Best Practices in University-Industry Collaboration

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Project Supported by Cambridge-MIT Institute (CMI)

Origins of CMI Industry-University Collaboration Study

- Persistent tendency for the UK to perform well in basic science, but to lag in commercialization
- Recognition of the dangers of trying to compete on cost alone – Porter report commissioned by UK government
- Lambert Report. Industry unable to capture value
- General trends driving industry towards increased collaboration with universitiesMore collaboration engendered by trend towards an open innovation paradigmR&D is more global, gain access to the best research
- Cambridge – MIT Institute launches the current study
  - Six year, $130 million grant from the UK government

Knowledge Transfer Inside the Firm

Background and biases:

- Applying a tested method and having a good idea for where to look.

Lean Transition of Emerging Industrial Capability

January 1998 - September 2001
US Air Force & Boeing Cooperative Research Agreement
$4 million, 4 year study

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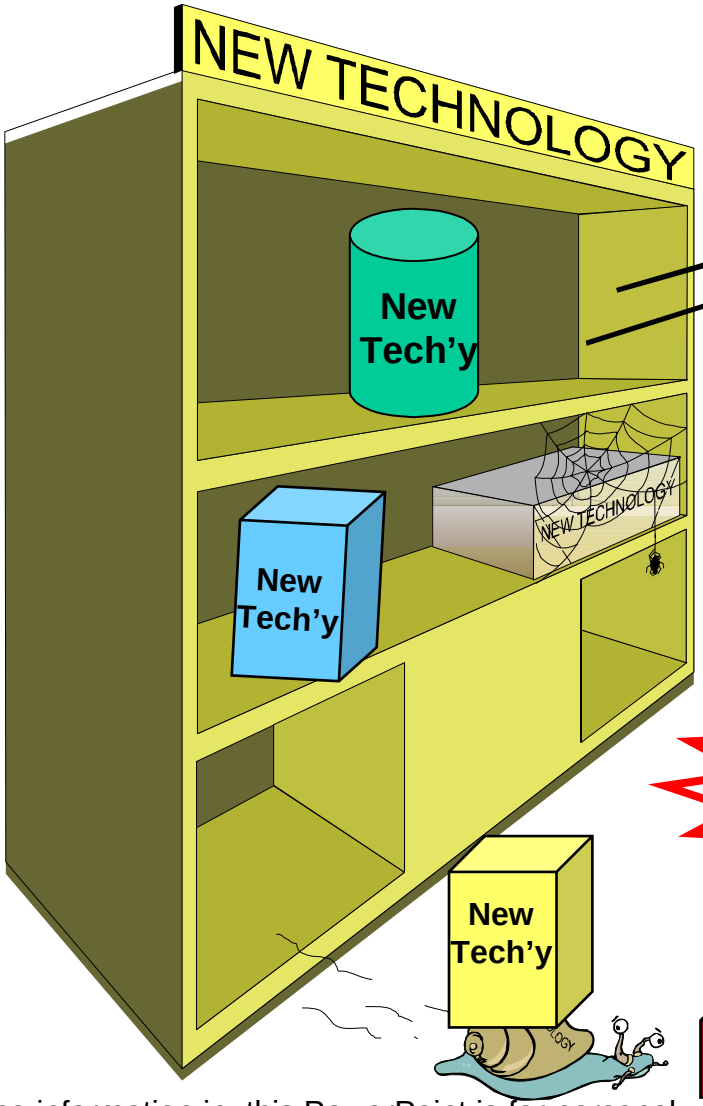
The Problem is Learning Why...

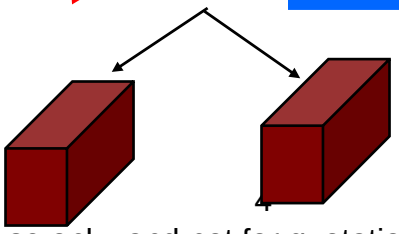


Enablers

- Some technologies seem to fly off the shelf and on to the the product.

Barriers

- Some technologies seem to take a lot of time & money to get onto the product.



- Others never make it at all.

Staffing, Engagement and Performance

- In studies of 300 cross-functional teams, found 150 reasons why teams failed. Two staffing factors stood out:
- Over-commitment hurts teams.
  - Causes delay
  - Less attention to detail, engagement, & buy-in
  - Limits solution search when task gets messy

    Who has the time?
- Specialist should participate on team
  - Was it the right question? Need for context.
  - What unspoken assumptions are in answer?
  - Commitment to a team solution.
- Staffing as key to engagement.

Defining Staffing Quality

- Use of word models and respondent is expert informant.
- Requirement that individuals had been on a specific team completed long enough to know the actual outcomes.
- Assumption of factual reporting.

Strong: Project informants were highly confident that all key skills were represented on the team; and members not on "too many tasks & teams."

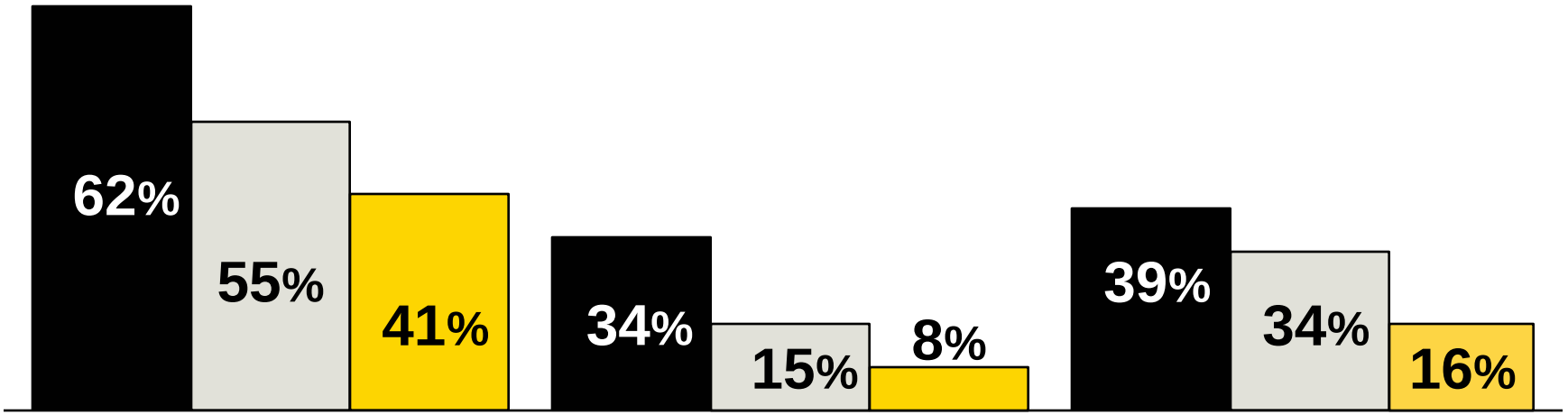
Average: Team seemed to have all key skills, and also seemed not to be over-committed.

Weak: There was not full representation of key skills, and/or a team was judged to be over-committed.

A word model to get three levels of staffing quality.

Staffing-in-practice and the Project Outcomes

Only for projects that achieved technology insertion



Project delay ***TauB= -.120, n.s.***

Maj. late eng. chg. ***TauB= -.237 at .003***

Failed meet tech.req. ***TauB= -.160 at .026***

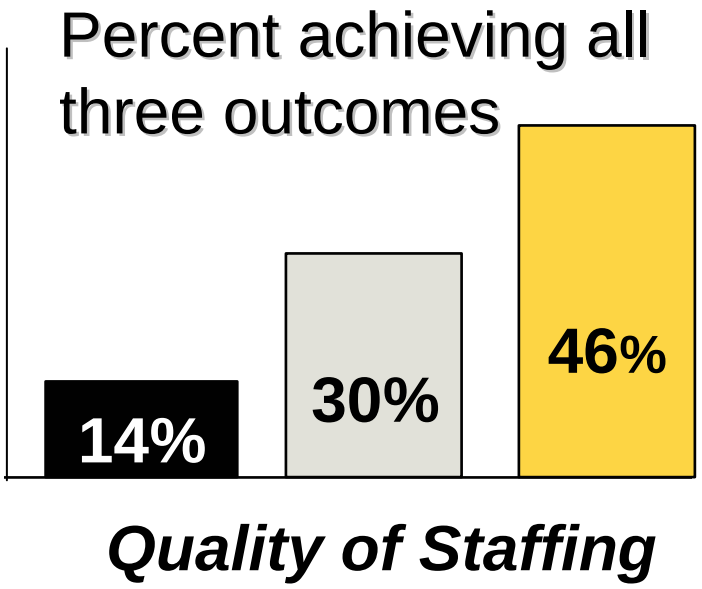
FULL REPRESENTATION OF BOTH KEY SKILLS & NO OVER-COMMITMENT RELATES TO AVOIDING DELAY, AVOIDING LATE ENGINEERING CHANGES, MEETING REQUIREMENTS

Staffing & Successful Development

Only for projects that achieved technology insertion

Index of Quality of Transition

Project on time	***= 1***
No/minor late eng.change	***= 1***
Met tech. requirements	***= 1***
Lean Score	***3***



Performance doubles if obvious problems of turnover, team participation, and over-commitment are avoided.

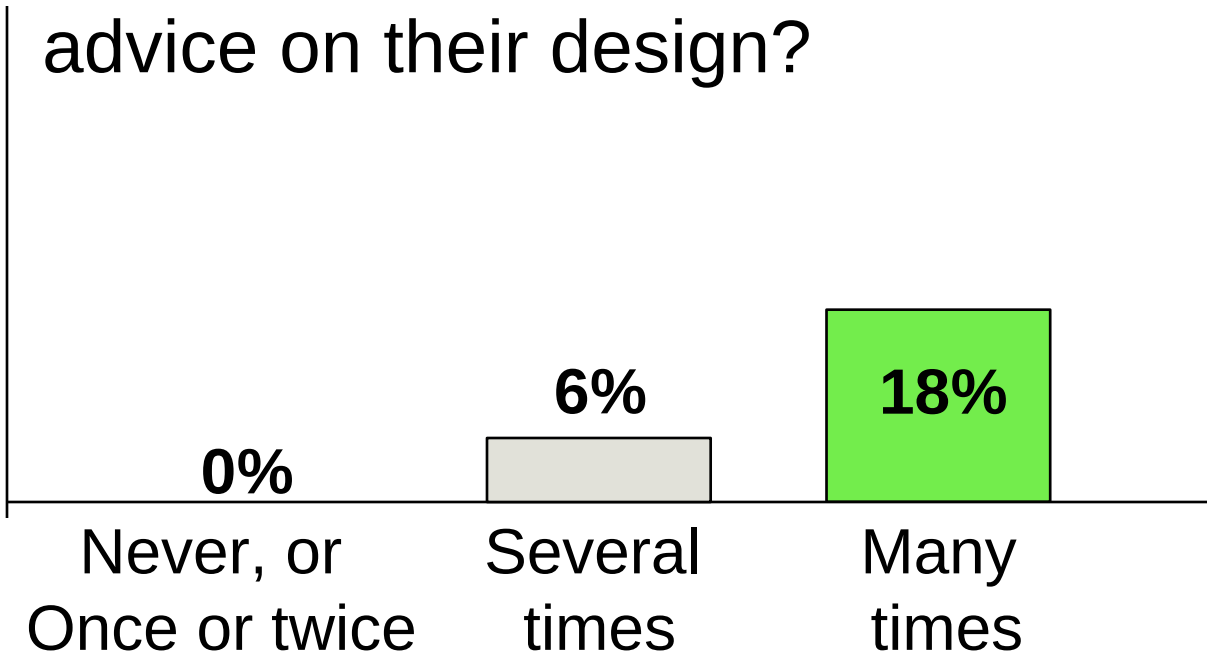
Performance triples if barriers to engagement are removed entirely

Supplier Engagement & Success: Weakly Staffed Teams

Percent of high performance projects

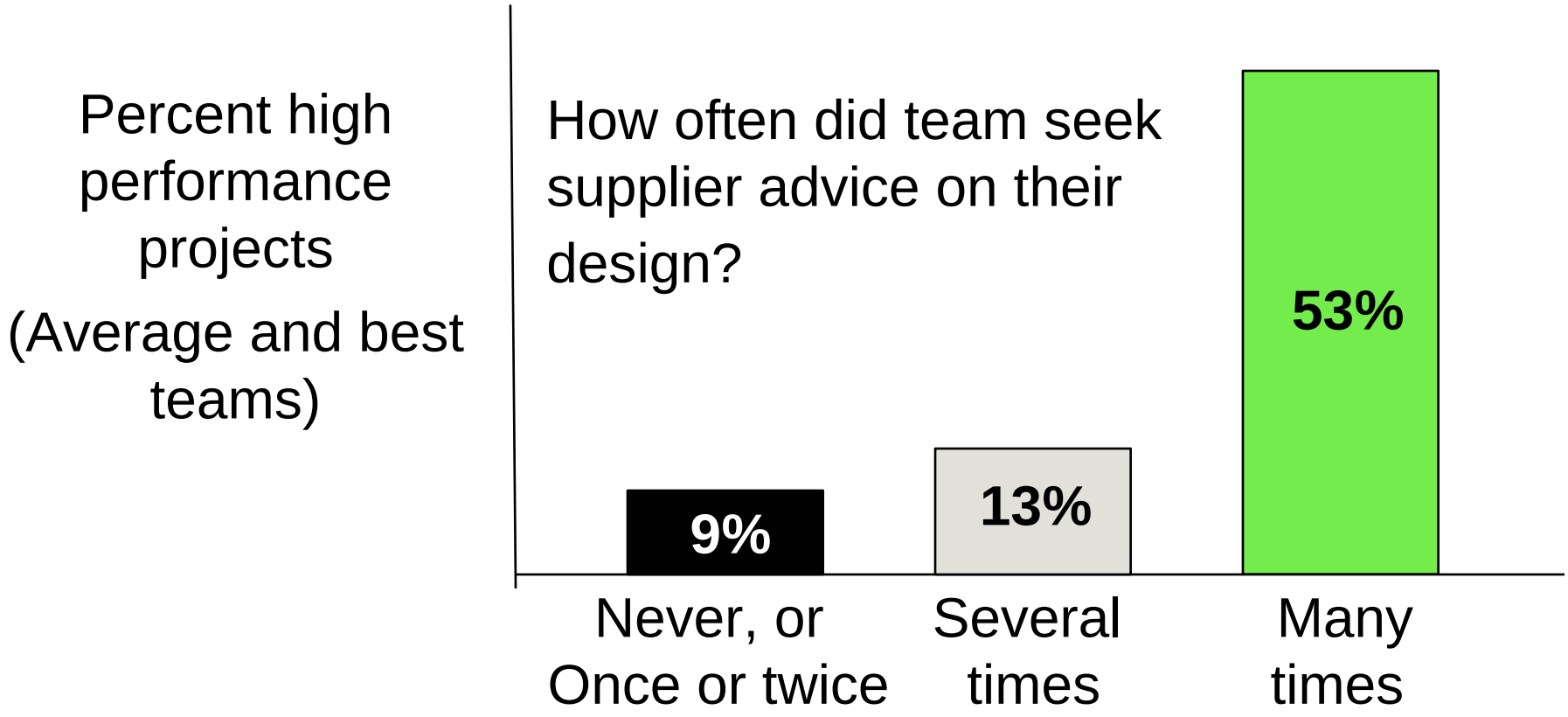
(Weakly staffed teams only)

How often did team seek supplier advice on their design?



Value of active supplier engagement adds very little when team staffing limits engagement

Supplier Engagement & Success: Better staffed teams



Massive improvement when there is supplier engagement **AND** unhampered team engagement

Why is this part of staffing so important?

- Knowledge is neither neutral nor explicit
  - "Facts" are relative to context
  - Deep assumptions no longer remembered
  - Knowledge embedded and lost in routine
- Functions/jobs with different responsibilities and experiences have different schema
  - Direct attention, lend importance
  - Make sense of information received
- So how does this apply to knowledge transfer across the industry university boundary?

It takes engagement from both sides.

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Origin of Present Study: Sources of Concern

- Persistent tendency for the UK to perform well in basic science, but to lag in commercialization
- Recognition of the dangers of trying to compete on cost alone – Porter report commissioned by UK government
- Lambert Report. Industry unable to capture value
- General trends driving industry towards increased collaboration with universities
  - More collaboration engendered by trend towards an open innovation paradigm
  - R&D is more global, gain access to the best research

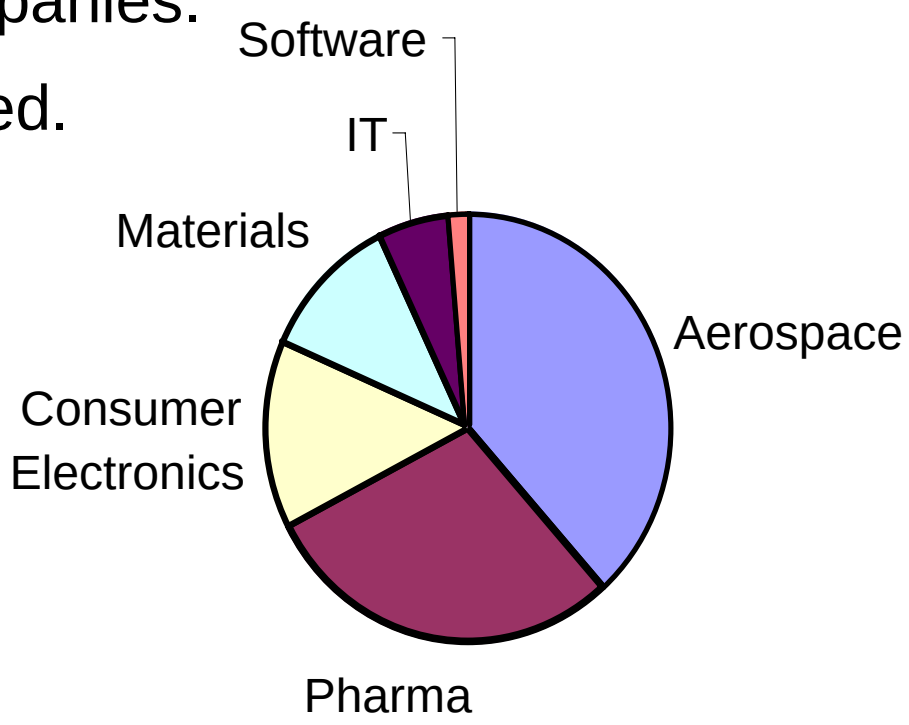
Study of Industry - University Collaboration Study ("Trafalgar")

To determine best practice in university and industry collaboration, where practice is defined as a tangible policy or activity that can be readily implemented.

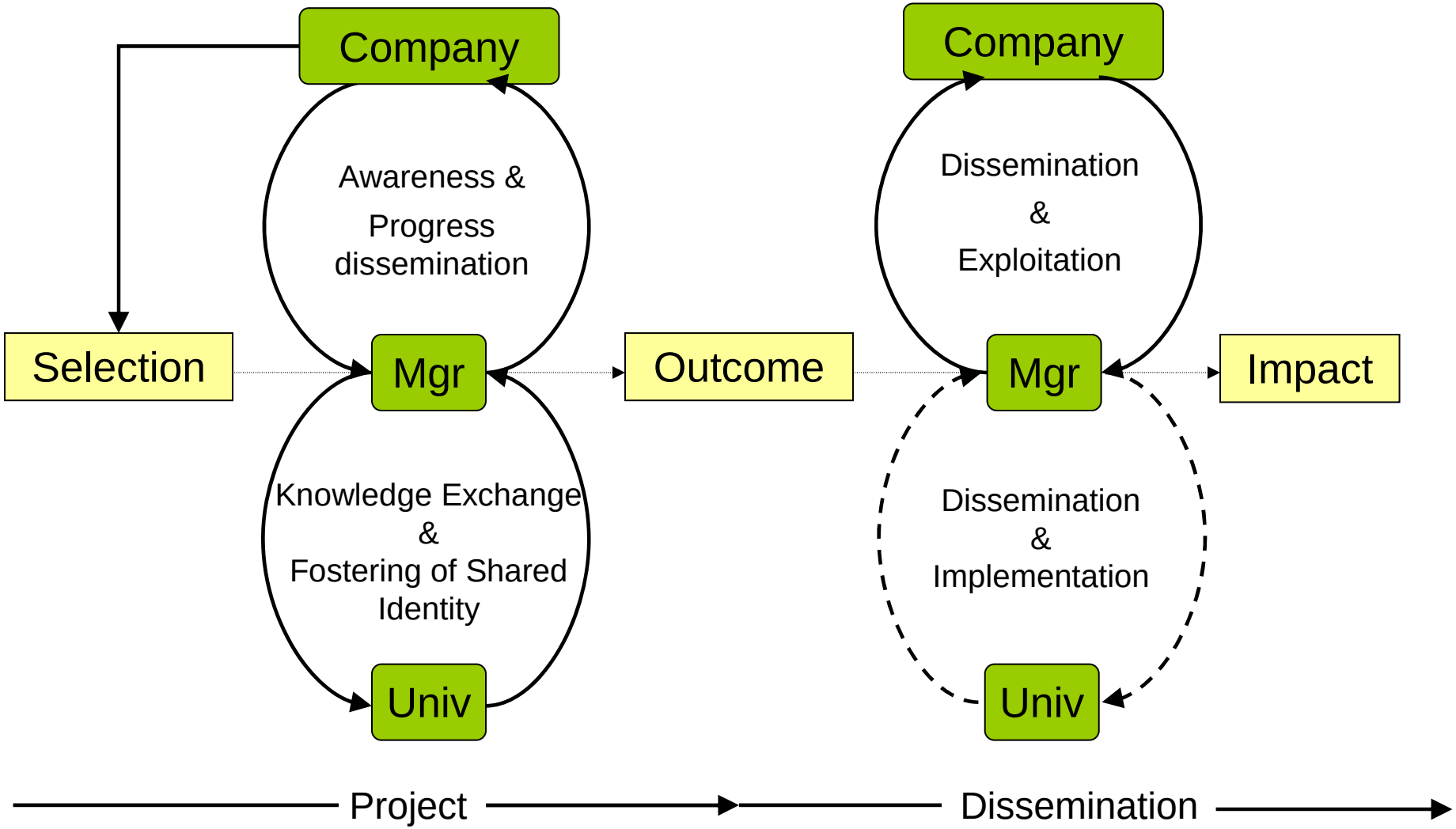
The need for actionable practices.

Number of Projects and Company Distribution

- 75 projects studied in 18 companies
- Work to continue in 2006 - 2007
- High quality international companies.
- Some sectors over-represented.
- No SMEs.
- Insufficient numbers to find any sector differences.
- Best practices may vary by sector.



University-Industry Collaboration Model



Value of Project Outcomes before Any Exploitation Effort

Projects are generally successful, with multiple outcomes

- 92.2% accomplished their intended goals
- 71.7% had valuable outcomes not originally planned
- 98.1% produced useful basic knowledge
  (58.5% of major value)
- 88.7% produced useful applied knowledge
  (62.3% of major value)
- 56.9% produced useful intellectual property
  (37.3% of major value)
- 80.4% strengthened important relationships
  (71.7% of major value)

These US and UK companies are effective at supporting the production of research.

Subsequent Impact on the Company

Many projects saw a consequential impact on the company

- 84.9% (N=44) projects produced **basic knowledge** that led to steps to **"influence company strategy**." Of these:
  - 27.3% Had a major impact on company
  - 47.7% Had a minor impact on company
  - 25.0% Were judged as having had little of no impact
- 74.5% (N=41) projects produced **applied knowledge** that led to steps to **use those results**. Of these:
  - 33.3% Had a major impact on company
  - 47.6% Had a minor impact on company
  - 19.0% Were judged as having had little of no impact

Judgment of impact of exploitation of project results on the company checked against senior management view.

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Outcomes to Impacts

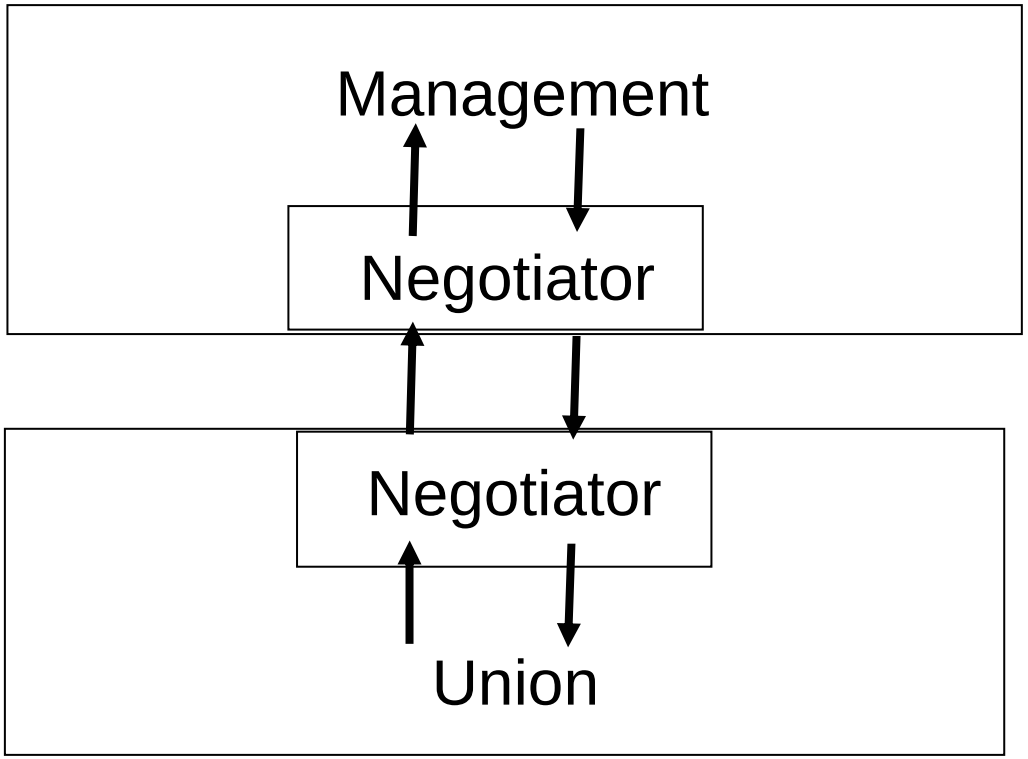
- Many projects have positive outcomes, but even among these elite firms, no impact on the company.

Type of Outcome	% of projects with **Major Outcomes** that have little to no impact
Basic	26%
Applied	33%
IP	37%

Yield Rate: "I would say realistically it's probably about 20 per cent. We'd like it to be higher. There have been... [projects] where you'd think…it would've gone somewhere but it didn't for whatever reason."

Boundary Spanning

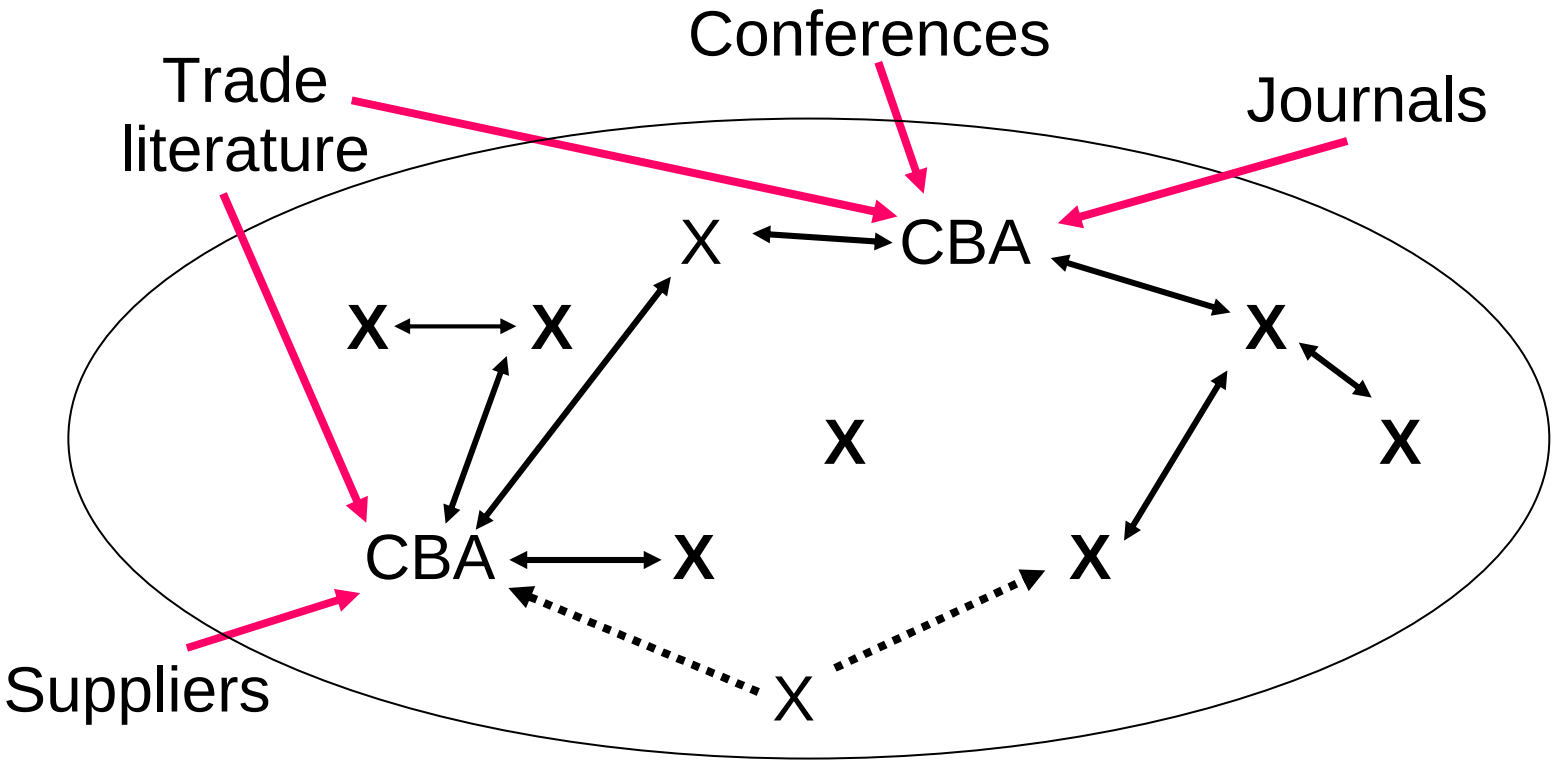
- Katz and Kahn, Social Psychology of the Organization



- Cross-boundary work seen as work involving high role conflict and stress.

Cross Boundary Agent in Technology Organizations

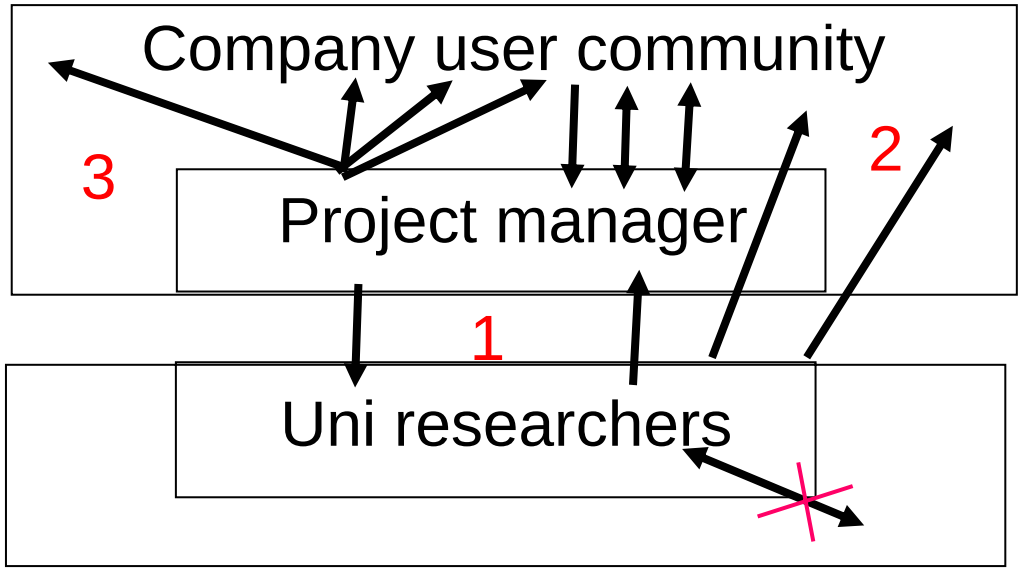
- Allen's "gatekeeper": Information Cross Boundary Agents



- Key professionals, usually "stars" in network, scan and disseminate information, and a sources for others

Boundary Spanning

- Hpothesized CBA model for knowledge exchange



Three relatively distinct processes:

1. The interaction between the project manager and researchers
2. The extent the researcher communicate with others in the company directly or with the manager's support
3. Project manager's independent representation role

University Researcher as Cross-Boundary Agent

Constituent Practices

How often did university researchers:

Visit the company and meet the program manager?

Visit and speak to company research groups?

Visit and discuss applications with business unit professionals?

Help the company solve an immediate operational problem?

- Items satisfy scaling criteria and together constitute a measure of an underlying concept.
- Offered as measure of research cross-boundary activity univerity research team.

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Project Manager as Cross-Boundary Agent

Practices

How often did company project manager:

Work with others to explore connections between the project and other technical developments?

Solicit suggestions from company technical professionals about how project would better fit needs?

Used ideas and results from project in discussions of future technologies the company might pursue?

- Items satisfy scaling criteria and together constitute a measure of an underlying concept.
- Offered as measure of inward-directed research cross-boundary activity by company project manager.

Internal Representational Activity and Were Steps Taken to Use Results

Did company take steps?	Level of representational activity: Low	High
To exploit new basic knowledge:		
No	28.6%	3.7%
Yes	71.4%	96.3%
	100.0%	100.0%
To exploit new applied knowledge:		
No	20.0%	14.8%
Yes	65.0%	85.2%
	100.0%	100.0%
To secure new intellectual property:		
No	47.4%	17.4%
Yes	52.6%	82.6%
	100.0%	100.0%

Internal Representation Practices and Impact of New Basic Knowledge

Impact of new basic knowledge on strategy?	Level of representational activity: Low	High
Little to none	46.7%	12.0%
Substantial	33.3%	60.0%
Major	20.0%	28.0%
Total	100.0% (N=15)	100.0% (N=25)

- Project manager inward representation activity has only modest impact on whether project results have major impact.
- The impact is found in increasing the use and subsequent impact of the average project. All but 12% have value for company.

The Cost of Under-staffing

Going back to the LeanTec aerospace project

- Management all felt teams were adequately staffed
- They were unwilling to cut back on number of projects

Analysis of 8 projects on cost of failure to achieve insertion.

  - Larger projects, measured in millions

Analysis of 15 projects on cost of delay and late engineering changes

  - Perhaps $12,000 to $14,000 per engineering change
  - Very similar numbers found in Air Force study

Best estimate: Millions of dollars lost in project performance to save staffing costs of roughly 50:1

To Get More Productivity from Industry-funded Research

- Budget what it takes for project managers time to do the job
- Obligate them to do internal representation with practices that include:

  Work with others to explore connections between the project and other technical developments?

  Solicit suggestions from company technical professionals about how project would better fit needs?

  Use ideas and results from project in discussions of future technologies the company might pursue?

- Build peer-to-peer relationships
- Require regular communications and visits by researchers
- Invest small amounts to find the right people and establish long term relationships

Staffing, Start-ups and Skunkworks

- Staff devoted to mission
  - Not “too many tasks and teams”
- Smaller organization, geographically concentrated
  - Enables informal communications
- Short horizons
  - Minimizes turn-over
- But lack history of long term relationships
  - Key advantage of established firms
  - Can obviously be brought in through personal contacts
    - A criteria to look for
  - Role of funding sources?

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END

- Project and partner selection
- Company approach and motivation to university partnerships
- Building alignment and common purpose
- Institutionalization and dissemination of knowledge within the corporation
- Outcome measures – does it make a difference?
- Focus on cross-boundary knowledge exchange

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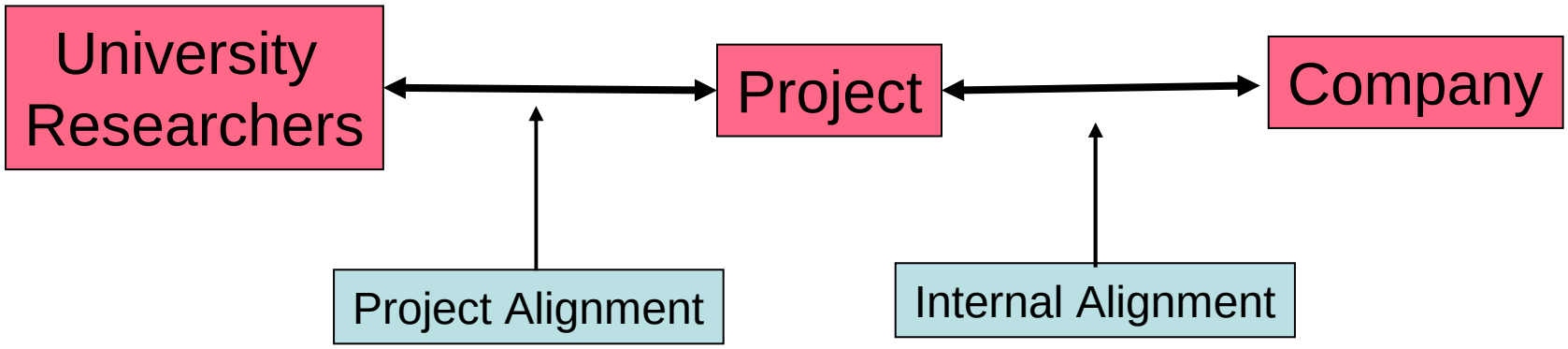
Next Steps

- Continue to expand project count for international companies
  - Enable cross-national anaysis
  - Balance industrial sectors
  - Repair weakenesses (e.g., PhD research projects)
  - Stabilise results of early findings
  - Allow sector and subgroup analysis
- Diseminate results to large companies
  - As recommended by 22 May industry group
- Wrap up current study by early 2007
- After that?

Vertical Alignment

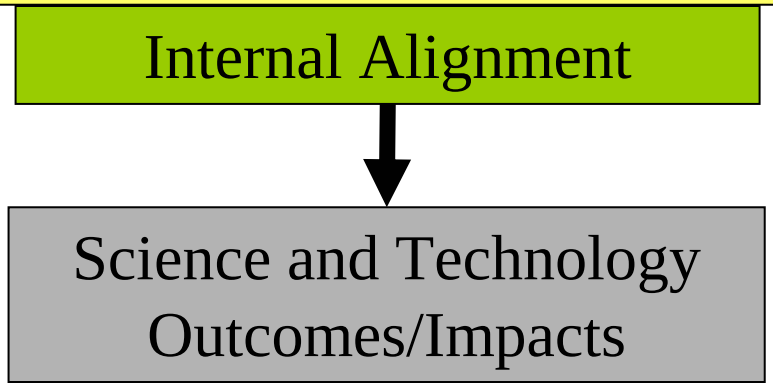
- **Definition**: Vertical alignment is the degree to which the project, if successful, will be useful to the company
- Vertical alignment differs from lateral alignment
  - Lateral alignment: Shared expectations and practices between university and company researchers



Internal Alignment Practices

Constituent Practices

- Project complemented other internal R&D
- Project required understanding company practices
- Projects expected to have a clear link to company strategy
- Professionals from other functional areas brought into meetings
- Project reviewed by a group of technical professionals
- Efforts made to integrate early findings with company research



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Agenda

- DTI & Swan
- When asked directly, 81.7% of the academics leading projects say that it is unlikely that this particular collaboration would have come about without CMI. It also appears that the CMI criteria in its call for proposals and selection system resulted in projects that had a relative high concern for the use of technology. Close to all (95.7%) of the projects were still curiosity driven, but they were also heavily concerned with developing new technology (97.7%) rather than basic research processes (33.3%). The projects were envisioned at the time of funding both as improving existing technologies (84.8%) and creating new technology (92.7%). The recipients of CMI funding also expected to take their research forward into advance development (90.9%) to bring technology to the point that it was ready for use, and 78.3% had looked ahead to a specific application to be addressed if the research were successful.
- As reported by the principle investigators and project Percent of allAt the time they were funded Did their research included a **basic** research element that: Was theory or curiosity driven95.7% Was concerned with improving basic research process33.3% Was concerned with developing a new technology97.7%Did their research included an **applied** research element that: Was concerned with improving an existing technology84.8% Was concerned with creating a new technology92.7%Did their research included **advanced development** that: Was concerned with improving an existing technology90.9% Had a specific application in mind78.3%
- The researchers have also been asked whether their projects have had an important research contribution. While one might do well not to rely entirely on the views of their own projects, the comparative levels are noteworthy. Two thirds (68.8%) feel their work has important or very important value for basic knowledge and theory, a not particularly surprising judgment from academics at elite universities. What is more interesting for the purposes here is that 85.5% feel that the basic knowledge they have created has made a valuable contribution by opening the way or enabling new use. Going further, 67.4% see that value tied to an identifiable and specific use. Absent the passage of time and the opportunity to revisit these projects, these results are at least suggestive that CMI supported a culture of consideration of use that resulted in research that was perceived and rich with applications.
- In 2006 as CMI support was ending, what was the value of the research for:Percent saying research has "Important" value Basic knowledge and theory68.8% Basic knowledge with consideration of use85.5% Applied knowledge that was tied to a specific use67.4%

Fostering Cross-Boundary Agent Activity