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 is 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, HCl,…

## Crypto
- Dan Boneh
- Stuart Haber
- Arjen Lenstra
- Rafi Ostrovsky
- Raj Rajagopalan
- 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
<table>
<thead>
<tr>
<th>Combinatorics/Theory</th>
<th>Crypto</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fan Chung →UPenn→UCSD</td>
<td>• Dan Boneh →Stanford</td>
</tr>
<tr>
<td>• Bill Cook →Rice →GTech</td>
<td>• Stuart Haber ...→HP Labs</td>
</tr>
<tr>
<td>• Milena Mihail →GTech</td>
<td>• Arjen Lenstra →Lucent →EPFL</td>
</tr>
<tr>
<td>• Paul Seymour →Princeton</td>
<td>• Rafi Ostrovsky →UCLA</td>
</tr>
<tr>
<td>• Subash Suri →WashU →UCSB</td>
<td>• Raj Rajagopalan →HP Labs</td>
</tr>
<tr>
<td>• Tom Trotter →ASU →GTech</td>
<td>• Avi Rubin</td>
</tr>
<tr>
<td>• Peter Winkler</td>
<td>• AT&amp;T Labs →Johns Hopkins</td>
</tr>
<tr>
<td></td>
<td>• Victor Shoup</td>
</tr>
<tr>
<td></td>
<td>• IBM Zurich →NYU</td>
</tr>
<tr>
<td></td>
<td>• Venkie Venkatesan</td>
</tr>
<tr>
<td></td>
<td>• MS Research</td>
</tr>
<tr>
<td></td>
<td>• Yacov Yacobi</td>
</tr>
<tr>
<td></td>
<td>• MS Research</td>
</tr>
</tbody>
</table>
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

Engineering /Business Contributions

Scientific/Academic Contributions

Research Group/Division
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, your 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

• Inspite 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
### American Competitiveness Initiative Research: FY 2007–FY 2016

<table>
<thead>
<tr>
<th></th>
<th>FY 2006 Funding (billions of dollars)</th>
<th>ACI Research FY 2007 (billions of dollars)</th>
<th>% increase</th>
<th>ACI Research FY 2016 (billions of dollars)</th>
<th>% increase over FY06</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF</td>
<td>$5.58</td>
<td>$6.02</td>
<td>7.8</td>
<td>$11.16</td>
<td>100.0</td>
</tr>
<tr>
<td>DoE SC</td>
<td>$3.60</td>
<td>$4.10</td>
<td>14.0</td>
<td>$7.19</td>
<td>100.0</td>
</tr>
<tr>
<td>NIST Core</td>
<td>$0.57(^3)</td>
<td>$0.54</td>
<td>-5.8(^4)</td>
<td>$1.14</td>
<td>100.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$9.75</td>
<td>$10.66</td>
<td>9.3</td>
<td>$19.49</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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)

- Engineers: 22%
- Social Scientists: 9%
- Life scientists: 4%
- Physical scientists: 4%
- Mathematical scientists: 2%
- Computer specialists: 59%


(from: Lazowska’s CRA 2006 talk)
Projected Science & Engineering Job Creation
(new jobs, 2004-2014)

Engineers 15%
Social Scientists 7%
Life scientists 4%
Physical scientists 2%
Mathematical scientists 1%
Computer specialists 71%

(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 your boss

• Get into the habit of communicating