



CA**PER**

Center for Advanced Power Engineering Research

Challenges imposed by University Research Requirements

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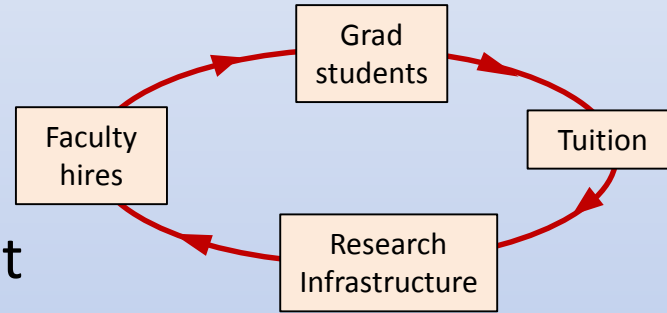
University of North Carolina at Charlotte

Outline

- Why research in academia?
- Carnegie categories
- Characteristics of top ranked institutions known for teaching excellence
- Characteristics of top ranked institutions known for research excellence
- Research expenditures
- Research at state vs. private schools
- Why do faculty candidates desire tenure-track positions?
- Does research really create a challenge in educating engineers?

Why Research in Academia?

- Advanced degrees
- Externally sponsored program
- Helps pad the university's budget
- Helps attract some of the best and brightest minds —students, faculty or staff — from around the country and the world
- Helps fund the development of research labs
- Helps the university get universal recognition
- **And, because research \$ are there for the taking!**



Carnegie Categories



- Doctoral Universities
 - Includes institutions that awarded at least 20 research/scholarship doctoral degrees during a year
- R1: Doctoral Universities – Highest Research Activity
 - **Clemson University**
 - Duke University
 - Georgia Tech
 - Florida State Univ.
 - **North Carolina State University**
 - Univ. of Tennessee
 - University of Central Florida
 - University of South Carolina-Columbia
 - Virginia Tech



Carnegie Categories



- R2: Doctoral Universities – Higher Research Activity
 - Auburn University
 - North Carolina A & T State University
 - **University of North Carolina at Charlotte**
- R3: Doctoral Universities – Moderate Research Activity
 - Idaho State University
 - Middle Tennessee State University

Carnegie Categories



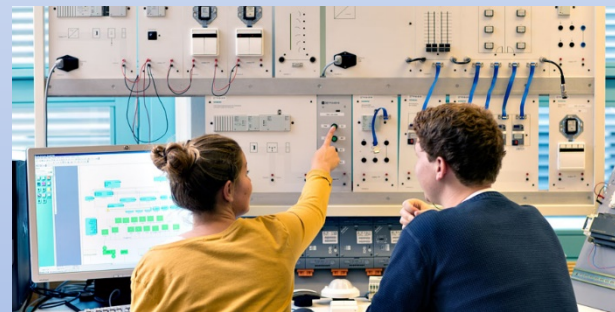
Other classes

- Master's Colleges and Universities
- Baccalaureate Colleges
- Baccalaureate/Associate's Colleges
- Associate's Colleges
- Special Focus Institutions
 - Two-Year
 - Four-Year
- Tribal Colleges

Characteristics of Institutions Known for Teaching Excellence

These tend to be schools:

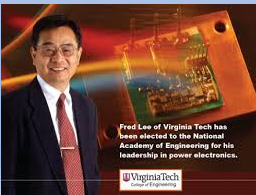
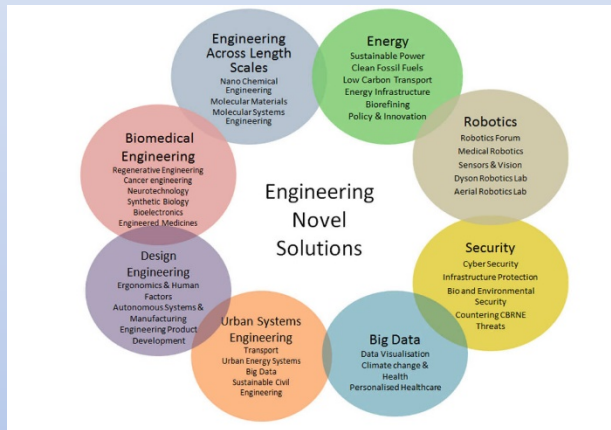
- that are generally **small**
- that are mostly **private**
- with low student to faculty ratios
- with acclaimed instructors
- with high admissions standards
- with innovative curriculum (e.g. projects based)
- where research is encouraged, but not required



Characteristics of Institutions Known for Research Excellence

These tend to be schools:

- with large student bodies
- that are Public/Private
- which have acclaimed researchers; Nobel laureates; NAE, NAS members
- with high admissions standards
- with high research expenditures



Characteristics of Institutions Known for Research Excellence, cont'd.

- Generally have large centers of excellence
 - Diverse group of faculty are members
 - A number of universities are partners
 - Funding from federal and industry sources
 - Most centers have an educational piece



University Research Expenditure

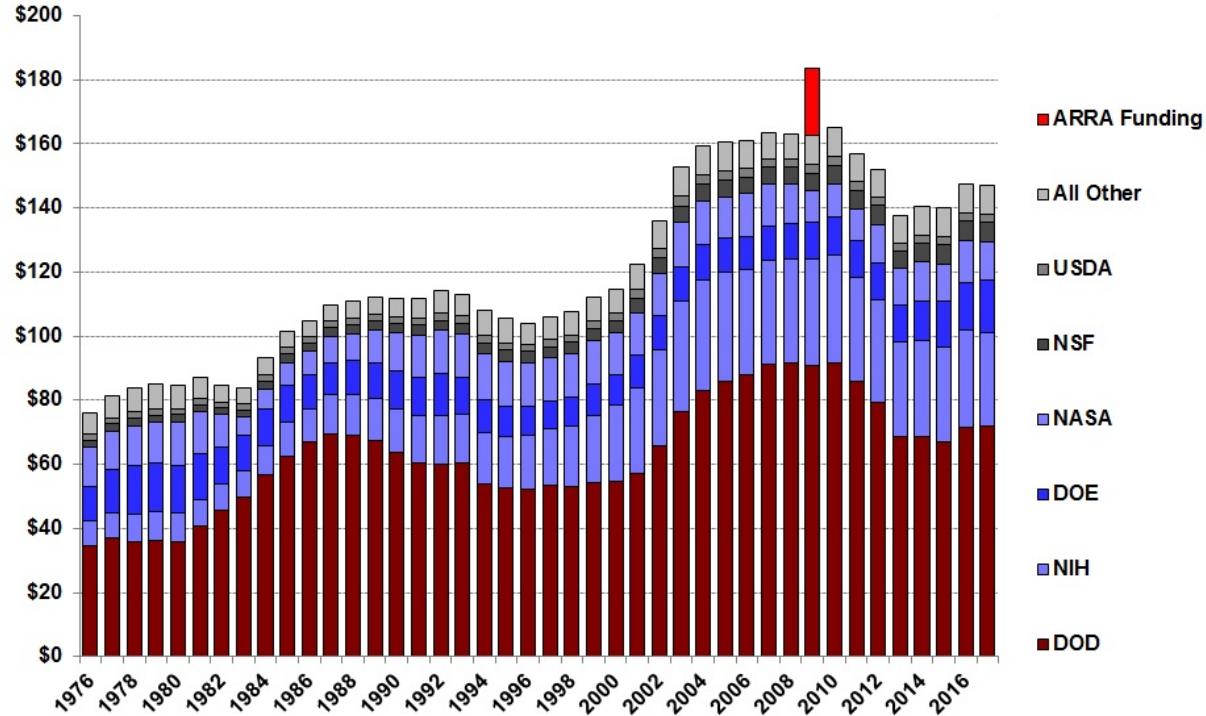
29% of federal R&D money goes to universities

Federal agencies that fund academic research

- National Science Foundation (NSF): \$7.6B
- Department of Defense (DoD): \$4B
 - Air Force
 - Army
 - Navy
 - DARPA, etc.
- National Inst. of Health (NIH): \$26B
- Department of Energy (DOE): \$2 ~ 4B
 - SC, EERE, FE, NE, ARPA-E, etc.

Trends in R&D by Agency

in billions of constant FY 2016 dollars

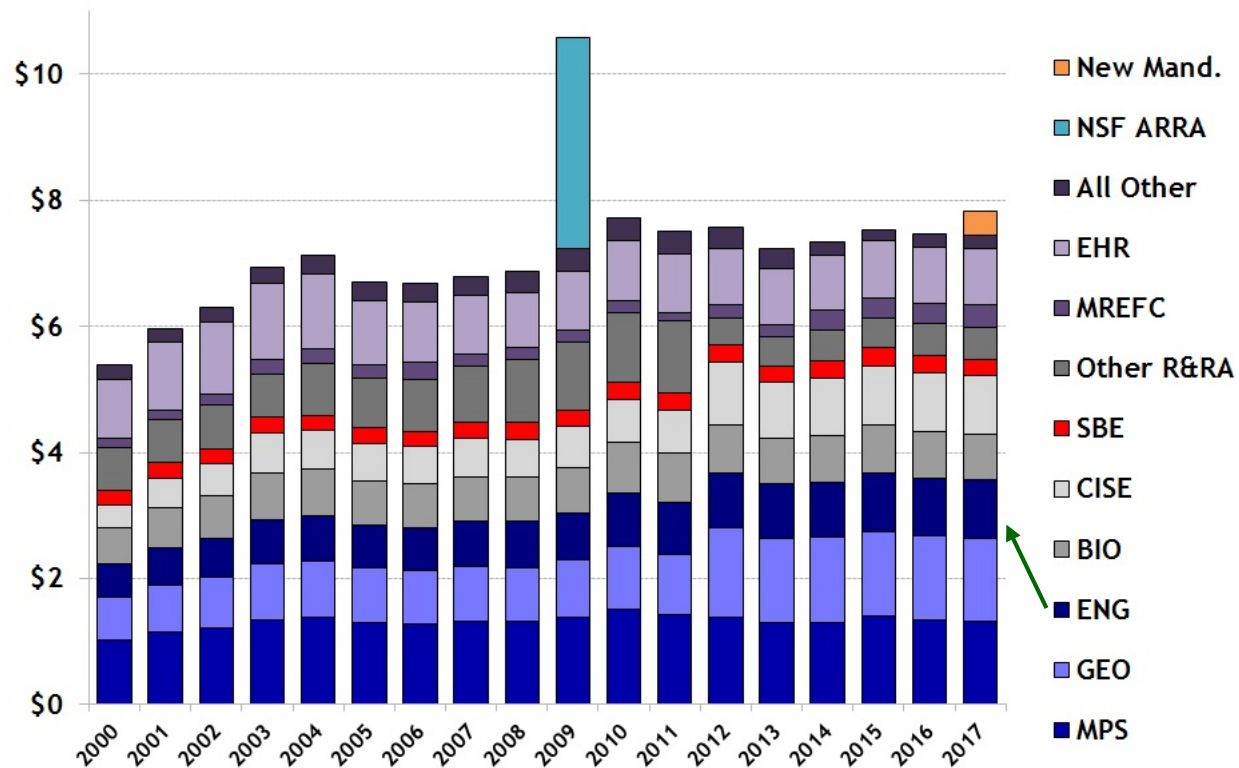


Source: AAAS Report: *Research & Development* series and analyses of FY 2017 budget request. 1976-1994 figures are NSF data on obligations in the Federal Funds survey. © 2016 AAAS

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National Science Foundation Budget

Budget Authority in billions of constant FY 2016 dollars



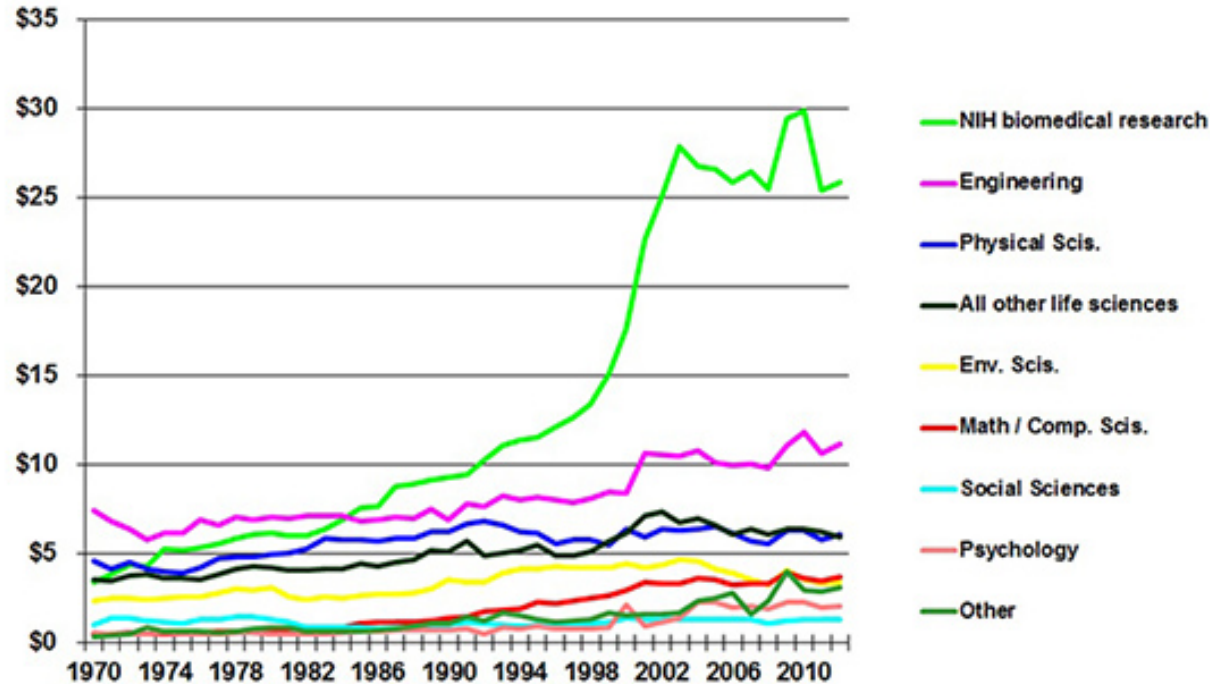
Source: NSF budget requests and AAAS R&D report series. FY 2016 figures are estimates, FY 2017 is the request. © 2016 AAAS

FY 2017 NSF Budget is \$8B

Almost exclusively for university research

Trends in Federal Research by Discipline, FY 1970-2012

obligations in billions of constant FY 2014 dollars



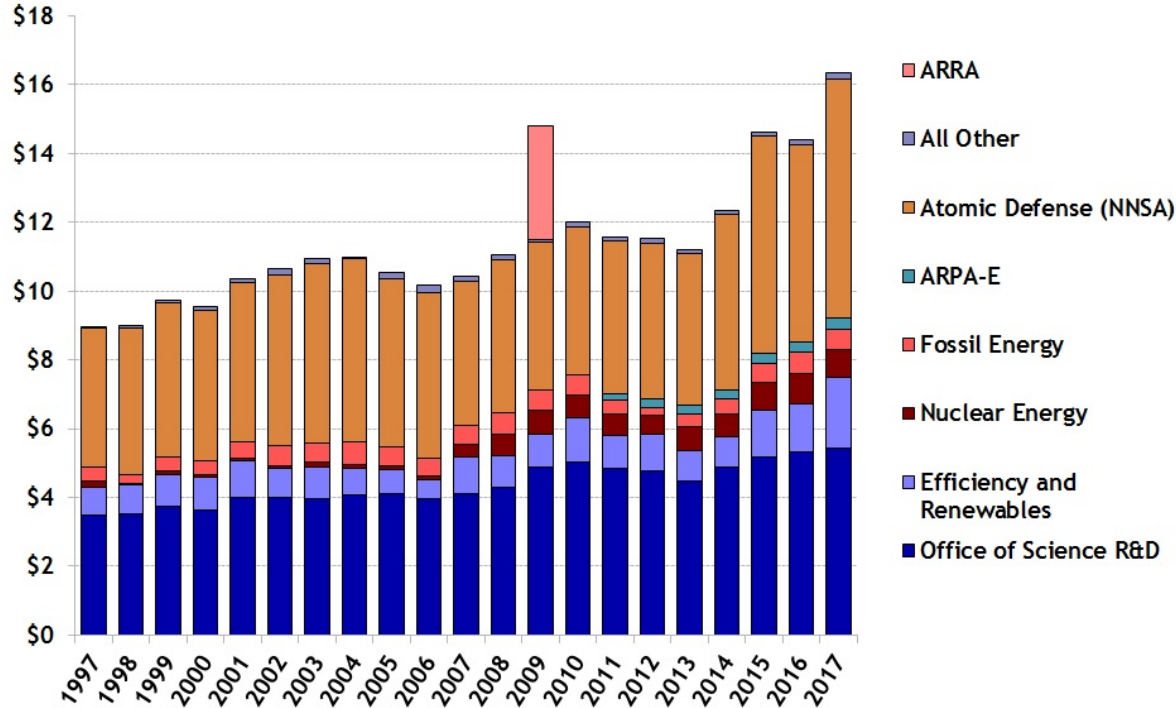
"Other" includes research not classified. Life sciences are split into NIH support and other agencies' support.

Source: National Science Foundation, *Federal Funds for R&D* series. FY 2011 and 2012 are preliminary. Includes Recovery Act funding beginning in FY09. Constant-dollar conversions based on OMB's GDP deflators. © 2014 AAAS

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Trends in DOE R&D, FY 1997-2017

in billions of constant FY 2016 dollars

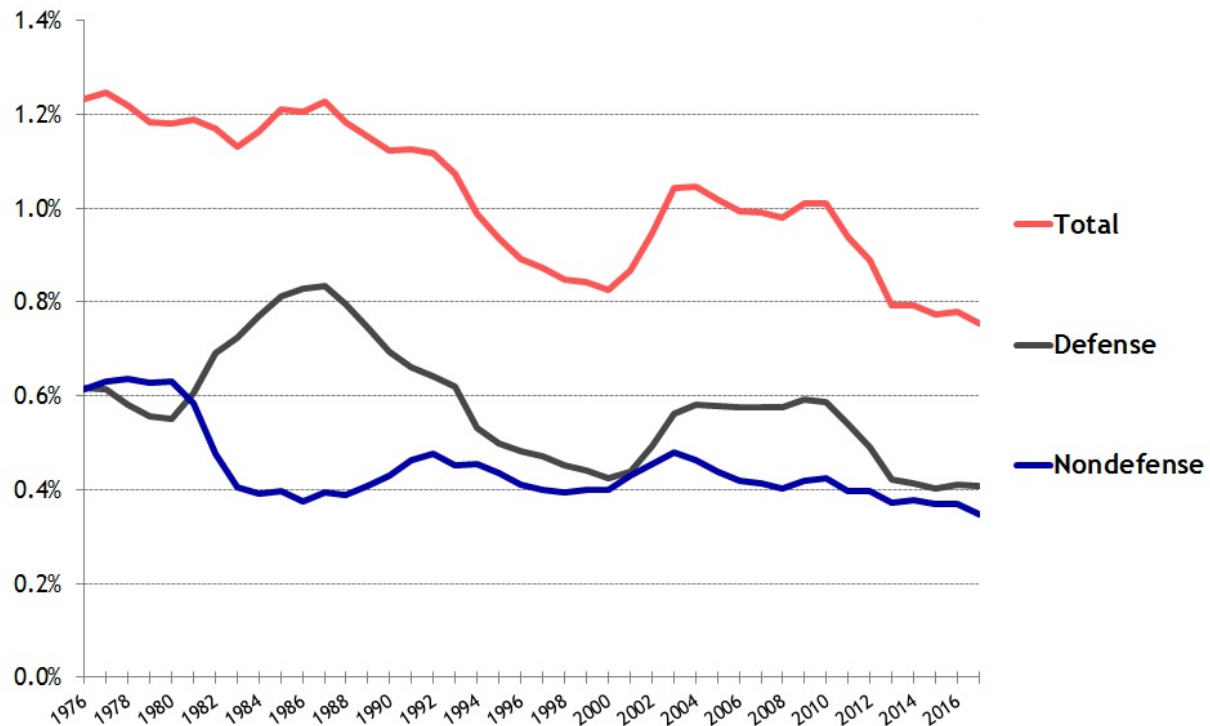


Source: Past AAAS R&D reports, OMB and agency budget documents, and appropriations documents. R&D includes conduct of R&D and R&D facilities. FY 2017 is the President's request. © 2016 AAAS

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Trends in Federal R&D

As a percent of GDP



Source: AAAS analyses of historical budget and agency data and the FY 2017 request. GDP figures from OMB. R&D includes conduct and facilities. © AAAS

Research Expenditure Rank

University	Rank	Expenditure (\$M)
Johns Hopkins University	1	2305.7
University of Michigan, Ann Arbor	2	1369.3
University of Washington, Seattle	3	1180.6
University of California, San Francisco	4	1126.6
University of California, San Diego	5	1101.5
University of Wisconsin-Madison	6	1069.1
Duke University	7	1036.7
Stanford University	8	1022.5
University of California, Los Angeles	9	1021.2
Harvard University	10	1013.7
Univ. of North Carolina at Chapel Hill	11	966.8
Cornell University	12	954.4
Massachusetts Institute of Technology	13	930.7
Georgia Institute of Technology	24	765.4
North Carolina State University	47	468.3
Clemson University	114	171.2
Univ. of North Carolina at Charlotte	245	24.9

Six of the top ten spenders are public universities

Private R1 Doctoral Universities

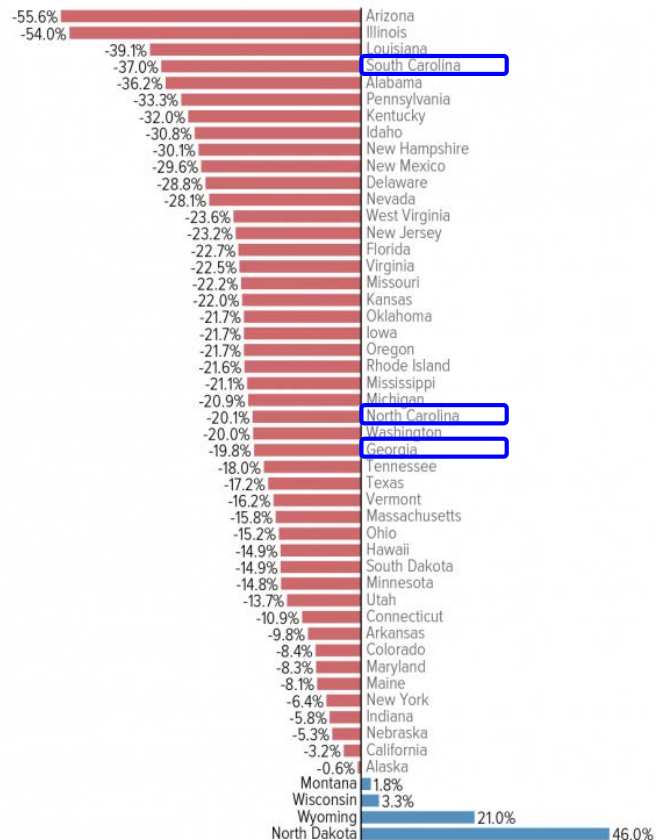
- Expect their faculty to be research active
- Large graduate student body
- A large percentage of undergrad students opt for graduate school
- Examples: Stanford, MIT, Northwestern, Duke, Cornell

Public R1 Doctoral Universities

- Does it make sense for state universities to require research?
- Examples: Arizona State, Univ. of Wisconsin, Univ. of Michigan, Univ. of Illinois at Urbana-Champaign, Texas A&M Univ., etc. are research intensive state universities
 - Some have strong power programs
 - A large percentage of students accepts job offers after graduation

State Funding for Higher Education Remains Far Below Pre-Recession Levels in Most States

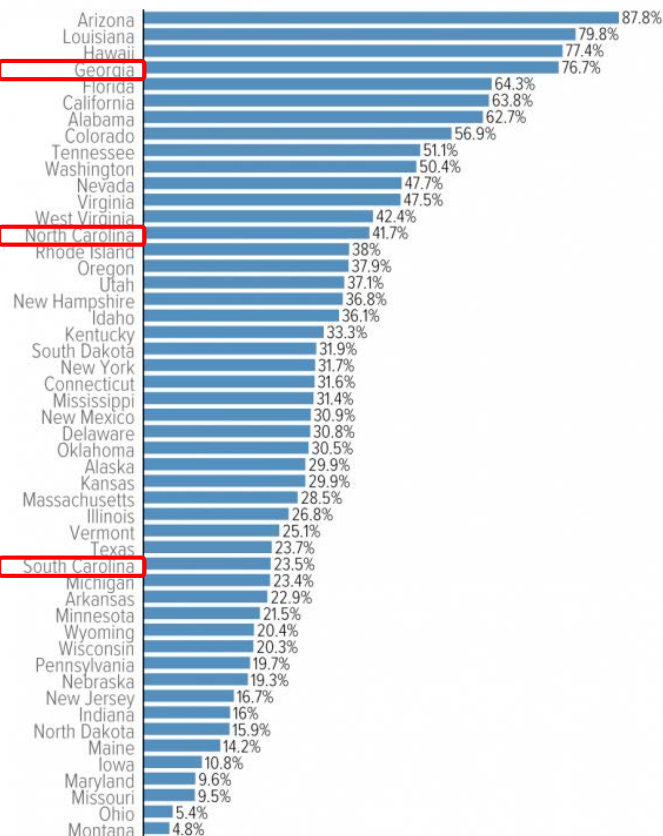
Percent change in state spending per student, inflation adjusted, 2008-2016



State of Public Doctoral Universities

Tuition Has Increased Sharply at Public Colleges and Universities

Percent change in average tuition at public, four-year colleges, inflation adjusted, 2008 - 2016



Public Doctoral Universities – A Dilemma

- In June 2016, Scott Walker – Governor of Wisconsin proposed \$250M cut from Wisconsin's higher education
- He wanted **academic research** and faculty **tenure** to end because neither was useful.
- Replace the university's mission to “**search for truth**” and “**improve the human condition**” with “**meet the state's workforce needs.**”

Public Universities – Pros of Acad. Research

- Many technological advances have been made thanks to university research
 - what kind of diseases to treat; what kind of drugs to invent (or make obsolete); how to monitor and control power flows, etc.
- Undergraduate students get to experience world class research

Public Universities – Cons of Acad. Research

- Faculty cannot devote to full-time teaching
 - Buying out from courses
- Hiring cost goes up
 - Retaining eminent researchers
- State legislatures don't understand the value of research
 - They often wonder why those "obnoxious hoity-toity professors" think they deserve better than other state employees.

Universities with Strong Undergrad Degrees

- Rose Hullman, Harvey-Mudd, Franklin W. Olin College of Engineering, Cal Poly San Luis Obispo
 - Most do not offer advanced degrees
 - Low student to faculty ratios
 - Almost all courses are at the UG level
- Research is not a strong suit, but encouraged to keep faculty abreast of latest developments in technology.
- Faculty primarily teach classes and conduct labs; hands-on lab experience is a major part of undergrad education.
- Faculty hired based on their passion for teaching and mentoring undergraduate students

Universities That Offer Both Bachelor's and Advanced Degrees

- NCSU, CU, UNCC, etc.
 - Courses are at both undergraduate and graduate level
 - Graduate upper level - complex interdisciplinary courses - needs research active faculty
 - May include tenure track faculty, research only faculty, teaching only faculty
 - Large percentage of students accept jobs after graduation
 - Some go on to grad school
 - Faculty hired based on a balanced portfolio of research and teaching

Why do Faculty Candidates Desire Tenure Track (TT) Research Positions

- New PhDs want to continue to work in their area of expertise; mentor new PhDs
- TT faculty face pressure to produce scholarly products and grants
- In some places, TT faculty have to bring 80% of their salary from extramural sources
- Tenure cases require sponsored research portfolio
 - What is the minimum?
- Tenure cases require scholarly publications
 - What is the minimum?
- TT research faculty make some of the best teachers. Why?

So, Does Research Create a Challenge in Educating Engineers?

- Depends on who is answering the question
 - Faculty and administration: NO
 - Students and parents: YES or INDIFFERENT
 - Legislature: YES
 - Employer: GENERALLY NO