



Fostering Materials Science: a Comparison between Germany and the US

Cynthia A. Volkert
Institut für Materialphysik
University of Göttingen

Abstract

- This presentation aims to identify new possibilities for fostering materials science in Germany by comparing current practices in Germany and the USA.
- Statistics and anecdotes, covering several aspects of materials science, will be used to illustrate the differences and similarities between the two countries.
- This comparison may help to identify opportunities and threats for the future of the field.



Statistics: Germany/EU and USA

- "There are three kinds of lies: lies, damned lies, and statistics." – attributed by Mark Twain to Benjamin Disraeli
- Demographics: number of researchers, funding
- University Structure
- Conferences and Professional Societies



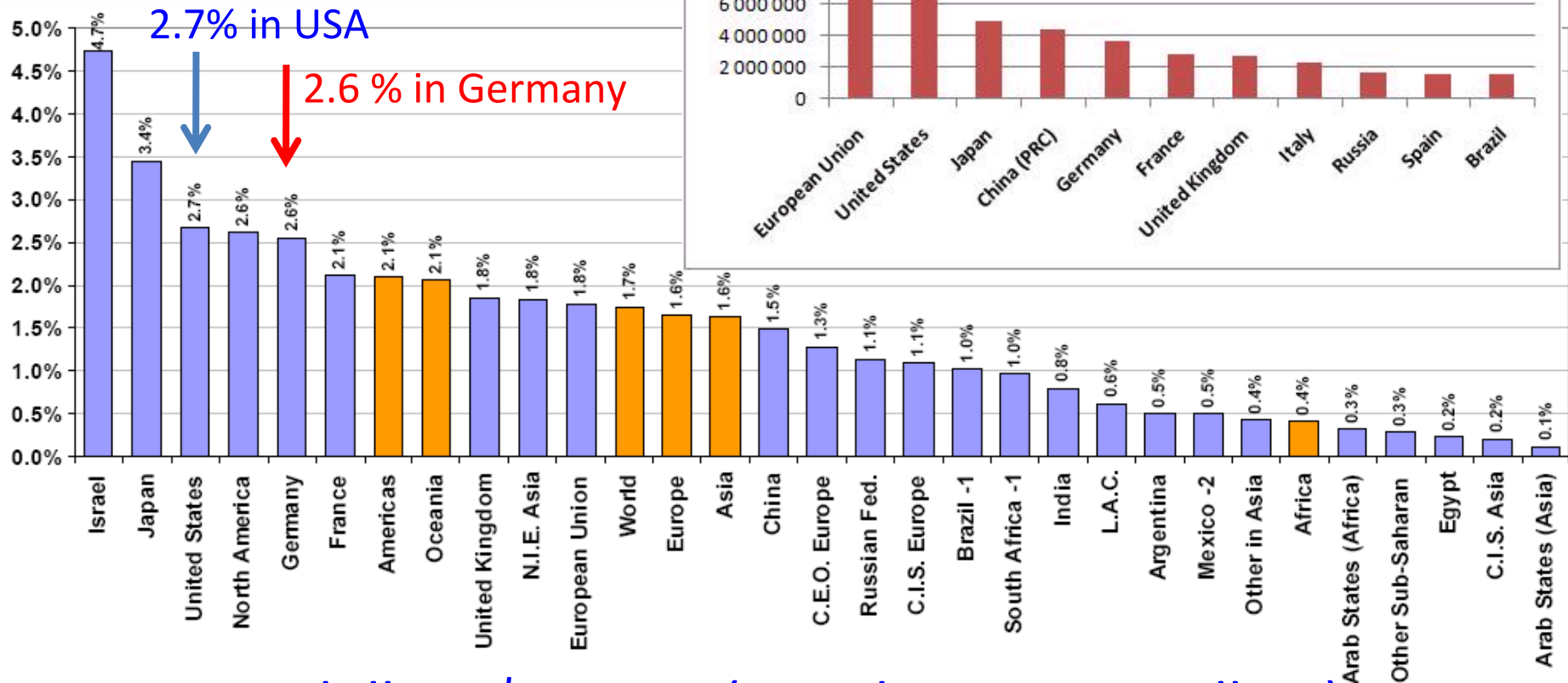
Demographics

- How much funding is available for research and development?
- How “successful” (measured by publications) is the research funding?
- How many people are doing research in Germany, the EU and the US?
- Sources:
 - OECD Science, Technology and Industry Outlook 2008
 - OECD Science, Technology and Industry Scoreboard 2009
 - UNESCO Institute for Statistics estimates, September 2009
 - Wikipedia



Support

Gross domestic expenditure



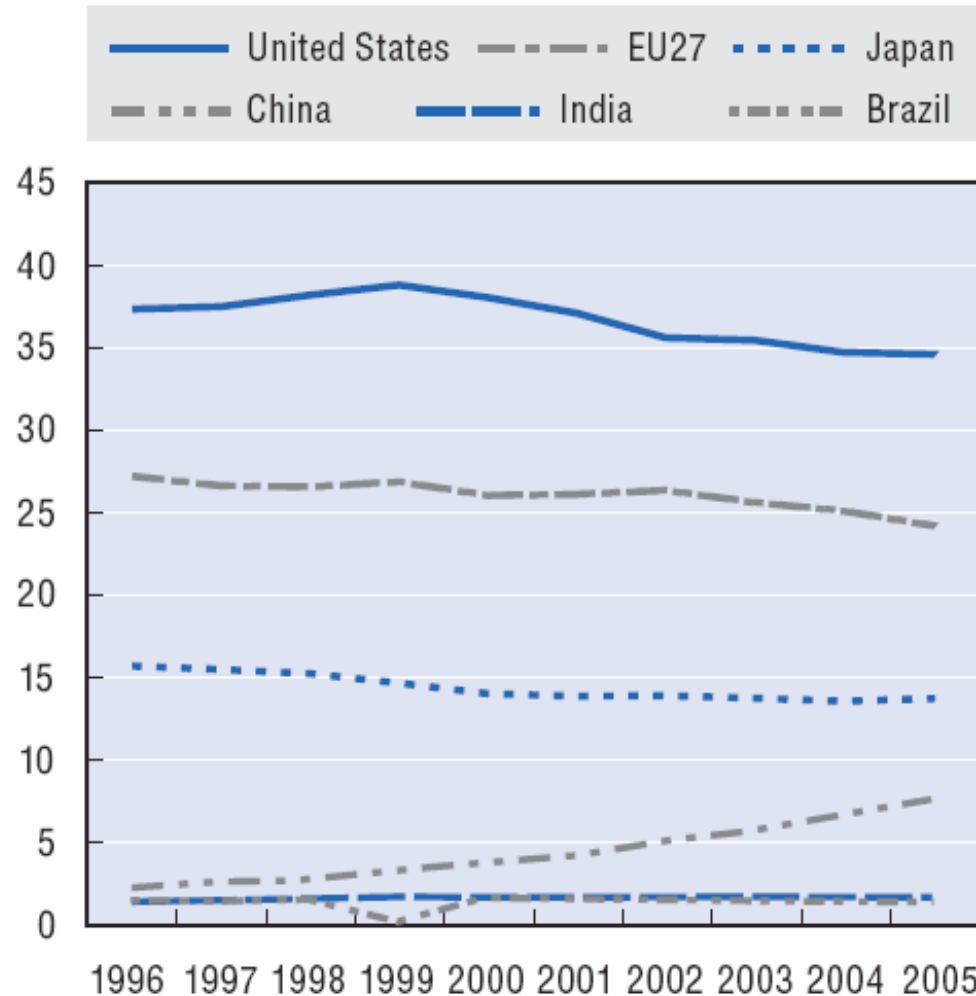
385 billion \$ in USA (population 310 million)

87 billion \$ in Germany (population 81 million)



Support for R&D

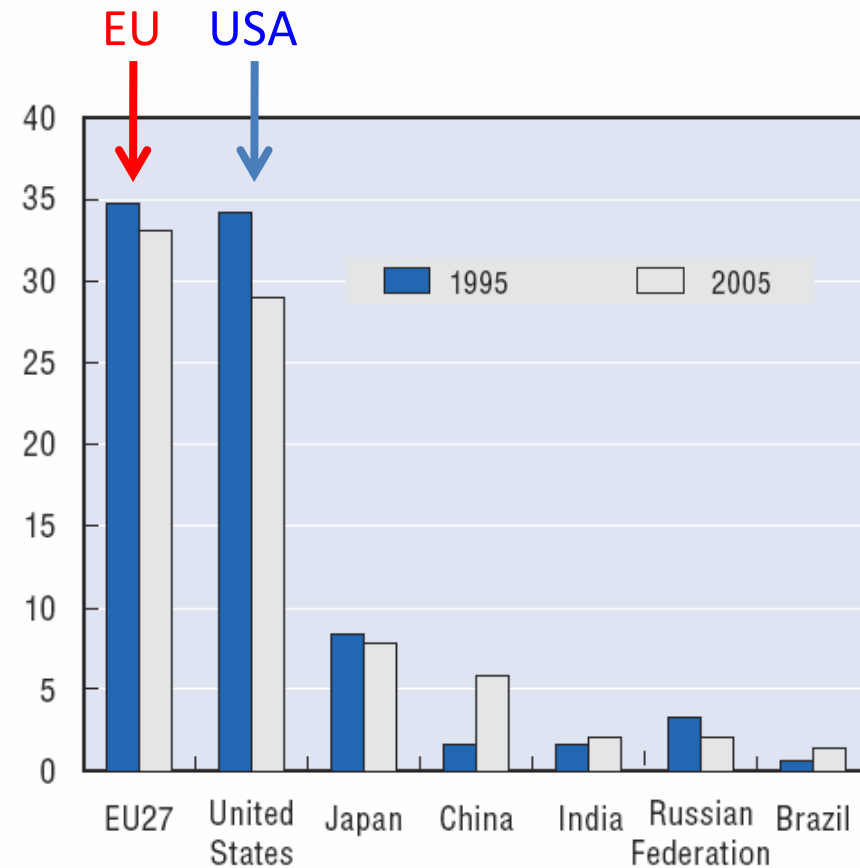
Evolution of global share of total R&D, 1996-2005
Percentage share



- Germany and the US invest a similar percentage of their GDP in R&D, but the US dominates because of size.
- Gross Domestic Product (GDP) = Bruttoinlandsprodukt

How we use the research funds...

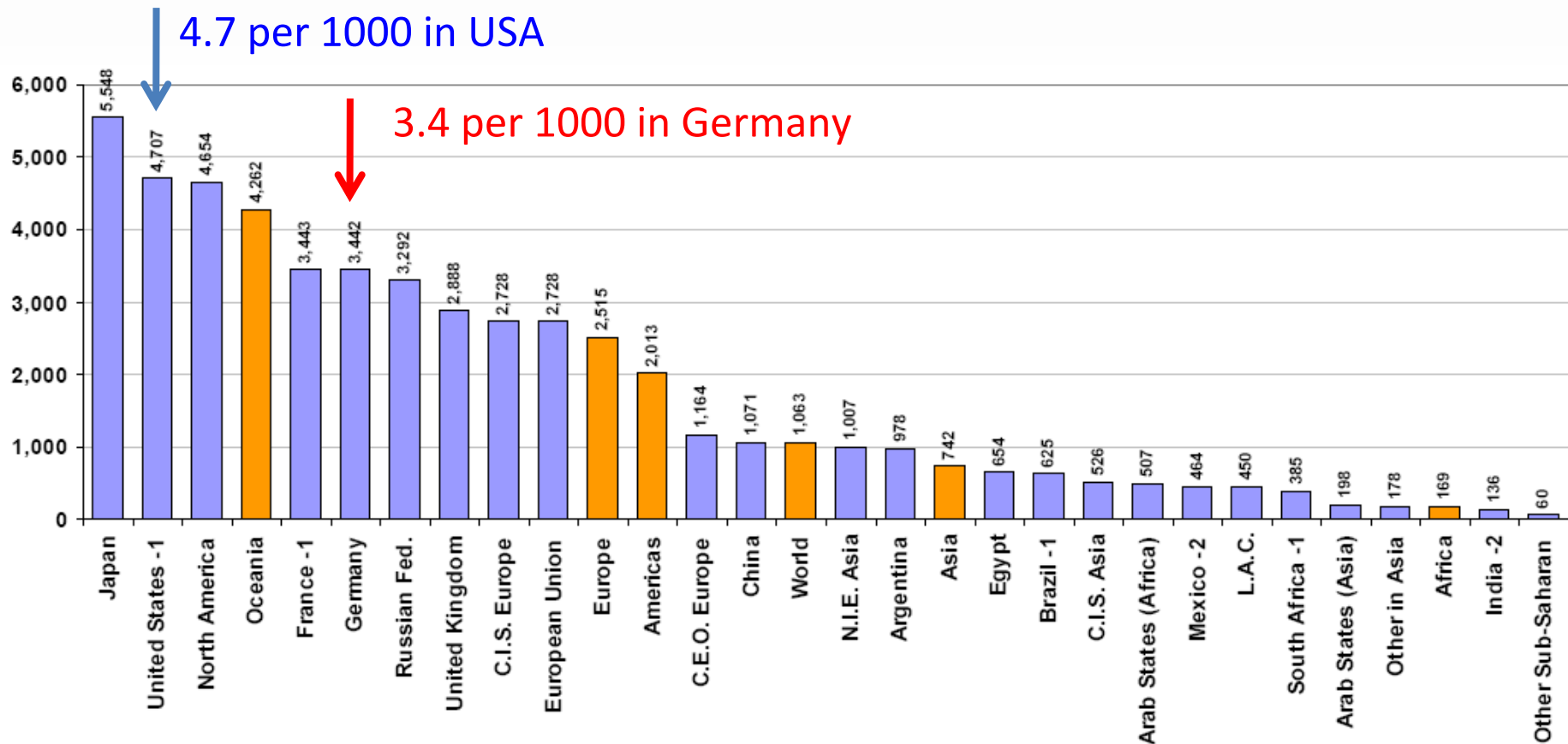
- Despite having a smaller global share of research funding (25% EU vs 35% US), the EU keeps up in publishing.



Global share of scientific publications, 1996 and 2005
Percentage share

Who is writing all of the papers?

Researchers per million inhabitants



14.6 million researchers in USA

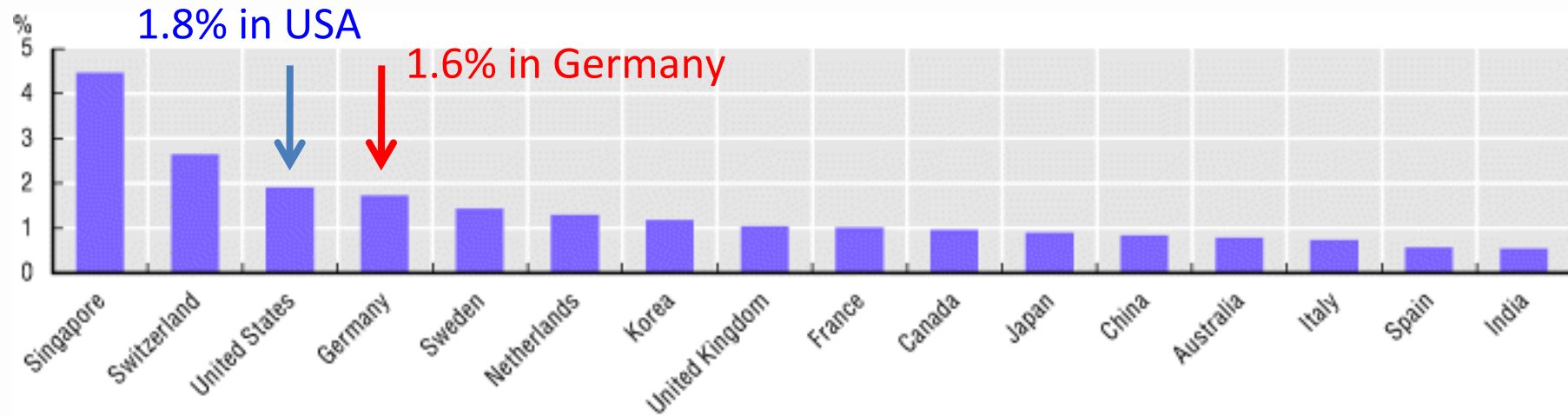
2.8 million researchers in Germany



Publications in MS&E

As measured by publications in Nanotechnology

Ratio of the country's share in nanomaterials articles to its share in all fields:

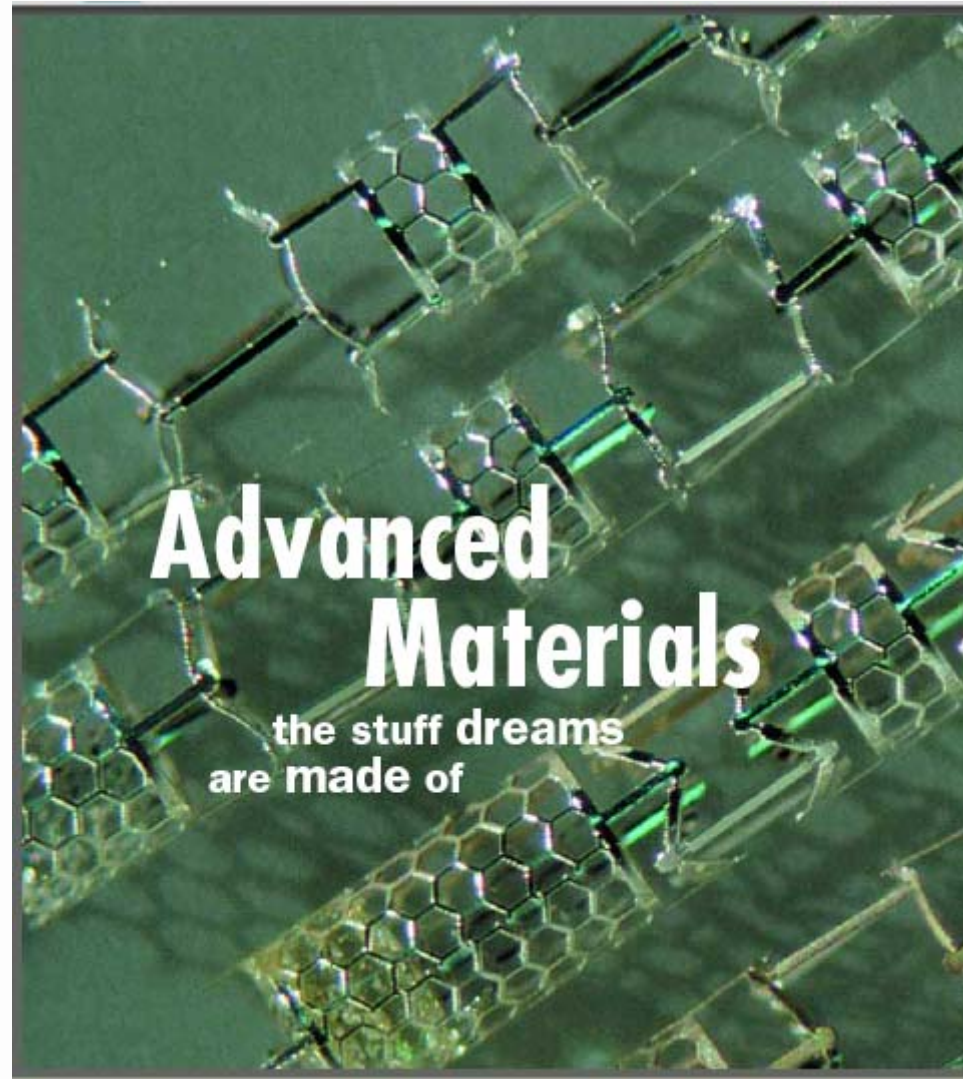


Funding Sources and Initiatives

- **Germany**
 - DFG
 - BMBF
 - BMWI
 - EU/ERC
 - Bundesländer
 - Foundations
 - ...
 - Excellence Program
 - Lots of smaller initiatives
 - ...
- **USA**
 - NSF
 - DOE
 - DOD
 - NIST
 - NASA
 - NIH
 - ...
 - MRSEC
 - NNI
 - EFRC ...

USA MRSECs

- NSF funded “Materials Research Science and Engineering Centers” (MRSECs)
- Program started in the 1980s
- Currently 31 centers in the USA.
- Have helped to identify materials as a strategic and important topic in USA.



NSF Publication, 2005

First Impressions

- Commitment to MS&E is evident in both countries.
- An MS&E researcher in Germany experiences the same demographics and same overall funding possibilities as in the USA. However, there are ca. 5 times as many MS&E researchers in the USA.
- USA funding sources and initiatives are more centralized; this influences the type of funding that is available.
- Materials have been officially recognized as a strategic topic earlier and more openly in the USA.

University Structure

- University structure influences how we define and categorize a field
- Resources:
 - **Germany:** DGM Schoolpool (www.materials-schoolpool.org) or Studentag Materialwissenschaft und Werkstofftechnik (www.stmw.de).
 - **USA:** University Materials Council (umatcon.org).
- Extremely diverse landscape in both countries: In Germany it is complicated by the co-existence of Bachelors/Masters and Diplom programs.



University Programs in MS&E

- **Germany - 37 Universities**
- 23 independent programs
- 9 together with “Maschinenbau”
- 4 together with “Wirtschaftsingenieurwesen”
- 2 together with “Produktionstechnik”
- 4 together with “Physik”
- 1 together with “Chemie”
- **USA - 99 Universities**
- 44 “Materials Science and Engineering”
- 14 together with Chemical (and Biomedical) Engineering
- 11 together with Metallurgy or Mining Engineering
- 10 “Materials Engineering” only.
- 8 together with Mechanical Engineering



How do you translate “Materials Science and Engineering”?

Materialwissenschaft und Werkstofftechnik (x3)	Materialphysik
Materialwissenschaft (x8)	Materialchemie
Werkstoffwissenschaft (x4)	Automotive Components, Engineering and Mechatronics
Werkstofftechnik (x5)	Keramik-, Glas- und Baustofftechnik
Werkstoffinformatik	Fahrzeugbau: Werkstoffe und Komponenten
Werkstoffingenieurwesen	Elektronik- und Sensormaterialien
Werkstoffwissenschaft und Werkstofftechnologie	Gießereitechnik
Materials Science and Engineering (x2)	Leichtbau- und Kunststofftechnik
Advanced Materials	Computational Engineering of Technical Systems
Computational Materials Science	Baustoffingenieur
Materials Science and Applied Mechanics	Material- und Fertigungstechnologie
Metallurgical Engineering	Neue Materialien
Chimie, Polymeres et Materiaux	Nano- und Produktionstechnik
Metallurgie und Werkstofftechnik	Kunststoff- und Werkstofftechnik
Engineering Science	Dentaltechnologie und Metallurgie

Second Impressions

- University programs in Germany in “MS&E”
 - Are more diverse
 - Show less clear identification with the broadly defined field of MS&E
 - Have fewer institutionalized combinations of “science” and “engineering”.



Professional Societies

- Fall into three categories
 - Broad-based MS&E (USA: ASM, TMS, MRS)
 - Specialized in area of MS&E (USA: Acers, SAMPE, Society for Biomaterials, SPE, AIST...)
 - Including aspects of MS&E (USA: APS, ACS, AVS, OSA, SPIE, IEEE, ASME...)
- As an example of how these societies serve the MS&E community, consider conferences.
- Broad-based MS&E conferences build broad-based communities of materials researchers.



Broad-based MS&E Conferences

- **Germany and Europe**
- EuroMat
- MSE
- E-MRS

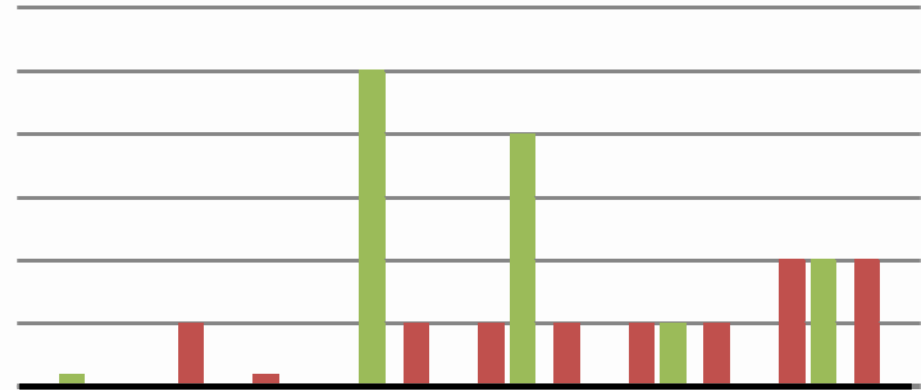


- **USA**
- MRS Spring and Fall
- TMS Annual
- MS&T

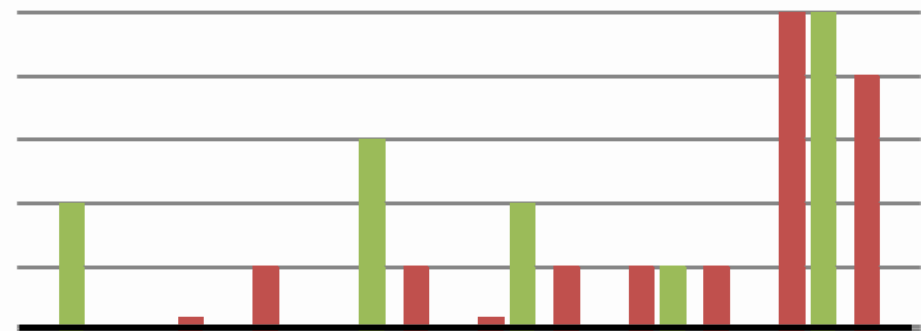


Cutting-edge topics

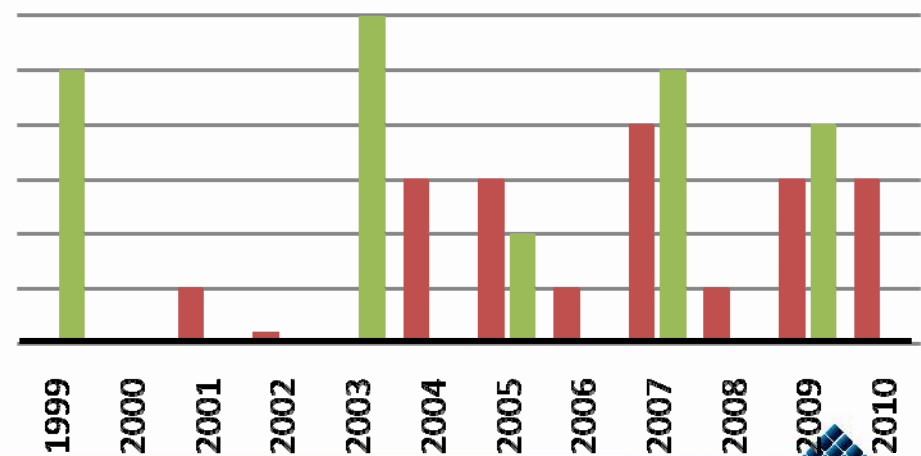
Biomaterials



Alternative Energy Materials



Nanomaterials



TMS

Euromat

Third Impressions

- Both US and German professional societies are serving the MS&E communities similarly.
- My prejudice, that new topics are taken up more quickly in the USA than in Germany is not supported.
- Nonetheless, hypothesize that there is a style difference: “Home vs House”
 - German societies and conferences more strongly support identification with a profession (e.g. DPG) = “Home”
 - US societies and conferences tend towards including basic and applied science and engineering that help to find the “right material for the job” = “House”



Summary

- Germany is comparable to the USA in overall funding and publications per MS&E researcher.
- However,
 - The USA has identified and promoted Materials Science and Materials Engineering as a single entity longer and more persuasively than Germany.
 - MS&E is identified both as a topical area (university departments) and as a funding area (MRSECs).
- Hypothesis: German conferences and societies tend to provide a professional “home” more than they provide a “house” for solving a problem.

