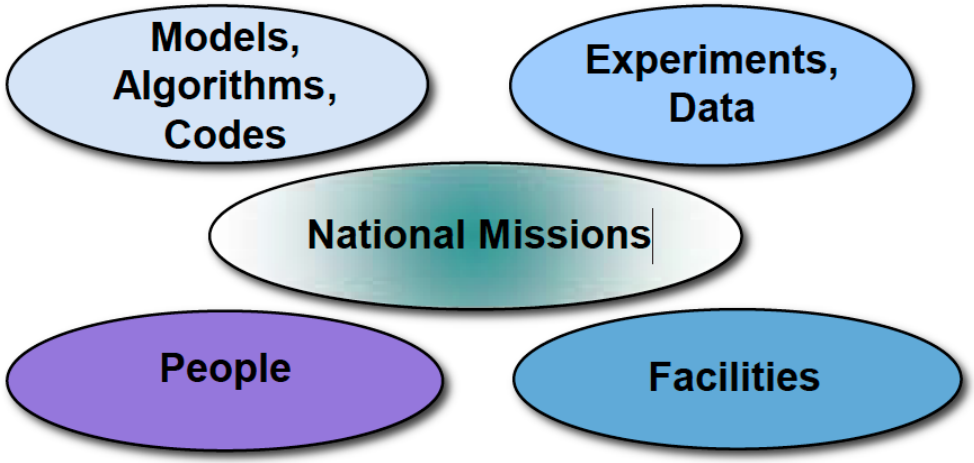
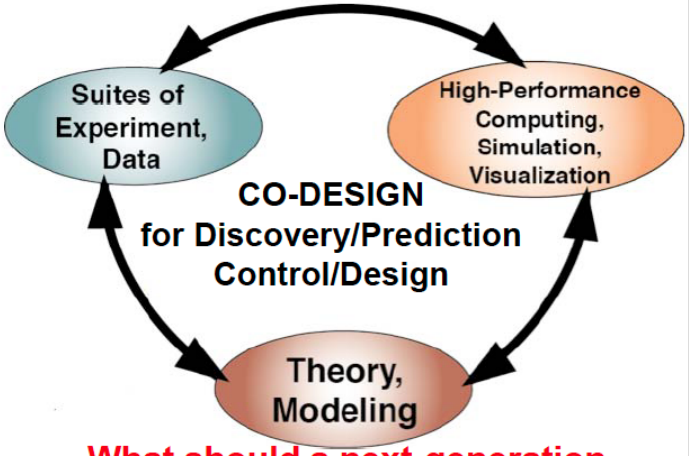
National Labs – Science and Technology: How we do business !





What should a next-generation user facility look like?

- **A new framework for transformational S,T, E at Science & Mission Frontiers**
  Integration and collaboration (DOE: EFRCs, SciDAC, Hubs, Co-Design Centers…)
  (OSTP: Adv. Manufacturing, Materials Genome…Initiatives)
- **LANL opportunities being developed: NW predictive capability framework, energy-climate, informatics, environmental management, cyber, … MaRIE**

DOE (SC, NNSA, App. Energy) has a full spectrum of assets for this future

Integrating National Assets for Discovery, Prediction, Control, Design

Networking – Why?

- People network for a variety of reasons, and knowing their reasons is important to have a useful exchange.
  - Jobs (both ways – seeking or hiring)
  - Programs
  - Information
  - Lobbying
  - Social (future interactions, visibility)

Networking – What are your goals?

- Short term goals?
- Medium range goals?
- Long term goals?

How will your environment help you achieve any of these goals?!!!! *(Otherwise, you are wasting your time.)*

In other words, build your resume…

Networking – Where do you go?

- Local Chapters!!!!
  - Student
  - City (ASM, TMS, AIST, AWS, ACerS, etc.)
- Workshops (very specific)
- Meetings
  - Give presentations, posters!
  - Go to committee meetings – get involved
  - Go to all functions
  - Go out!

Networking – Who do you talk to?

- Figure it out before you arrive
- Keep an open mind
- Look for the win-win situations
- Take advantage of now (not later)
- Have proposals/ideas of your own!!!

Networking – How to do it…?

- What to do (have fun!)
  - Be prepared (do your homework)
  - Be inquisitive
  - Follow-up (if positive – e-mail)
  - Be confident (but respectful and enthusiastic)
  - Be involved!!!!!
- What not to do
  - Do not beg
  - Do not be nervous
  - Do not be negative

Summary

- Is is science or engineering that you want ?
- National Laboratories offer exciting opportunities in science and engineering career paths
- Technical meetings offer MANY networking opportunities – Get the most from your attendance !