STEM, Immigration, and Controversy: Does the U.S. have enough STEM Workers?

MICHAEL S. TEITELBAUM
LABOR AND WORKLIFE PROGRAM
HARVARD LAW SCHOOL
TEITELBAUM@SLOAN.ORG

THE PROVOST’S FORUMS ON THE PUBLIC UNIVERSITY AND THE SOCIAL GOOD

UNIVERSITY OF CALIFORNIA AT DAVIS

OCTOBER 9, 2014
Influential omens of US insufficiency

- “...In the race for the future, America is in danger of falling behind...our generation’s Sputnik moment is back.” - *President Barack Obama, Dec 6, 2010*

- “deep concern about the United States’ ability to maintain its scientific and technological superiority through this decade and beyond.” - *Business Roundtable, Tapping America’s Potential, 2005*

- “A quiet crisis”, “a disturbing mosaic”...suggest that US will be unable to compete in a globalizing world. *National Academies, Rising Above the Gathering Storm, 2007*
Not new: long history of “alarm/boom/bust”

- **Recurrent sequences:**
  - Alarm | Boom (R&D/education/visa) | Bust

- **Round 1: post-WW II – 1957**
  - Cold War support boom for physics (DoD, AEC)

- **Round 2: 1957-1970s - post-Sputnik**
  - NASA, Apollo program, NDEA, NSF budget increases
    - Apollo: Huge allocation of $, and of S&E talent

- **Round 3: 1981-early 1990s**
  - DoD buildup; “Nation at Risk”; “shortfall” projections (NSF/PRA)

  - Booms in IT, internet, telecom, biotech; H-1B tripled; then busts 2001

- **Round 5: 1998-2008**
  - NIH “funding crisis”, doubled 1998-2003; then flat budget=“funding crisis”

- **Are we now in Round 6?**
There are many ways to fall behind

1. Education
   - K-12 weak?
   - S&E grads too few?

2. Research (basic & applied)

3. Workforce shortages that impede innovation

Michael S. Teitelbaum
1. Education

- Here is what everyone knows...
- “STEM” shortages due to failing K-12 ...
- ... and declining student interest
- Common solutions
  - Fix K-12 science/math
  - Encourage many more STEM majors
  - Import STEM workers from e.g. China, India
- This is the conventional view - little debate
  - Business Roundtable, CoC, “Rising Above”
  - Political leaders, and bipartisan
  - Interest groups that otherwise disagree
  - Echoed by mainstream media
The Evidence: K-12 education in sci/math

- **US average** student performance is “medium,” “middling”
  - PISA, TIMSS

- **But inequality** in US education unusually high
  - Large numbers are high-performing in sci/math
  - However large numbers also low-performing
  - = lower average

- **Disconnect:** most S&E majors come from high-performing tiers

- **Caveat emptor:** ~half of top-10 PISA “countries” are:
  - Very small: Liechtenstein (37,000); Estonia (1.3 million)
  - Cities & city-states:
    - Shanghai, Macao, Hong Kong – not China, not “countries”
    - Singapore (5.4 million, 100% urban)

- **However, also some larger countries in top-10 PISA ranks**
  - Japan (127m), S Korea (49m), Poland (38m), Canada (35m)
**OPINION:** New York Times, Editorial Board, December 7, 2013

“American students are bored by math, science and engineering. They buy smartphones and tablets by the millions but don’t pursue the skills necessary to build them. ... despite the high pay and the importance of such jobs to the country’s future, the vast majority of high school graduates don’t want to go after them...”

“Nearly 90 percent of high school graduates say they’re not interested in a career or a college major involving...STEM, according to a survey of more than a million students who take the ACT test. The number of students who want to pursue engineering or computer science jobs is actually falling, precipitously, at just the moment when the need for those workers is soaring. (Within five years, there will be 2.4 million STEM job openings.)”
ACT: “The Condition of STEM 2013”

Key Findings

1. Interest in STEM is high. Almost half (48.3%) of students in the 2013 ACT-tested graduating class have an interest in STEM majors or occupations. While these are encouraging numbers, more must be done to keep these students engaged in STEM fields.

   - 23.4% of students had an expressed interest only in STEM. Intervention strategies for the students with an expressed interest only allows students to understand what place in a specific major or occupation and defines an educational plan for the student.
   - 8.5% of students had a measured interest only in STEM. ACT Interest Inventory results suggest an inherent interest in a STEM major or occupation, yet they have not expressed an interest in pursuing a STEM major. A wider net must be cast with the goal of guiding and nurturing students with an expressed and/or measured interest so they can understand how to experience success in STEM fields. More must be done to identify and foster this interest earlier in students’ educational experiences.

2. Achievement levels in math and science are highest when expressed and measured interest match. ACT’s College Choice Report, Part 1, released in November 2013, showed the importance an expressed and measured interest match has on students’ progression into postsecondary education. We see the same influence on achievement levels in STEM. Across all four STEM areas, student achievement was highest for those with both expressed and measured interest, typically followed by expressed only and ending with measured only. Students interested in Engineering and Technology were most likely to meet the math and science Benchmarks. Overall, Benchmark attainment percentages are consistent between expressed and measured interest, except in the area of math, meaning academically the difference between these groups is in math, not science. This raises the question of
Key Findings:

“Interest in STEM is high. Almost half (48.3%) of students in the 2013 ACT-tested graduating class have an interest in STEM majors or occupations. While these are encouraging numbers, more must be done to keep these students engaged in STEM fields.”

How explain puzzling disparity?

A few caveats about ACT data:

- “STEM” has no agreed definition. ACT’s definition..
  - Excludes social sciences
  - Includes health and medicine
- “ACT-tested graduating class” limited to students intending college
- So not entire age cohort, though >1/2
Intending majors: not falling

Source: UCLA Higher Education Research Institute

• Freshmen intentions not falling

Percent entering freshmen intending STEM major, 1995-2012
...by race & ethnicity: not falling
Do this mean K-12 science/math OK?

- Certainly not; lots of problems
- True: S&E majors from upper tiers; large & strong
- Also true: large % of rest lack basic competence
- And every kid now needs science/math competency
  - …required for decent career in many occupations
  - …necessary to be an informed citizen
  - …equivalent to basic literacy in 19th C.
- An impt challenge; but not causing S&E “shortages”
2. US Falling Behind in Basic Research?

- US predominant since World War II
  - Previous leaders devastated by war (esp Europe)
- Wise postwar policies facilitated US rise to predominance
  - Vannevar Bush: “Science – the Endless Frontier” (1945)
- Key: Federal research funding, to universities not govt labs
- …and Federal funding large [Jaffe, *Science*, 2 May 2014]
  - Almost half of total research funding by all OECD governments
  - ~1% of GDP, more than any large country
- US still globally predominant, and strengthening
  - but others rising faster from lower base, catching up (esp. Europe)
  - less true in Asia: R&D is more applied research & development
But problems, structural

- Higher education: destabilizing positive feedback
- PhDs/postdocs: lead role as RA research workforce
- More research $ begets more PhDs/postdocs
  - NSF: 86% of 44,000 NSF-financed graduate students are RA’s
  - NIH: 78% of NIH-financed grad students & postdocs
- Odd drivers of demand for RA’s
  - Driven by univ research funding, not by demand in labor market
- Prospective PhDs/postdocs get little career info
  - Many naïve on career prospects, e.g. academe now “alternative”
  - Cf. professional schools at same universities
- Especially problematic in biomedical fields
...Forty years ago [from 1983]...there were few research universities, each with a small faculty and a handful of students... a major scholar in a research university would have several graduate students: he would see to the dissertation and graduation of perhaps one or two each year; these would go to some other research university, where they would carry on the work...Such was the expansion of the system that for a decade virtually all graduating PhDs could find teaching jobs and constitute the intellectual progeny of some master; and each of these too expected to foster a similar number of descendants... It was a truly happy arrangement for everyone concerned.

Those who were seduced by this perspective included demographers, who did not face the fact that...one descendant per year... a doubling each year, could continue for only a very short time. Most of us believed in birth control ..., but not for our own profession, and certainly not for our own professional descendants. The more offspring we could have the greater our weight in the academy...

Only long afterwards did it occur to any of us, myself included, that in the stationary condition to which every system must ultimately converge, each scholar can have one student who will take up his work...not one per year, but one per 30 or more years.

The established research universities saw the looming job shortage, and they reduced their intakes... But the newer graduate schools...had very recently persuaded their administrators and their legislatures to put up those buildings, hire that faculty... To justify the expenditure they admitted PhD students for whom they should have known that in the end there could be no appropriate posts...
Too Many PhD Graduates or Too Few Academic Job Openings: The Basic Reproductive Number $R_0$ in Academia

Richard C. Larson$^1$, Navid Ghaffarzadegan$^2*$ and Yi Xue$^1$

$^1$Engineering Systems Division, Massachusetts Institute of Technology, Cambridge, MA, USA
$^2$Grado Department of Industrial and Systems Engineering, Virginia Tech, Blacksburg, VA, USA

The academic job market has become increasingly competitive for PhD graduates. In this note, we ask the basic question of ‘Are we producing more PhDs than needed?’ We take a systems approach and offer a ‘birth rate’ perspective: professors graduate PhDs who later become professors themselves, an analogue to how a population grows. We show that the reproduction rate in academia is very high. For example, in engineering, a professor in the US graduates 7.8 new PhDs during his/her whole career on average, and only one of these graduates can replace the professor’s position. This implies that in a steady state, only 12.8% of PhD graduates can attain academic positions in the USA. The key insight is that the system in many places is saturated, far beyond capacity to absorb new PhDs in academia at the rates that they are being produced. Based on the analysis, we discuss policy implications. Copyright © 2013 John Wiley & Sons, Ltd.
Isn’t there also negative feedback (stabilizing)?

- **Yes:** Talented US students have options; pursue other careers
- Domestic system would “adjust”; but increasingly global
- An unplanned policy intersection re: visa & funding rules
- **Visas:** No limits on students and postdocs
  - 1st degrees rising rapidly (esp China); postdocs limited outside US
- **Funding:** Can be financed by Federal research grants
  - Even though ineligible for NSF/NIH fellowship & training grants
- **Biomedical postdocs:** now 60% international?
- **Clarify the goals**
  - Provide low-cost lab staff for funded research projects?
  - Fill or expand PhD programs?
  - Provide US-subsidized PhD education globally?
Additional sources of instability

- **Positive feedback re: research**
  - More research $ begets more proposals
  - Incentives favor expansion (salary rules@NIH; indirects)
    - NIH ecosystem requires +6% budget annually to be stable

- **Incompatible timeframes**
  - Basic research intrinsically long-term
  - Appropriations annual, acceleration & deceleration

- **A recipe for oscillation, instability, boom/bust**
NIH budget 1960-2012
current & constant dollars (2012, GDP and BRDPI)
NIH: more funding, lower success

Success Rates of R01 Equivalent Competing Applications (1962-1969 estimated by NIH)

- Fiscal Year
  - Applications
  - Awards
  - Success Rate

Michael S. Teitelbaum 10/13/14
NSF: declining success despite rising funding
Research funding system highly productive, yet...

- ...booms and busts cause harms
- If research funds rise, then flatten or fall—
- Students: prospects wane while training?
- Research faculty: disrupted research, careers?
- Universities: risks of having “leveraged up”
  - “Soft” funding for salaries, debt for facilities
  - Expanded PhD students & postdocs as lab workforce
- Result: if budget growth lag=>financial crises
- Risks highest in biomedical fields
Many are calling for large increases in the budget for the National Institutes of Health (NIH) to address the damaging effects on biomedical research resulting from recent flat funding levels. Yet politicians respond with skepticism, as the NIH budget is already very large and was doubled over the 5-year period 1998 to 2003 (1). What is often left unsaid is that the fundamental problems are structural in nature—biomedical research funding is both erratic and subject to positive-feedback loops (2, 3) that together drive the system ineluctably toward damaging instability. It may be possible to create broad political support for large annual NIH funding increases into the indefinite future. But if not, objective analyses of systemic instabilities, followed by incremental adjustments, would be strongly in the interest of maintaining the quality of U.S. biomedical research.

Concerns about crises and discouragement resulting from flat funding levels for the National Institutes of Health (NIH) over the last 5 years (4) are valid and widely shared. Special worries are being expressed by NIH leadership about “the impact of this difficult situation on junior scientists, and on the ability of established investigators to maintain their laboratories” (5).

Crisis Despite the Doubling
NIH research funding is more difficult to get compared to before. NIH spending has stagnated for 5 years of small annual decreases (7). The inflation-adjusted budget today is not much higher than it would have been had smaller NIH budget increases, common before 1998, been sustained from 1998 to 2008 (9–11). Third, the number of applications for new and competing NIH research grants nearly doubled, from about 24,000 in 1998 to more than 47,000 in 2007. This was due primarily to a near-doubling of grant applicants, many of whom were trained under NIH research funding—from nearly 20,000 in 1998 to nearly 39,000 in 2007. In addition, the number of applications for all NIH-funded research—impacting that biomedical research had become dependent on at least 6% annual budget increases. As if on cue, damaging crises emerged when the increases from 2003 onward proved to be smaller than 6%.

The harsh impacts of these structural problems now are being felt by research institutions and individual biomedical researchers. Yet, none of these institutions or individuals has it within their power to modify the key structural elements of the system in which they find themselves. These can be addressed only at the level of policy and administrative leadership. But what of NIH leadership?
3. STEM workforce “shortages”?

- “STEM” education coined at NSF 2001
  - Referred to educational fields
- “STEM occupations” later, but no agreed definition
- From 5% to 20% of workforce (~155m)
  - 5%, or 8m (SEI): S&E occupations, BS/BA+
  - 11%, or 17m (SEI): S&E degrees, BS/BA+
  - 20%, or 26m in 2011 (“STEM”: Rothwell/Brookings)
    - NB: includes skilled workers such as A/C installers, electricians, carpenters, plumbers, welders, auto mechanics, etc.
- With such a range, no wonder confusion prevails
Other sources of confusion also

- Terminology often used interchangeably
  - “Skill gaps” (K-12 fails to provide basic skills)
  - “Shortages” (of scientists, engineers, IT)
  - “Mismatches” (over/under-supply specific skills)

- Like others, Cappelli finds little support for claims

- 3 possible explanations for employer claims
  - Lobbying tool for more labor, lower wages
  - Shorter employee tenure => more turnover/hiring
  - Higher specificity of job requirements narrows pool

www.nber.org/papers/w20382
Will focus here on “S&E” occupations: natural sciences, engineering, social/behavioral

- A critical part of workforce of modern economy
- But small: ~5%
- No credible evidence of general shortages
- If shortages exist, should see:
  - Rising relative real wages for S&E occupations? NO
  - Faster-than-average employment growth? YES & NO
  - Low/declining unemployment rates? NO
    - compare w/ other high-skill occ’s, not entire workforce

[Sources: most academic researchers; RAND; Urban Institute]
General shortages claims: Misleading

- No one has found empirical evidence of
- Variation across S&E fields (under- & over-supply co-exist)
- Across time
  - All fields change over time (auto, civil, petroleum engineering)
- Across geography
  - Local hothouses (e.g. Silicon Valley, Boston, DC metro, RT, Austin)
    - Booms & busts with high frequency & amplitude
    - Silicon Valley housing costs highest in nation, 4X national median
  - Atypical: National generalizations are perilous
- By level and content of degrees
  - Non-academic careers primary even for PhDs; academe=“alterative”?  
  - Employers hire some PhDs, but mostly master’s and BA/BS
  - Yet most graduate science degrees not configured for non-academe
  - Exceptions: Professional Science Master’s (PSM) degrees
Robust growth of the PSM degree

300!
The Professional Science Masters Program reached its 300th affiliated program in 2013.

2013: Our 300th program.
2012: Responsibility for PSM Affiliation and curation of the sciencemasters.com webpage transfers from the Council of Graduate Schools to a newly-established National PSM Office that is hosted at Keck Graduate Institute.
2011: The number of PSM programs expands rapidly as university systems in California, North Carolina, New York, Florida, and New Jersey implement system-wide PSM initiatives.
2007: The National Professional Science Master’s Association forms to engage businesses, industries, nonprofit organizations, government agencies, and professional associations in the development of PSM degree programs and with internship and job placement for PSM degree program students and graduates.
2006: The Council of Graduate Schools, seeking to improve and advance graduate education, assumes primary responsibility for supporting and expanding the Sloan Professional Science Master’s (PSM) initiative, with the goal of making it a regular feature of high quality U.S. graduate education.
2001: A Sloan grant to the Council of Graduate Schools (CGS) extends the PSM initiative to master’s-focused institutions, which award 40% of science/math master’s degrees and where faculty are heavily invested in high quality master’s education.
1997: Beginning in 1997, the Sloan Foundation makes grants to 14 research universities to support the founding of programs in the natural sciences and mathematics, followed by a targeted bioinformatics set of programs at another 12 research institutions.

"PSM graduates understand the contribution of STEM knowledge to real issues. They will become the leaders in innovation that will spur the next generation of economic development."

Dr. James Moran, Vice Chancellor Pennsylvania State System of Higher Education (PASSHE)

The PSM degree is designed to train the next generation of STEM professionals for integrator and leadership roles in science-intensive industries. By helping translate research into commercialization, PSM graduates are able to fuel innovation and economic growth.
Or are “shortages” in demand, not supply?

“In particular, careful reading of such statements indicates that the speakers have in effect been saying: There are not as many engineers and scientists as this nation should have in order to do all the things that need doing such as maintaining our rapid rate of technological progress, raising our standard of living, keeping us militarily strong, etc. In other words, they are saying that (in the economic sense) demand for technically skilled manpower ought to be greater than it is—it is really a shortage of demand for scientists and engineers that concerns them.”

Kenneth Arrow and William Capron (1959)
Under- & over-producing—simultaneously?

- **Under-producing:** in some fields, some degree levels
  - Assoc degrees, quality master’s (non-academe), engineering BS?
  - NB: Employers claiming “shortages” often mean these

- **Over-producing:** some fields, some degree levels
  - E.g. biomedical PhDs/postdocs exceed workforce demand

- **Counter-arguments:**
  - We cannot have “too many” highly-educated S&Es
  - “Human capital”; they will find their way, create and innovate
  - If not employable in S&E, will strengthen non-S&E occupations
Why over- and under-production?

- Higher educ: weak feedback from labor market
- Degree trends lag well behind demand booms & busts
- Govts subsidize: via loans, state univ’s, tax, research grants
  - Yet less influence on majors than in other countries
- PhD student views: sunk costs, brass rings, Lake Wobegon
- Research university perspectives
  - PhDs can be financed from research grants, while…
  - Science master’s degrees typically require personal financing
  - Associate degrees: state/local $ (waning), & personal funds
  - Engineering BS: personal, @publics where fees rising fast
First degrees in NS&E fields: International comparisons

China large, & clear outlier on growth rate
- Chinese govt has strong influence on fields pursued
- Chinese NS&E degrees are heavily concentrated in engineering (~31%)
Engineering 1\textsuperscript{st} degrees drive differences (correct point made frequently by late Chuck Vest)

<table>
<thead>
<tr>
<th></th>
<th>% 1st degrees in NS&amp;E</th>
<th>% 1st degrees in engineering</th>
</tr>
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<tbody>
<tr>
<td>China</td>
<td>44</td>
<td>31</td>
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<tr>
<td>S. Korea</td>
<td>36</td>
<td>24</td>
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<td>Taiwan</td>
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<td>23</td>
</tr>
<tr>
<td>Japan</td>
<td>23</td>
<td>17</td>
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<td>Germany</td>
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<td>13</td>
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<td>UK</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>USA</td>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: calculated from NSB, Science & Engineering Indicators, Appendix Table 2-37, latest year (~2010)
Evidence: US markets do respond

- Petroleum engineering—backwater to top dog
- Comp sci – demand-driven booms & busts
- Govt supply booms abort market responses?
Is interest in computer science declining?

Tsunami or Sea Change?
Responding to the Explosion of Student Interest in Computer Science

Ed Lazowska
Bill & Melinda Gates Chair in Computer Science & Engineering
University of Washington

Eric Roberts
Professor of Computer Science and Bass University Fellow in Undergraduate Education
Stanford University

Jim Kurose
Distinguished Professor
School of Computer Science
University of Massachusetts Amherst

NCWIT 10th Anniversary Summit, May 2014
CRA Conference at Snowbird, July 2014

(Updated 7/23/2014 following CRA Conference at Snowbird)

“Introductory [CS] course enrollments are exploding”

Demand for CS major increasing

Demand for the major is increasing

![Graphs showing increasing demand for major in Stanford, MIT, University of Pennsylvania, and Harvard](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAIgAAADdCAMAAABRvJlSAAABl0lEQVR42u3Bb6R....)

It seems likely that the recent dramatic growth will continue (although cycles are inevitable)

![Graph showing computer science bachelors degrees granted](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAIgAAADdCAMAAABRvJlSAAABl0lEQVR42u3Bb6R....)


Michael S. Teitelbaum
Puzzle: “shortage” claims prevail despite evidence

- Expensive lobbying: led by IT employers, imm bar
  - Support from some in higher education, government
  - Claims echoed by non-specialist media

- Why? Shortage claims work politically

- Those questioning shortage claims far weaker
  - academic researchers, RAND analysts, etc. – easily ignored
  - S&E societies that disagree unable to counter
    - Internal conflicts, poorly-funded, balkanized

- Result? No contest – shortage claims prevail
Where are we now?

- ? Mid-point, 6th round of alarm/boom/bust?
- Pressure on USG to address claimed “shortages”
- Increase funds for R&D and S&E education
  - But discretionary budget limited by entitlements, economy
  - Repeats of past budget booms seem unlikely (can’t be sure)
- Increase visas instead?
  - Not constrained by budget limits
  - “Left-right” lobbying coalitions, but public opposition
    - Both parties divided, but becoming more partisan
IT lobbyists’ goal: expand H-1B visas

• Temporary (“nonimmigrant”), but long-term (7+ years)
• Capped, but large (stock over 500,000+)
  ○ Interesting: Univ’s uncapped, visas used for e.g. postdocs
• Most employers not required to recruit domestically
  ○ NB: commonly reported incorrectly in media
• Low education minima: BA/BS, or equiv experience
• Weak wage standards, weak enforcement (complaints)
• Employers can contract out H-1Bs to other employers
• “Indenture” for H-1Bs seeking green cards
• Larger numbers than permanent visas => backlog
• Largest users: offshore outsourcers - unanticipated
# Largest users of H-1B visas

## Table 4.1. Employers with the Most New H-1B Visa Approvals, Fiscal Years 2012 and 2011

<table>
<thead>
<tr>
<th>Company</th>
<th>FY2012</th>
<th>FY2011</th>
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</thead>
<tbody>
<tr>
<td>1. Cognizant</td>
<td>9281</td>
<td>5095</td>
</tr>
<tr>
<td>2. Tata</td>
<td>7469</td>
<td>1659</td>
</tr>
<tr>
<td>3. Infosys</td>
<td>5600</td>
<td>3360</td>
</tr>
<tr>
<td>4. Wipro</td>
<td>4304</td>
<td>2803</td>
</tr>
<tr>
<td>5. Accenture</td>
<td>4037</td>
<td>1304</td>
</tr>
<tr>
<td>6. HCL America</td>
<td>2070</td>
<td>930</td>
</tr>
<tr>
<td>7. Mahindra Group (incl Satyam)</td>
<td>1963</td>
<td>404</td>
</tr>
<tr>
<td>8. IBM</td>
<td>1846</td>
<td>987</td>
</tr>
<tr>
<td>9. Larsen &amp; Toubro</td>
<td>1832</td>
<td>1156</td>
</tr>
<tr>
<td>10. Deloitte</td>
<td>1668</td>
<td>798</td>
</tr>
<tr>
<td>11. Microsoft</td>
<td>1497</td>
<td>1384</td>
</tr>
<tr>
<td>12. Patni Americas</td>
<td>1260</td>
<td>164</td>
</tr>
<tr>
<td>13. Syntel</td>
<td>1161</td>
<td>363</td>
</tr>
</tbody>
</table>


Some company divisions were combined, such as IBM Corp. and IBM India, Tata consulting and engineering groups, etc.
Will President Obama expand S&E visas?

- Promising “executive action” after election
- Also urging more US majors in S&E...
- If stimulates supply boom, will bust ensue?
- Stay tuned....
Biomedical leaders seek system stabilizers

- In-depth report on biomedical research workforce
  - By high-level group appointed by NIH Director
Rescuing US biomedical research from its systemic flaws

Bruce Alberts\textsuperscript{a}, Marc W. Kirschner\textsuperscript{b}, Shirley Tilghman\textsuperscript{c}, and Harold Varmus\textsuperscript{d}
\textsuperscript{a}Department of Biophysics and Biochemistry, University of California, San Francisco, CA 94158; \textsuperscript{b}Department of Systems Biology, Harvard Medical School, Boston, MA 02115; \textsuperscript{c}Department of Molecular Biology, Princeton University, Princeton, NJ 08540; and \textsuperscript{d}National Cancer Institute, Bethesda, MD 20892

Edited by Inder M. Verma, The Salk Institute for Biological Studies, La Jolla, CA, and approved March 18, 2014 (received for review March 7, 2014)

The long-held but erroneous assumption of never-ending rapid growth in biomedical science has created an unsustainable hypercompetitive system that is discouraging even the most outstanding prospective students from entering our profession—and making it difficult for seasoned investigators to produce their best work. This is a recipe for long-term decline, and the problems cannot be solved with simplistic approaches. Instead, it is time to confront the dangers at hand and rethink some fundamental features of the US biomedical research ecosystem.
Some possible stabilizers

- **Stabilizers for improved K-12 science/math**
  - Essential for all kids; don’t depend on “shortage” claims

- **Stabilizers for graduate education**
  - Align more with career prospects, less with research funds
  - Transparency on career outcomes, more nimble programs
  - Clarify goals of interactions between visas & funding

- **Stabilizers for research institutions**
  - Diminish incentives to “leverage up” on soft money
  - Create flywheels, counter-cyclical $ (e.g. bridge funding)

- **Stabilizers for Federal R&D budgets**
  - Steadier growth, e.g. 5-year budget plan (Quartet)
    - Doubling demands? Be careful what you wish for…

- **AND:** objective data and research on critical system
THANK YOU!

Comments, corrections are very welcome

Michael Teitelbaum
teitelbaum@sloan.org
Additional slides if needed
S&E bachelors: White flight?

Figure 2-19
Share of S&E bachelor’s degrees among U.S. citizens and permanent residents, by race and ethnicity: 2000–11

URM and Asian or Pacific Islander (Percent)
White (Percent)

Asian or Pacific Islander
75
73
71

Black or African American
69
67
67

Hispanic
65
64
63

White
62
61
60

American Indian or Alaska Native
57
56
55

URM = underrepresented minorities (black, Hispanic, and American Indian or Alaska Native).

NOTES: Hispanic may be any race. American Indian or Alaska Native, Asian or Pacific Islander, black or African American, and white refer to individuals who are not of Hispanic origin. Percentages do not sum to 100 because data do not include individuals who did not report their race and ethnicity.


Science and Engineering Indicators 2014
Recent book (Princeton University Press, 2014)