

Corporate Lab or Academic Department, Which Fits?

Bill Aiello

University of British Columbia



What's this talk about?

- Give a description of life in a corporate research lab and life at a research university for folks on (or contemplating being on) the job market
 - Plenty of similarities but tons of differences
- Both can be a good life but...
 - the proclivities and talents of some folks make them better suited to one versus the other
- “Really? *Both* can be a good life?”
 - “Hasn’t corporate America turned its back on basic research over the last twenty years?”
 - “And didn’t you yourself jump from an industrial lab to a university?”
- There is no question that the industrial lab glory days are gone, but life at a university is also much different than it was 20 years ago



The Good Old Days

- After Ph.D. & Postdoc joined Bellcore in 1989
 - Bellcore was formed as R&D org co-owned by seven Baby Bells after AT&T split in 1984
 - One of the very best combinatorics/theory groups anywhere in the world
- The job: approximate the early scientific trajectory of the senior researchers in the lab
 - Not exactly a cake walk!



Bellcore in the Glory Days

Combinatorics/Theory

- Fan Chung
- Bill Cook
- Milena Mihail
- Paul Seymour
- Subash Suri
- Tom Trotter
- Peter Winkler

+ Coding, Stats, Networking,
HCI,...

Crypto

- Dan Boneh
- Stuart Haber
- Arjen Lenstra
- Rafi Ostrovsky
- Raj Rajagoplan
- Avi Rubin
- Victor Shoup
- Venkie Venkatesan
- Yacov Yacobi



The Good Old Days

- After Ph.D. & Postdoc joined Bellcore in 1989
 - One of the very best combinatorics/theory groups anywhere in the world
 - Bellcore was formed as R&D org co-owned by seven Baby Bells after AT&T split in 1984
- The job: approximate the early scientific trajectory of the senior researchers in the lab
 - Not exactly a cake walk
- By ~1997, Bellcore was completely out of the basic research game. Superposition of two stories:
 - One specific to Baby Bells and telecom industry
 - One about broad changes affecting nearly all industrial research



Where are they now?

Combinatorics/Theory

- Fan Chung →UPenn→UCSD
- Bill Cook →Rice →GTech
- Milena Mihail →GTech
- Paul Seymour →Princeton
- Subash Suri →WashU →UCSB
- Tom Trotter →ASU →GTech
- Peter Winkler
→Lucent →Dartmouth

Crypto

- Dan Boneh →Stanford
- Stuart Haber ...→HP Labs
- Arjen Lenstra →Lucent →EPFL
- Rafi Ostrovsky →UCLA
- Raj Rajagoplan →HP Labs
- Avi Rubin
→AT&T Labs →Johns Hopkins
- Victor Shoup
→IBM Zurich →NYU
- Venkie Venkatesan
→MS Research
- Yacov Yacobi →MS Research



The Good Old Days

- After Ph.D. & Postdoc joined Bellcore in 1989
 - One of the very best combinatorics/theory groups anywhere in the world
 - Bellcore was formed as R&D org co-owned by seven Baby Bells after AT&T split in 1984
- The job: approximate the early scientific trajectory of the senior researchers in the lab
 - Not exactly a cake walk
- By ~1997, Bellcore is completely out of the basic research game. Superposition of two stories:
 - One specific to Baby Bells and telecom industry
 - One about broad changes affecting nearly all industrial research
- After some nasty legal bits, I joined AT&T Labs in 1998



Security Group at AT&T Labs

- Matt Blaze
- Lori Cranor
- John Ioanides
- Tal Malkin
- Patrick McDaniel
- Omer Reingold
- Avi Rubin
- Rebecca Wright

- Steve Bellovin
- Jake Lacey
- Dahlia Malki
- Matt Franklin
- Mike Reiter



Dot Com Era

- Huge amount of capital flows into telecom and high tech sectors supporting a huge amount of speculative work, in start-ups and large companies
- In '98, AT&T operated the largest long-distance network, IP backbone, cable network, and a large cell network
 - Seemingly unlimited opportunity for research in services, networking, data management, software systems
- Exciting Times
 - Not quite the Good Old Days
 - Emphasis on R & D related to AT&T's business and pressure on Research to justify its expense
 - But enough optimism to allow for a wide diversity of work



End of Telecom Era

- Overvalued .com market--AT&T pays too much for cable assets
- MCI overstates earnings
- Analysts beat down AT&T's stock relative to MCI's
 - AT&T's stock plummets about 9 months before .dot com bubble bursts
- AT&T's board panics and sells off last mile assets (cell and cable networks)
- Reduces AT&T to providing two commodity services:
 - Long distance: Large but decrease revenues and margins
 - Enterprise and Backbone data: small but increasing revenue
- Research budget and personnel reduced by a factor of two over about 18 months
- All of this superimposed on general trends re: research support in corporate America



Where are they now?

- Matt Blaze →UPenn
- Lori Cranor →CMU
- John Ioannides →Columbia
- Tal Malkin →Columbia
- Patrick McDaniel →Penn State
- Omer Reingold →Weizmann
- Avi Rubin →Johns Hopkins
- Rebecca Wright →Stevens

- Steve Bellovin →Columbia
- Matt Franklin →SRI →UC Davis
- Mike Reiter →Lucent →CMU



The End of the Good Old Days

- Then:
 - Handful of very large, dominant companies supporting research
 - Deeply rooted ideological support for research in Gov & Industry as part of competition with USSR
 - Basic research had a huge payoff for U.S./West as a whole, but much less competitive advantage for individual companies
 - Very few household hold stocks; dividend to price ratio important measure for return on investment--investing for the long haul



The End of the Gold Old Days

- Then:
 - Handful of very large, dominant companies supporting research
 - Deeply rooted ideological support for research in Gov & Industry as part of competition with USSR
 - Basic research had a huge payoff for U.S./West as a whole, but much less competitive advantage for individual companies
 - Very few household hold stocks; dividend to price ratio important measure for return on investment--investing for the long haul
- Now:
 - Many of these companies have struggled: disruptive technological change, extremely competitive technical marketplace
 - Fall of the Berlin Wall, disintegration of USSR
 - Research investment no longer seen as a compelling public good
 - Rise of Multinational capitalism, trustworthy mechanisms and institutions for moving money around the globe
 - Growth of 401k's, retail investing, return on equity moves from dividend to capital gain, emphasis on quarterly analysis, extremely competitive capital markets
- Support for basic research for its own sake, a luxury no* company can afford



Old Model vs New Model

- Old Model:
 - Research org judged primarily on science and engineering excellence
 - Everyone is expected to be or become a star researcher; everyone is a PI
 - Little expectation to bring in support (either internal or external) to pay for resources:
 - Travel, Post Docs, Equipment, summer interns
 - Company provides reasonably generous level of support (except for summer interns)
 - Resource allocation by Research Management mainly based on research outcomes
 - Large numbers of people in a relatively small number of areas (except for largest labs)
 - Collaboration with Research org peers is the norm



New Model

- Research org judged primarily on short and medium term contributions to company:
 - Types of contributions:
 - Advanced prototypes of possible next gen products and services
 - Intellectual property: patents, etc.
 - Technical leadership on
 - internal projects: strategic planning, new product/service architecture/spec/development
 - client presentations and client consulting
 - vendor interactions, vendor management
 - industry initiatives and standards

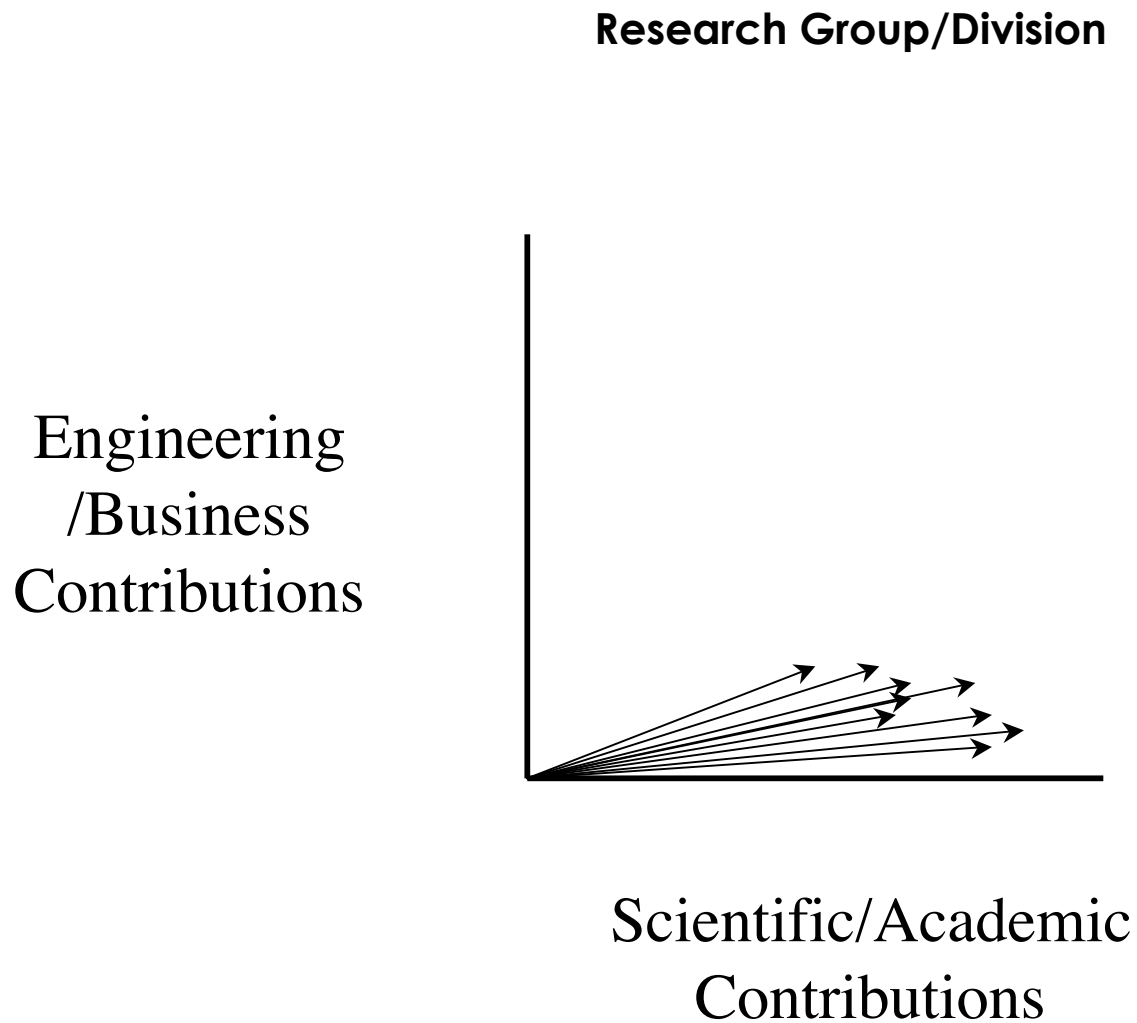


New Model

- Requires Research org to manage a pipeline that achieves a high output rate of such contributions
 - Requires Research org to really understand the company's business and industry
 - Requires Research org personnel to develop strong partnerships throughout company
 - Requires diverse Research org personnel: few technical leads, many first rate technologist/ developers
 - Requires diverse set of projects
 - Requires being one step ahead of company needs
 - To maintain political upper hand, this should appear to be magic
 - If you do this, management will not ask too many questions about how you do it
 - If you don't do this, you may not be able to justify expenditures on long term capabilities



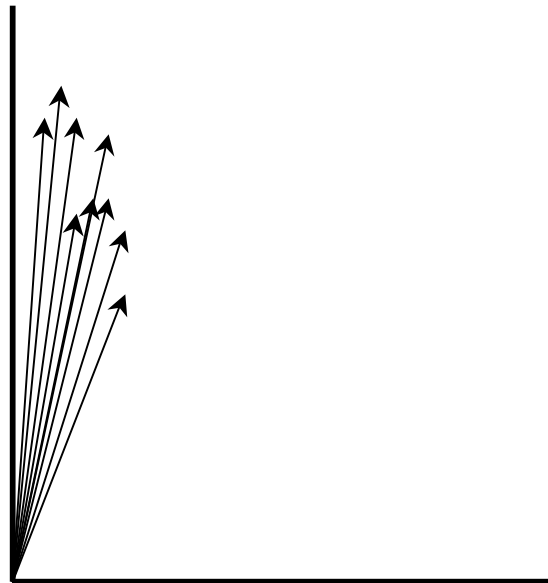
Old Model



Old Model

Development Group/Division

Engineering
/Business
Contributions



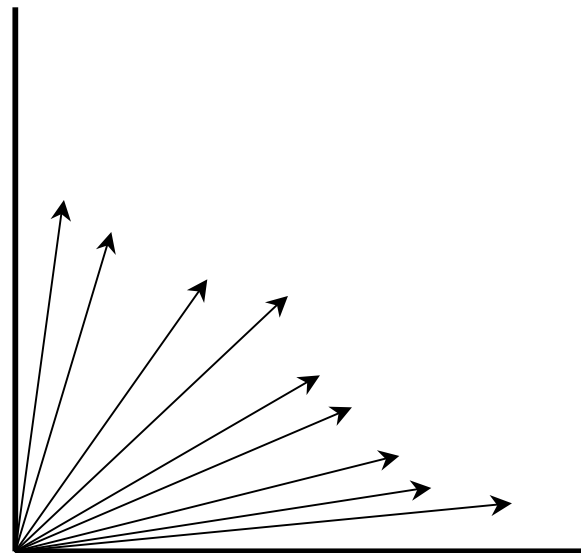
Scientific/Academic
Contributions



New Model

Research Group/Division

Engineering
/Business
Contributions



Scientific/Academic
Contributions



Academic Research in a Corp Lab

Tough question: Why should any company pay for the time spent producing an academic paper, work that becomes part of the public domain?

Two answers:

1. Technical leadership generalizes

- Empirical fact: Many of the folks who consistently provide outsized internal technical contributions/ leadership, are folks who like to also mix it up in the global marketplace of ideas and are good at it
- And you want to keep such people happy

2. Utilization of Public Domain knowledge

- Public knowledge is of no value to a company without internal experts who can analyze, extract, apply
- A huge amount of the knowledge is implicit
- People best able to analyze, extract, apply are those who actively produce papers themselves



Downsides of a Corp Lab

- Budget and resource allocations not transparent, esp. to a junior researcher
- *Very* challenging navigating the political waters in a large corp; finding, developing, maintaining partnerships
 - Political complexity of a corporation is several orders of magnitude greater than a University department
 - Some are naturally adept
- Many failure modes for staying on the academic publishing track
- No tenure, company and industry fortunes can change dramatically over your career
 - Some are confident they'll keep up their skills, expertise, and marketability and are not bothered by this in the least
- Some corporate positions may conflict with personal values



Advantages of a Corp Lab

- Grant writing not required
 - Corp picks up you full salary, reasonable travel and equipment, and a small amount of student support
- Career support, coaching part of your supervisor's job
- Access to real problems, real data
 - Front row seat to the discipline of the market
 - Research abstractions are of little value if they are generalizations of the wrong things
- Possibility of having real world impact
 - Can influence products & services that actually get deployed



What about academia?

To a first approximation

Corporate Lab

Academic Department

Company Projects → Undergrad Teaching

Academic Research → Academic Research



What about academia?

To a first approximation

Corporate Lab

Academic Department

Company Projects → Undergrad Teaching

Academic Research → Academic Research

*But the organizational models are **very** different*



The Department as a Business

A department is engaged in two distinct, lightly coupled enterprises:

- Education
- Research



The Educational Enterprise

- Dept Product:
 - Delta in expertise & intellectual sophistication of majors between enrollment and graduation
- Educational revenue covers huge fraction of Dept central budget
- Income: to Univ for Education from student tuition + state/provincial subsidies
 - Income to Dept flows through Univ & Dean
 - Based on historical budgets + enrollment numbers + ...
 - Complications: differences in time constants
- Enrollment + other Dean factors partly dependent on strength/quality of program
- Quality--and hence dept central budget--dependent on whole dept: faculty, grad students, staff
- Looks a bit like a non-profit organization



Research Enterprise

- Business Model: Dept looks like conglomerate/holding company
 - E.g., 50 professors, 50 separate businesses
 - The businesses share the cost of some shared resources:
 - physical plant, computing infrastructure, administration
 - CEO of each business responsible for success or failure of that business
- Each business: Professor Inc.



Research Enterprise, cont.

- Implications for dept: governance of holding company very flat:
 - transparency, fairness, consensus
 - Good: No Professor Inc inherently privileged over another
 - Bad: Often making a good option quickly is better than designing the perfect option slowly
 - Root of complaints about department politics
 - Overall organizational politics & complexity of a corporation is much higher but # of people involved in any one decision is lower
- Both the Research Enterprise and the Educational Enterprise have to coexist in one org structure



Professor Inc

- Products:
 - Scientific and engineering artifacts;
 - primarily papers, also talks, prototypes/tools,...
 - Masters and Ph.D. students--also your employees
- Multiple roles for the Professor of Professor Inc:
 - CTO--develop technical vision
 - CFO--manage the money
 - CEO
 - Represent company externally, sell/market technical vision to funders--bring in the money!
 - Manage product development cycle, manage/mentor/motivate the employees
 - Overall responsibility for putting the pieces together and making it all work



Assistant Professor Inc

- Small company in start-up mode
- You have to get competent at the CTO, CFO, CEO roles very quickly
 - In start-ups, there's a reason that VC's insist that the founders become CTOs and someone with management experience becomes the CEO
 - Missteps managing students common but costly
- Bootstrap funding problem: \$\$ doesn't come until well after first round of products are out the door
 - make sure you negotiate good start-up funding with the department



Getting to Assoc Professor Inc: Tenure and Promotion

- You'll be judged primarily on the contributions and impact of your portfolio of work
- What about teaching?
 - You need to be a good teacher
 - Being an excellent teacher requires an enormous amount of time
- And Service?
 - Internal: be a good department citizen but no need to take a leadership role
 - External: Letter writers and Dept/Univ will use this as indicators of standing within your community: program committees, invited talks,...



External Letters

- External letters are the single most important component of your case. They will comment on:
 - A few of your papers that they are familiar with and the specific contributions and impact of those papers
 - Their impression of the strength of your overall portfolio of work
 - Your community service, particularly if they have shared a PC or have run a workshop/conf w/ you
 - The quality of your talks as a proxy for your teaching ability
 - The quality of your students talks as a proxy for your student mentoring ability



Academia works best if:

- You work best when you're running the show
 - You want to try out the CEO role of Professor Inc
- You don't mind the grant game--in fact, you're pretty good at it
 - You're entrepreneurial
- You genuinely enjoy teaching
- You find the marketplace of ideas much more compelling than in the marketplace of products/services
- Your personal life is such that you can be unnaturally singleminded for ~6 years



Corporate Lab works best if:

- You have a facility for balancing your own agenda with multiple other agendas
 - You enjoy group projects: working with and learning from your peers
 - You know how to be a good citizen without being just a good citizen
 - You have a facility for navigating in complex political waters
- You'd prefer not to be out in front all the time on marketing and fund raising
 - You'd rather spend the time on tangible projects
- You are a technologists at heart
 - The marketplace of ideas is not sufficient
 - You feel strongly about the discipline of the market
- Teaching is not particularly interesting to you
 - You'd rather spend the time on tangible projects
- Your personal life is such that you can be very singleminded for



- For most people it is not exclusive-or
- It is possible, but not easy, to keep both options open
- Timing of moving from Industry to Academia can be tricky



Job Prospects

- In spite of enrollment numbers, still some hiring in CS departments
 - Academic hiring is going through a phase transition
 - Two years of Post Doc is likely to become the norm
 - May be more post doc positions over time in US if ACI comes through
- Growth in CIT industries very strong, companies cannot find enough good people
 - Will translate into bigger enrollments
 - Will translate into more R & D expenditures
- Many different types of R&D orgs: Large Corp, Gov Labs, Soft Money Labs,.....

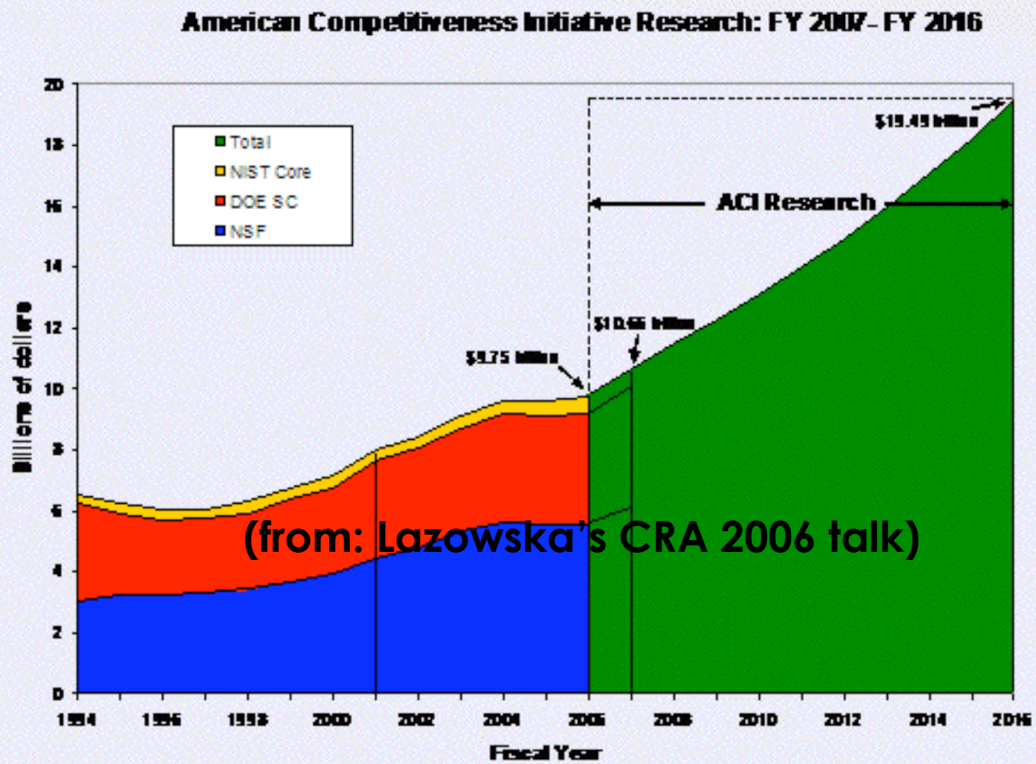


Elements of the ACI (from: Lazowska's CRA 2006 talk)

- Research
 - Commitment to double NSF, DoE SC, NIST over 10 years
 - Make permanent the R&D tax credit
- Education
 - 70,000 new teachers, alternative teacher certification, bolster AP, improve participation in math and science
- Workforce/Immigration
 - Expand worker training programs
 - Flexible H-1B caps, reform visa issues



Figure 1: ACI Research Funding, 2007-2016.



(from:
Lazowska's
CRA 2006 talk)

| | FY 2006 Funding | ACI Research FY 2007 | | ACI Research FY 2016 | |
|------------------------|-----------------------|-----------------------|-------------------|-----------------------|----------------------|
| | (billions of dollars) | (billions of dollars) | % increase | (billions of dollars) | % increase over FY06 |
| NSF | \$5.58 | \$6.02 | 7.8 | \$11.16 ¹ | 100.0 |
| DoE SC | \$3.60 | \$4.10 | 14.0 | \$7.19 ¹ | 100.0 |
| NIST Core ² | \$0.57 ³ | \$0.54 | -5.8 ⁴ | \$1.14 ¹ | 100.0 |
| TOTAL | \$9.75 | \$10.66 | 9.3 | \$19.49 | 100.0 |

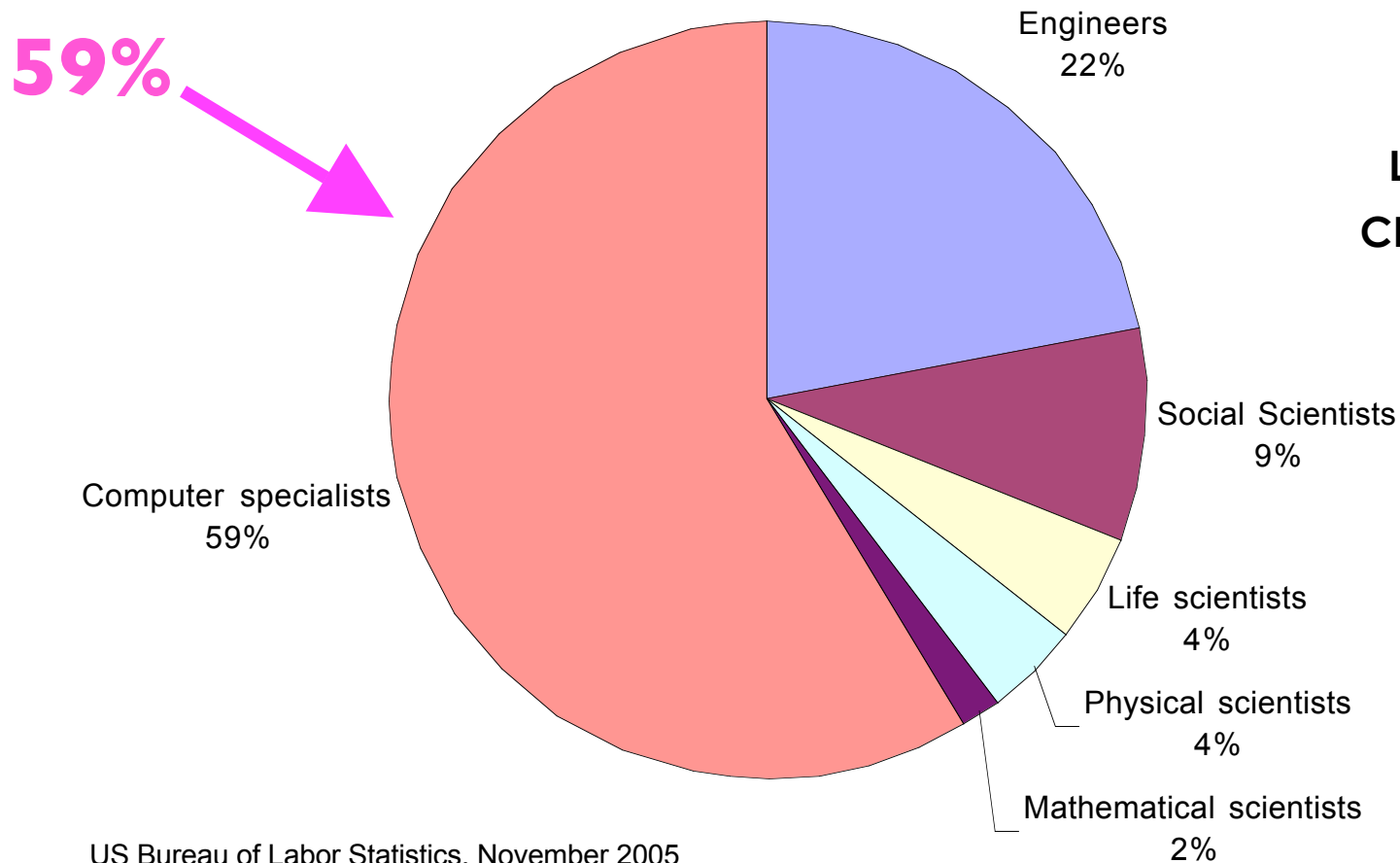
¹ ACI doubles total research fund; individual agency allocations remain to be determined.

² NIST core consists of NIST lab research and construction accounts.

³ The 2006 enacted level for NIST core includes \$137 million in earmarks.

⁴ Represents a 24 percent increase after accounting for earmarks.

Projected Science & Engineering Job Openings (new jobs plus net replacements, 2004-2014)

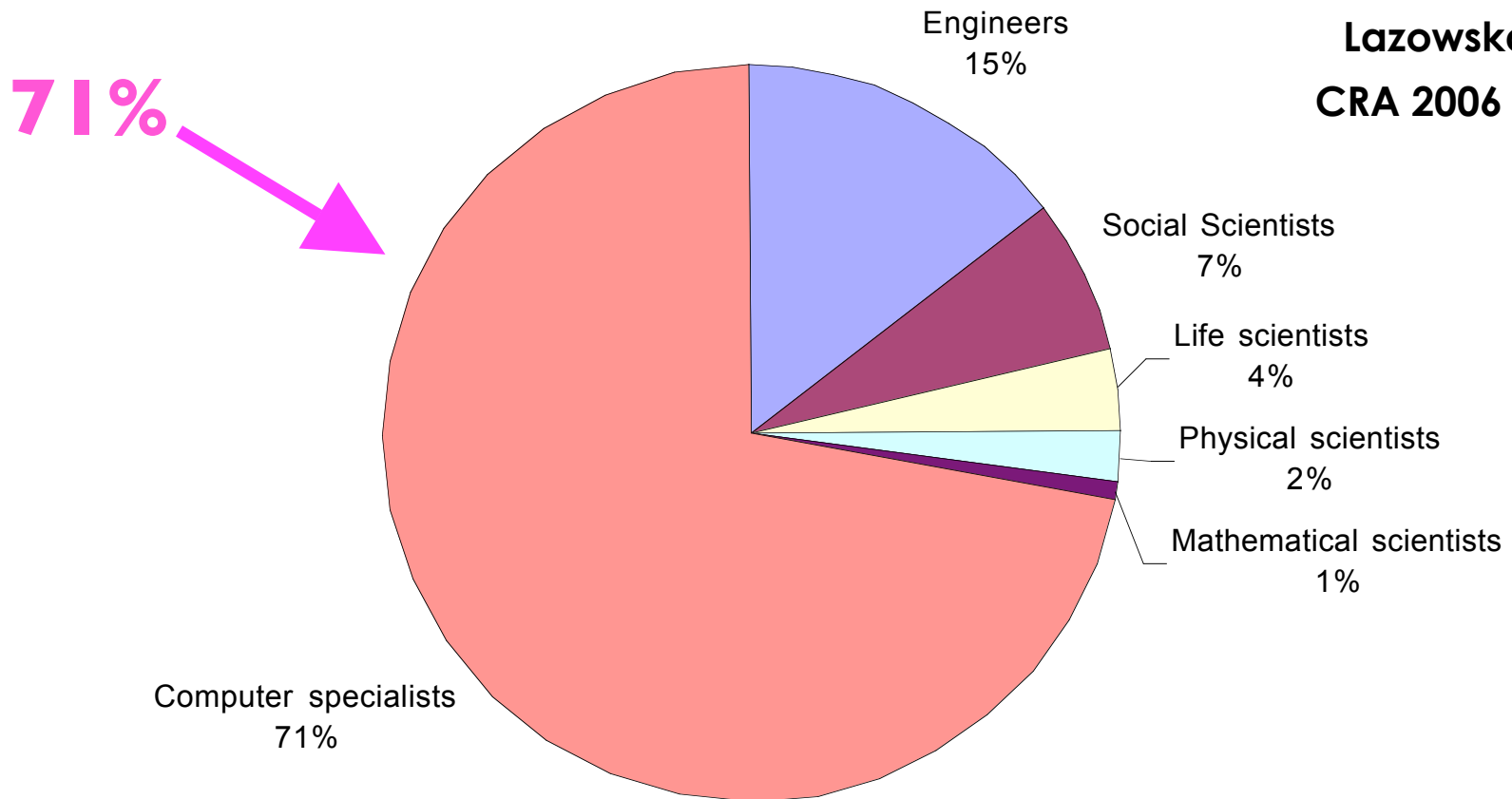


(from:
Lazowska's
CRA 2006 talk)

US Bureau of Labor Statistics, November 2005
<http://www.bls.gov/opub/mlr/2005/11/art5full.pdf>

Projected Science & Engineering Job Creation (new jobs, 2004-2014)

(from:
Lazowska's
CRA 2006 talk)



Advice to new professors

- Identify one mentor in the department and one outside
 - Get advice on grantsmanship and on managing students
 - Have a serious chat with them once a year about your progress with cv in hand
- Learn about your national funding agencies, current funding programs and priorities--get to know the program officers
- Don't wait five years to learn the details of your tenure and promotion policies
- Work often with more senior colleagues
 - Tendency to write papers only with your grad students--fight against that tendency
- Don't worry too much about the numbers
 - Your contribution/impact is the integration over your portfolio of work
 - Lots of ways to have a high impact portfolio
- Wait until you have tenure to go for the teaching awards
- Find ways to keep a pulse on the discipline of the market
 - Collaborate with R & D folks, send your students on summer internships
- Get into the habit of communicating



Advice for starting in a Lab

- When interviewing ask the research management
 - Their prognostication of their industry, their view of the company's strategy, how the lab is shaping and supporting that strategy
 - The funding model for the Lab
 - The why-pay-for-academic-papers question
- Spend time building knowledge about your company/ industry
- Learn about the performance review practices and other incentives
- General rule: publishing track iff top performer
 - Need to produce high quality academic work in relevant areas
 - Need to contribute internally, show promise of technical leadership
 - Need to find some projects that are win-win
 - Avoid black hole internal projects--work against being too much of a good citizen
 - Maintain consultant role on company projects--need support from management for this



Lab Advice, con't

- Develop a strong working relationship with your boss.
 - He/ she can/should:
 - Provide coaching, feedback, career support
 - Be the conduit/shield for Lab and Company connections/projects
 - Develop and push a unique agenda but take into account his/her incentives/agenda
 - Get in the queue for summer interns, travel, equipment early
- Collaborate with Academics
- Find a mentor in addition to you boss
- Get into the habit of communicating

