Vertical Integration

Or

Why do research?
Why do research in house?
Outline

- Exploring the role of IP
- Why do (basic) research?
- Why do (basic) research in house?

Iain Cockburn
Boston University and NBER

Rebecca Henderson
MIT and NBER
IP in historical perspective

US Patents granted per 1000 population
Survey methodology

- Targeted at senior IP managers, typically Chief Patent Counsel
- Depth at the expense of breadth: 18 page questionnaire, more than 120 questions!
- Core sample frame: IPO membership, supplemented with additional mailing to Delphion list
- Response rate: 1/3 of IPO membership, 5% of others. N=66.
Sample characteristics

- Sample of responding companies dominated by large manufacturing companies
  - Chemicals 22%
  - IT and communications 44%
  - Life sciences 15%
  - Mechanical 16%

- Average sales $20bn, 2001 market cap $44bn
- Average of 14 full time IP attorneys, 264 patent applications, $91MM licensing revenue
We found:

- Many companies report limits to the effectiveness of patents: 43% (!) agree that “many of our most important ideas cannot be effectively protected with patents”
- Yet most rate formal IP rights the most important means of controlling the use of technology
- Contract law (NDAs, NCAs etc.) also highly rated
Strategic use of IP?

- Our overall impression is that the IP strategy of the majority of companies is **defensive**
  - Non-confrontational responses to competitors
  - Relatively conservative and cautious policies
- Companies are ambivalent about the role of IP in business strategy
  - Many report that profitability and returns to R&D are linked to strong IP positions and aggressive strategic posture, but few report activity by their company consistent with this…
Competitive interaction in IP

- 65% of surveyed companies report that the most profitable companies in their industry “react aggressively to IP activity by competitors”

- But
  - Less than 20% would attempt to “fence in” an aggressive competitor by building IP assets
  - More than 90% do not “always evaluate competitor reactions” when filing patents
  - Only 1/3 anticipate triggering an “arms race” if many new patents are filed
So... why do firms do basic research (with their own money)?

Source: Kwanghui Lim: “The Relationship between Research and Innovation in the Semiconductor and Pharmaceutical Industries: Implications for Theories of Knowledge Spillovers“

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Research before the World Wars

**Goal**: Understand the world

First “gentlemen” & then Universities, Foundations

**Incentive**: prestige, fun, the social good

**Goal**: Make the widget work

**Incentive**: Make $$

Firms
Research before the World Wars

“Basic”, “Curiosity driven” research
- Researchers motivated by the intrinsic interest of the problem, orientated to their peers, not to application
- Choice of problems dictated by individual researchers on the basis of curiosity

“Applied” research
- Researchers motivated by the desire to make money, have an impact on the world
- Choice of problems motivated by the needs of the market place
Research before the World Wars

- “Basic” research makes enormous progress, but few firms invest in it.
  - Except the German chemical industry
- Many major technological advances driven by engineers “tinkering”
  - Steel, Steam
- And technological advances that do use science use old, publicly available science
  - Electricity
  - Telephony
Sputnik and the World Wars

Goal: Understand the world

Incentive: prestige, fun, the social good

Radar
The Atom Bomb
Penicillin
The Man on the Moon

Incentive: Make $$

Goal: Make the widget work

Firms
After the Wars

Goal: Understand the world

Universities, Foundations

Incentive: prestige, fun, the social good

NASA DOD

Goal: Make the widget work

Traditional Applied Research

Incentive: Make $$
Corporate Research Labs in the Golden Age

- Bell Labs
- RCA Sarnoff Labs
- Xerox Parc
- IBM & the Watson Labs
- GE
- Alcoa
- DuPont
- Kodak
The Golden Age Research Model “Build it and they will come”

For Example:
- The transistor
- The CAT scanner
- Cohen/Boyer patent
- Nylon
- Protease Inhibitors
Core assumptions of “golden age” research

- Curiosity driven – understand the problems and the applications will follow
- Not overly constrained by financial or cost goals
- Hire the very best people and give them freedom
- Stay closely connected to the university and to the community of public science
More recently:
The Golden Age model in question

- Many firms unable to capitalize on major discoveries, or benefits take years to emerge:
  - The RCA disc
  - Xerox PARC
  - Kevlar
  - Lucent & Bell Labs

- A significant number of breakthroughs come through close user/market contact, *not* from the corporate labs
Why would a private firm ever invest in basic research?

- **Monopoly power**
  - (Tight appropriability or tightly held complementary assets!)

- **Maintain & attract key people**
  - (Do scientists pay to do good science?)

- **Build absorptive capacity**
Absorptive Capacity:

- **What:**
  - The ability to take advantage of knowledge generated outside the boundaries of the firm, the function or the business unit

- **Why:**
  - Much key knowledge generated outside:
    » “Basic” research
    » Competitive research
    » Knowledge elsewhere in the firm

- **How??**
Building absorptive capacity

- Reading the journals is not enough: to understand outside developments one must invest in the science - “to decode the signal one must build a receiver”
- Thus it may be necessary to:
  - Invest in “basic” or leading edge research
  - Reward individuals on the basis of their standing outside the firm -- and to allow publication
  - “Give away” key ideas in order to be a “player”
  - Take part in joint ventures or industry consortia that keep the firm “in the loop”
- Notice that such “research tourism” will have to be managed/incented differently!
Current “best practice” attempts to balance & integrate the two poles:

“Basic” or “fundamental” science

“Applied” research
Some firms continue to fund central research aggressively

“Basic” or “fundamental” science

Genomics, Photonics
Msoft, P&G

“Applied” research
But others have moved away from central research completely

“Basic” or “fundamental” science

Intel

“Applied” research
A variety of approaches are used to balance this tension:

- Explicit funding levels (Tier 1, Tier 2, Tier 3)
- Organizational structure
- Control over the central research budget
- Processes or temporary structures: cross functional teams, working groups
- “In-bound” marketing
Many companies set explicit funding levels:

- Tier I: 5% "Basic" or "fundamental" science
- Tier II: 25% "Applied" research
- Tier III: 70%

Source: Hauser. Check numbers!
Many firms give some control over central research funding to the business units.

Source: Chester article, 1995
Check exact numbers!
Or experiment with alternative organizational forms

AR = Applied Research
PD = Product development
A = Acquisitions

Science

AR AR AR
PD PD PD

Telecommunications
Display Technologies
Speciality Materials

AR
PD
A

Science

Telecommunications
Display Technologies
Speciality Materials
Other firms have experimented with hybrid organizational structures

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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</table>
| ✷ Supports necessary scale for critical technologies  
✷ Manage career paths  
✷ Avoid redundancy | ✷ Difficult inter-unit communication  
✷ Restricted view of whole  
✷ Can become too removed from the business |
| ✷ Focused cross functional coordination  
✷ More efficient development  
✷ Development of team management skills | ✷ Confusion of team roles  
✷ Shortage of good project management  
✷ Death by many teams  
✷ Degradation of fxnl skills |
| ✷ Focused attention to multiple objectives  
✷ Best of both worlds: coordination and specialization | ✷ Confusion of roles  
✷ High overhead  
✷ Powerful individuals tip the balance of power  
✷ Worst of both worlds |

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**Centers of Excellence**

- **Pros**:
  - Supports necessary scale for critical technologies
  - Manage career paths
  - Avoid redundancy
- **Cons**:
  - Difficult inter-unit communication
  - Restricted view of whole
  - Can become too removed from the business

**Teams**

- **Pros**:
  - Focused cross functional coordination
  - More efficient development
  - Development of team management skills
- **Cons**:
  - Confusion of team roles
  - Shortage of good project management
  - Death by many teams
  - Degradation of fxnl skills

**Matrix**

- **Pros**:
  - Focused attention to multiple objectives
  - Best of both worlds: coordination and specialization
- **Cons**:
  - Confusion of roles
  - High overhead
  - Powerful individuals tip the balance of power
  - Worst of both worlds
All R&D structures have limitations that can (in principle) be managed with the right processes

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<tr>
<th>Making Central Research more Decentralized</th>
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<tbody>
<tr>
<td>• Institute <strong>contracting</strong> mechanism whereby Business Units can invest their R&amp;D dollars by sponsoring projects in central Research</td>
<td>• Employ <strong>Portfolio process</strong> that ensures balance between platforms, derivatives, and breakthroughs</td>
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<td>• Create <strong>Councils</strong> comprising senior technical members (e.g. TDOs) from the business units to win endorsement for Research programs and ensure relevance</td>
<td>• Create <strong>cross-Business Councils</strong> responsible for synergies between research done within the businesses</td>
</tr>
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<td>• Provide <strong>communication mechanisms</strong> for central Research to showcase their programs (conferences, “technology fairs”, “catalogs”, “trolling”)</td>
<td>• Fund <strong>outside research</strong> in universities, start-up companies, or other outside organizations</td>
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<td>• Institute <strong>funding mechanisms</strong> that require project transfer to the business at a future date or require projects to win matching funds from the business</td>
<td>• <strong>Co-locate</strong> Decentralized R&amp;D resources within central labs to promote synergy and preserve critical mass in scientific disciplines</td>
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<td>• Support <strong>internship programs</strong> that lend researchers to the businesses</td>
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<tr>
<td>• Organize by <strong>product technology</strong></td>
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Should we do (basic) research in house?

Or
If the money is in lobster restaurants, should the lobster fisherman go into the restaurant business?
The ideal R&D Organization is:

- Fast
- Efficient
- Close to the leading edge of science
- Generating critical knowledge internally
- Creative and freewheeling
- Staffed by the best people

But close to the business and the customer
But able to take advantage of outside developments
But disciplined & focused
But not dominated by prima donnas
Managing R&D thus means managing tension:

- Between the long and the short term
- Between “basic” and “applied” research
- Between the inside and the outside
- Between pure technology focus and pure market focus
- Between managing by results and managing by effort
Key Questions:

- When should an entrepreneurial firm develop its own:
  - Manufacturing
  - Research
  - Sales
  - ..... capabilities?

- When should a mature firm outsource its:
  - Manufacturing
  - Research
  - Sales
  - ..... capabilities?
Exercise:

- **Under what conditions** should an entrepreneurial firm develop it’s own:
  - Manufacturing
  - Distribution
  - Sales
  - ….. capabilities?

- And when should it subcontract/partner for them?
Comparing “make” vs. “buy”
Outsourcing Basic Research: Intel?

Supplier

Asset

“Effort”

Intermediate good

User (Value=Q)

User (Value=P)
Key Considerations:

- How easy is it to write contracts?
  - How tight is the IP regime?
  - How much uncertainty is there?
  - “Specificity” of the asset – how “thick” is the market?

- What will happen to “entrepreneurial energy”?

- What will be the key complementary assets going forward?
So “make” (i.e. do it in-house) if:

- There are significant IP worries
- There are likely to be contractual problems
  - We can’t be sure of getting the “fair” price
  - We can’t be sure they’ll do the work “right”
  - *i.e.*, when market are “thin” or there is limited information
- We have unique competencies that are relevant
- And if buying won’t destroy everyone’s incentives to be creative and energetic
But remember…

- One cannot “buy” profit – if everyone knows it is there – it will be in the price
- Besides, shouldn’t we “stick to our knitting”?  
- Wouldn’t you rather deal with an independent firm, whom you could fire, than an internal subsidiary?