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Best Practices for Industry-University Collaboration

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Universities can be major resources in a company's innovation strategy. But to extract the most business value from research, companies need to follow these seven rules.

BY JULIO A. PERTUZÉ, EDWARD S. CALDER, EDWARD M. GREITZER AND WILLIAM A. LUCAS

MOST PREVIOUS STUDIES of industry-university collaboration have framed the analysis of such partnerships in terms of research project *outcomes*, defined here as a result that creates an opportunity for a company, such as guidance for the direction of technology development. From a business standpoint, however, research outcome is of only incidental importance. What matters is not outcome but *impact* — how the new knowledge derived from a collaboration with a university can contribute to a company's performance. Are new products made possible? New and more effective manufacturing processes? Novel kinds of computer hardware or software that enable greater logistical efficiencies? Patentable materials, designs or processes that enhance competitive advantage?

Managers see working with academia as beneficial only to the extent that it advances the company toward its goals. The focus of our research, therefore, was on the *impact* of the collaboration on company products, processes or people, as evaluated both by the direct industry managers of university projects and by senior technical personnel with a view across projects. While constructing industry-university agreements is an important, and often lengthy, precursor to the collaboration, this article is concerned with specifically how those collaborations can best be carried out once the agreements are



THE LEADING QUESTION

How can companies best achieve competitive impact from industry-university research collaborations?

FINDINGS

► There is an outcome-impact gap in university collaborations: Promising outcomes of university projects often fail to translate into tangible impacts for the companies involved.

► Seven best practices can bridge this outcome-impact gap.

Collaborations between university researchers and companies can result in project outcomes that have a major impact on a company's competitiveness or productivity.



ABOUT THE RESEARCH

This article reports the results of a three-year study aimed at determining best practices for industry-university collaboration. Data were collected at 25 research-intensive multinational companies from the aerospace, information technology, materials, consumer electronics, automotive, biomedical, mining, paper and petrochemical industries. Interviews of the responsible project managers plus senior technology personnel associated with industry-university collaboration were conducted for more than 100 university projects sponsored by the companies.

We asked the companies to provide examples both of successful projects and those that failed to meet expectations. We determined the amount of success through a survey with a series of questions on two distinct levels: (1) Did the collaboration achieve what it set out to do and if so, (2) What were the consequences for the company? The former gave information that related to the project's outcome. The latter enabled evaluation of the project's subsequent impact on the company. Quantitative and qualitative information regarding the levels of success of the collaborations were obtained, leading to our identification of seven best practices for managing collaborations.

in place. In particular, we sought to determine, in a measurable way, "best practices" for the selection process — the management and the development of relationships that enable a company to capitalize on a research partnership with a university.

To identify these best practices, we surveyed more than 100 projects at 25 multinational companies that engage in research collaborations with a broad base of universities; a dozen of those projects involved collaboration with the Massachusetts Institute of Technology. (See "About the Research.") We targeted companies with substantial experience that allowed us to tap the accumulated knowledge of experienced managers in companies with successful track records in utilizing university research.

Drawing on the quantitative and qualitative information provided by the industry project managers and senior technologists, we have identified seven practices consistently found in industry-university research collaborations that had a substantive impact for the company. (See "The Seven Keys to Collaboration Success.") The first four practices pertain to criteria for selecting the collaboration in the first place. These provide the foundation for management and for connection of the university research to the company. The last three build on this foundation and address issues of project management and of fostering maximally productive relationships between the company and the university researchers.

Taken singly, the seven best practices are neither new nor surprising. What is new is that the seven have been extracted from a quantitative study that included a large number of other practices as statistically important predictors of better university project outcomes and company impact. (See "Five Things That Don't Affect a Collaboration's Impact," p. 86.) Further, the practices also were identified as important in qualitative interviews with the company project managers and senior technical personnel. These provide actionable items for project managers that can benefit their interactions with academia.

Although the specific focus was on industry's collaborations with academia, these lessons have broader applicability. Indeed, this set of best practices could apply to management and integration into a company of any externally performed research. These findings may thus also be pertinent to collaborations with nonuniversity research organi-

zations, such as government labs and nonprofit organizations, as well as to industry consortia.

The Outcome-Impact Gap

The main observation that drives this discussion is that industry-university collaborations often produce interesting outcomes — for example, an insightful technical paper, a proposed process or a new computer code — but those outcomes have minor or no impact on company productivity or competitiveness. (See "The Outcome-Impact Gap for Industry-University Collaborations," p. 87.) Roughly 50% of the examined projects resulted in what were seen as major outcomes (i.e., produced new ideas or solutions to problems, developed new methods of analysis or generated new intellectual property of potential benefit for the company). Given the risks in research funding, that is an impressive batting average. The fact that almost half the projects had successful and consequential outcomes suggests that these companies are effective in their selection of university research projects.

That's the good news. The bad news is that only 40% of the projects with major research outcomes were exploited in ways that led to major impact, defined as an observable and generally agreed-upon positive effect on the company's competitiveness or productivity. The other 60% of the projects underachieved, at least from a business standpoint: The outcomes did not make their way into products or processes or influence company decisions.

This study aims to determine and address the conditions that lead to such reflections. The "outcome-impact gap" is not unique to industry-university collaboration. A similar effect has been noted, for example, in government-sponsored Engineering Research Centers.¹ The present work, however, focuses on university research that is directly selected by, and funded by, industry.

As in other models of cross-boundary knowledge flows, it is important to have two-way knowledge transfer between the university research team and the company personnel managing the project, as well as between the company project manager and others in the company. (See "Knowledge Exchange Paths in Industry-University Collaboration," p. 89.) In addition, the project manager should represent the project's progress to groups inside the company and capture

and pass on to the university team ideas, suggestions and potential linkages to other company activities.

The project manager, however, is not the only channel for knowledge flow. The capability for impact is enhanced if there are direct communications between the university and other units within the company (e.g., design, development, manufacturing, marketing and so on). No matter how knowledgeable the project manager is in the technical field, the chance of making new connections for the research are greater if individuals involved with development, manufacturing or production, for example, have the opportunity to be in direct contact with university researchers. The probability that useful information will be brought to bear on the development of the university research or its subsequent application is enhanced by all these two-way flows.

A further finding is that these knowledge exchanges need to continue even after the contractual research project is completed; lack of attention to this point was one reason for failure to exploit successful project outcomes. The survey questions were thus designed to investigate whether the channels for knowledge exchange were active both during and after project completion, as well as to examine the quality of the relationships.

Seven Best Practices for Industry-University Collaboration

On the basis of these observations, we propose a set of seven guidelines that companies should follow to get the most value out of their research collaborations with industry. While adhering to this set of best practices will not guarantee success, it will help managers to steer around the pitfalls that beset many of these partnerships and to realize more of their business potential. Taken together, these practices can measurably enhance the capability of industry-university collaboration to have positive impact on company products and processes.

THE SEVEN KEYS TO COLLABORATION SUCCESS

1. Define the project's strategic context as part of the selection process.

- Use your company research portfolio to determine collaboration opportunities.
- Define specific collaboration outputs that can provide value to the company.
- Identify internal users of this output at the working level; executive champions are not a substitute for this requirement.

2. Select boundary-spanning project managers with three key attributes:

- In-depth knowledge of the technology needs in the field
- The inclination to network across functional and organizational boundaries
- The ability to make connections between research and opportunities for product applications

3. Share with the university team the vision of how the collaboration can help the company.

- Select researchers who will understand company practices and technology goals.
- Ensure that the university team appreciates the project's strategic context.

4. Invest in long-term relationships.

- Plan multiyear collaboration time frames.
- Cultivate relationships with target university researchers, even if research is not directly supported.

5. Establish strong communication linkage with the university team.

- Conduct face-to-face meetings on a regular basis.
- Develop an overall communication routine to supplement the meetings.
- Encourage extended personnel exchange, both company to university and university to company.

6. Build broad awareness of the project within the company.

- Promote university team interactions with different functional areas within the company.
- Promote feedback to the university team on project alignment with company needs.

7. Support the work internally both *during the contract and after*, until the research can be exploited.

- Provide appropriate internal support for technical and management oversight.
- Include accountability for company uptake of research results as part of the project manager role.

Practice 1: Define the Project's Strategic Context as Part of the Selection Process

Industry-university collaborations must be aligned with the company's research and development strategy and address a tangible need of the company. If not, there is high risk of investing in projects that have little or no impact. One senior technology manager stated: "Ensure that there is a tight link between the current commercial strategy and the research collaboration." While this is a sound recommendation, we emphasize that the context of an aligned R&D strategy is not a synonym for "short term." The point is that there should be a vision within the company about what the university project will provide to the company. University research that lacks *both* a link to the company's R&D portfolio *and* a company unit that cares about the result is unlikely to be given enough attention to prove useful.

University projects with links to internal company interests create a strong continuing basis for collaboration when the research complements the company's own R&D or when the project is considered important for the company's technological

FIVETHINGS THAT DON'T AFFECT A COLLABORATION'S IMPACT

Several factors widely thought to be important to industry-university collaborations in fact had little effect on the projects' business impact.

1 Presence of an executive "champion."

Although a powerful ally in the executive suite can help obtain support for a project, we did not find a correlation between the existence of such a champion and project impact. To deliver value, the key is whether the project addresses a real need, as perceived by working engineers in the company (see Practice 1).

2 Geographic proximity.

Companies scouted for collaborators worldwide and were able to bridge geographic distance through visits, personnel exchanges and student internships. The important factor is not proximity but personal interaction between the academic research team and the company (see Practice 5).

3 Overall project cost.

The time frame of the project, not the amount of funding, is important (see Practice 4).

4 Type of research: basic, applied or advanced development.

There was no statistically significant difference in terms of impact between projects with different missions. What is important is that the projects address a tangible need for the company (see Practice 1).

5 Location of project manager.

We found no evidence that the location of the project manager, whether at a central laboratory or a business unit, affects project impact. What is important is that the project manager is able to span these organizational barriers (see Practice 2).

leadership. Further, when company personnel work on areas linked to the university project, the knowledge flows connected with the collaboration are heightened, providing additional pathways for uptake of the results. These additional linkages broaden and diversify the communications channels that are key to maintaining project alignment, and in some cases even can enable a realignment of the research goals with changing company strategy. Although having a company executive as a champion for the project can be helpful in terms of support,² we found no evidence that this could substitute for a strong connection of the university team with the company research and development strategy. For the research uptake to have impact, the issue is not whether there is support at a high level; it is whether the project addresses a real need as perceived by the company's working engineers.

This latter point is illustrated by the history of a collaboration sponsored by an engine manufacturer. The partnership arose from a suggestion by a member of the board of directors who thought it would be useful to have a strong connection to a university laboratory with a major research presence in the field. Other senior management agreed and provided funds for a project proposed by the head of the laboratory. The company supported the project for six years, some of the work was done using company product hardware and the project produced several publications. From the university perspective, the project was challenging and the results were instructive and useful, leading to better understanding of how the devices being studied behaved. No one at the working level or first level of management, however, saw a clear link to problems the company was having or to constraints on their design processes. They took no ownership of the project and paid little attention to its results, despite the strong desire of the university group to be useful.

Practice 2: Select Boundary-Spanning Project Managers

In every organization, there are certain individuals who naturally engage in networking activities, maintaining relationships that cross organizational lines. These "boundary spanners" are the main conduits by which knowledge is acquired from external sources and disseminated inside the organization,³ and they play an essential role in how any organization

benefits from and adapts to its environment. Companies dependent on new technology rely on a particular type of boundary spanner — the technical boundary spanner — to capture and use this technology successfully. Effective technical boundary spanners, whether as a result of personality or training, recognize their responsibility to facilitate knowledge exchange with both the university research group and within their company. They are key to turning collaboration research outcomes into company impacts.

Boundary spanners contribute to the success of industry-university collaboration in two primary ways. First, they effect a broad dissemination of the research results inside the company. That is especially true for introducing the findings to individuals beyond the research community who have responsibility for development, manufacturing and other functions. Second, they provide feedback to the university researchers through information they bring back from the company's technical community, a mechanism for keeping the research aligned with the company's needs, as described in Practice 1.

One example of boundary spanning was in a collaboration between a university and a robotics company. The company project manager was located in an R&D division and the university project was seen as basic research, years away from producing anything that would affect a company product. However, the project manager made it a point to visit individuals in the company's manufacturing operations. These interactions in turn led to ideas about how the next generation of robotics might be evolved into tools and integrated into the manufacturing process. They also provided information on the best direction for the project to proceed — in this case, a direction the project manager would not otherwise have considered. For this project, the outcomes may have been interesting without the project manager's actions: The researchers were bright, the topic had a high profile and anything the collaboration produced might have sparked attention. Without the cross-boundary discussions, however, it is unlikely that the project results would have been adopted as part of a manufacturing process with potential for major impact on the company.

Technical communities within a company play an important role in the formation of boundary spanners. These communities provide opportunities for

younger professionals to develop diverse networks and demonstrate the inclination and the professional skill for managing university projects. The diversity of a project manager's network facilitates the knowledge transfer process;⁴ individuals exposed to diverse groups are better able to communicate complex ideas than people who always interact with the same group.⁵ A number of companies explicitly encourage the existence of these communities through mechanisms such as internal technical presentations and employee participation in technical conferences.

Technical communities also facilitate the identification of new ideas and applications that can lead to successful outcomes not envisioned in the original contract, as illustrated by the robotics example. Project managers who participated in these communities typically interacted with other groups about the project's results, leading to new avenues for enhanced impact on the company. As one vice president for external research told us: "It is important that the project managers are extroverted. They need to enjoy interacting with people. One of our project managers has a business card that says 'hunter-gatherer.' That is precisely the mentality that is needed in this work."

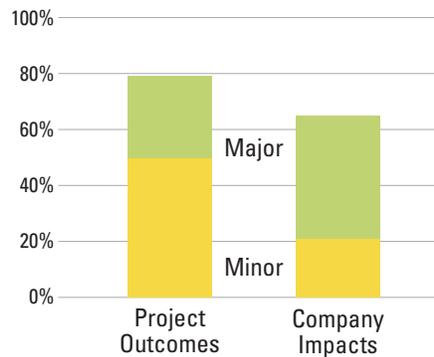
Practice 3: Share With the University Research Team the Vision of How the Collaboration Can Help the Company

Our data show that academic research is more likely to have positive impact on a company if the university researchers have a strong knowledge of the business setting, company practices and how the research fits company strategy. These conditions occurred more often when university researchers had worked in the same or similar industries in the past, giving them insight into linking research results to industry practices. If university researchers do not already have this background, the project manager must find a way to provide that knowledge to them.

Interviews revealed, however, that some project managers chose not to communicate the strategic context of the project and the high-level goals to the university researchers. A common reason cited was concern about losing a competitive edge. While this concern is understandable, stifling communication has a significant downside. Take, for example, one collaboration aimed at improving the production

THE OUTCOME-IMPACT GAP FOR INDUSTRY-UNIVERSITY COLLABORATIONS

About half of the 106 projects studied resulted in what were seen as major outcomes (i.e., they produced new ideas or solutions to problems, developed new methods of analysis or generated new intellectual property of potential benefit for the company). But only about 20% of the projects led to major impacts on the company that participated in the collaboration.



process for a biotechnology product. The company contacted a faculty member with the relevant expertise and set up a two-year project. The company project manager disclosed the specific company needs, but did not explain how the project fit into the company's related strategy. The project manager told us that this was an explicit choice; the company, he said, "is really reserved when it comes to revealing its technology strategy." The result was that the solution delivered by the university researcher met the need in a way that was not consistent with other strategic considerations. It consequently had no subsequent value to the company.

This illustrates the tension between secrecy and disclosure that many companies face when interacting with university researchers. But companies that shared their goals and strategy in depth achieved collaborations with higher impact. As suggested by another project manager at a different company: "You should not underestimate the need to continuously remember the goals of the project to all the participants, especially the students." Indeed, the tension between secrecy and disclosure often was defused by creating relationships and trust between a company and a university research group. As another project manager stated, "Usually we have a better disclosure of objectives with universities that we have previously worked with. This is because we already have a common trust." The time needed to create such trust is one of several reasons

for the importance of long-term industry-university relationships, as discussed in Practice 4.

Practice 4: Invest in Long-Term Relationships Industry and academia do research on markedly different time frames. Industry is driven by economic and product cycles, while academic research project duration depends largely on the time required for a graduate degree program (a year and a half to two years for a master's degree, three to four years for a doctorate). Both parties thus need to be upfront, and realistic, about their time expectations. The creation of multi-year collaboration programs addresses this mismatch and improves the chance of a successful research outcome. (The average duration of the collaborations examined was two and a half years.) Over longer time periods, members of research teams develop better joint understanding of the research problem and common vocabulary in which to communicate the research results.⁶ The effect of duration can be contrasted with that of project budget size, which did not have a significant effect for the projects analyzed. As one project manager recommended: "Set up longer-term funding cycles. One year is too much pressure."

A secondary finding relates to the presence of long-term relationships. In nearly 80% of the examined collaboration projects, there had been a declared previous connection between the company and the university group. The presence of this previous relationship was positively correlated with the outcome of the subsequent collaboration. There is thus a benefit to developing and maintaining such connections, even if they are at the personal level and not contractual.

Practice 5: Establish Strong Communication Linkage With the University Team It is beneficial to have the university researchers visit the company and interact with company personnel. The more often these visits occur, the better the outcome and impact of the project. Such visits can facilitate the creation of strong personal relationships. Personal interactions are also crucial in the transmission of unwritten tacit knowledge⁷ such as details of design or development practices. Regular meetings at the company thus foster the success of the collaboration.

Companies can complement these personal interactions with regularly scheduled video and

telephone communications. These communications are used to established known and "routine" (as opposed to a special meeting) opportunities for the timely resolution of small problems. They also provide the company an opportunity to foster project discipline, helping to prevent the project from drifting away from its original purpose. Such teleconferences alternatively allow the company to communicate changes in interests or strategy that the research could be adapted to address.

While companies located close to their university partners have apparent advantages in increasing the level of visits and interactions, geographic proximity did not differentiate the success of the examined collaborations. The most probable reason is that face-to-face visits were made with roughly the same frequency regardless of distance, and colocation has little value if the opportunity that it creates is not taken advantage of. Further, companies are increasing interaction with universities by sending company personnel on extended stays as visiting researchers, by providing opportunities for faculty sabbaticals and leaves at the company and by providing student internships. These activities depend little on geography.

Finally, with the objective of ensuring that face-to-face meetings happen regularly, companies can (and do) actively encourage project managers and other employees to meet researchers at the university. As summed up by a director of external research: "Our collaboration process is university centered. I encourage people to meet university researchers on their turf."

Practice 6: Build Broad Awareness of the Project Within the Company Contact between university researchers and individuals in the company over and above the project manager increased the research's impact for the company. University researchers who were introduced to professionals from different functional areas (for example, manufacturing, product development or sales) were able to share methods, lessons or discoveries on a broad front. As a result of this wider awareness, the university team received useful suggestions from other company perspectives than that of the project manager's group.

The consequences of not achieving such awareness are seen in the history of a project to develop

techniques for drilling shaped holes in a complex part. The university researchers were tasked to develop an improved methodology with specific technical goals. The team delivered an approach with the desired features, and both the company project manager and the university researchers, who had worked together closely, were pleased with the outcome. The project manager then went to the production engineers to explore making the approach part of the manufacturing process. While the members of the production staff were impressed by the technology, they saw it as too expensive to implement, given their recent investments to upgrade the equipment for the hole drilling process. The company did not develop the approach any further and may not ever use it operationally. The situation could have been avoided had there been communication with manufacturing personnel during, rather than after, project completion.

Project outcome and the subsequent value of the research was higher for projects that had larger numbers of company employees involved while the research was under way; broad participation was important during the active research stage and before final outcomes had been produced. Specifically, there was a positive correlation between the number of people involved, directly or indirectly, in the collaboration and the project outcomes. Some companies actively fostered this broader engagement, in essence creating additional boundary-spanning activity to augment that done by the project manager. As one project manager recognized, “Now there is a push to incorporate more people into meetings with the university researchers to have multiple focal points to increase the diffusion of knowledge.”

Practice 7: Support the Work Internally Both During the Contract and After, Until the Research Can Be Exploited Successful management of industry-university collaborations implies a wider view than deliverables and contract fulfillment, because creating and sustaining a peer-to-peer relationship is central to success. Strong personal relationships serve as a catalyst for increasing knowledge flows. If these exist, people are more willing to invest time and effort in communicating knowledge to others.⁸ To incentivize and enable such investment, company project managers need to provide appropriate

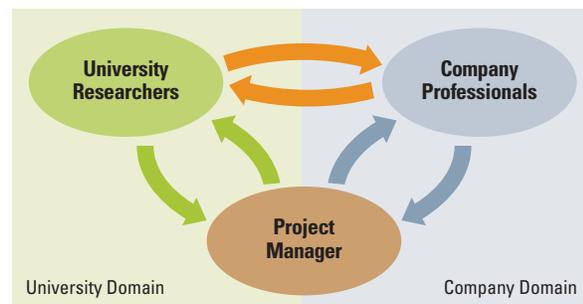
internal support for their work in the collaboration. The amounts quoted vary, but one general rule mentioned was that for every dollar spent outside, the company should devote a dollar inside.

The most effective industry-university collaborations were characterized by a sense of partnership — company project managers felt that they and the university researchers were partners exploring an area together. The level of project manager effort needed for such joint exploration implies provision of appropriate internal support. On the other hand, surveys showed that some project managers had demands that kept them from being able to devote what they thought was a suitable amount of time to the project. Those collaborations tended to produce lower outcomes than projects in which project management needs were more fully supported. Insufficient internal support means more than insufficient management time; it also implies negative impact on the relationship with university researchers.

To foster ownership of, and commitment to, a project, it is thus useful to include the dissemination of project results as an explicit part of the project manager’s performance review. Establishing this practice made it more likely that people inside the company would take steps to exploit the opportunity delivered by the university project’s outcomes, and ultimately increased the project’s impact on the company.

KNOWLEDGE EXCHANGE PATHS IN INDUSTRY-UNIVERSITY COLLABORATION

An effective communications framework can help bridge the gap between outcome and impact. It is important to have two-way knowledge transfer between the university researchers and the company’s project manager (green arrows), as well as between the project manager and others in the company (blue arrows). In addition, the project manager should keep groups inside the company abreast of progress on the research collaboration, and inform the university team of ideas from the company regarding potential linkages to other company activities (orange arrows).



A further aspect of Practice 7 is stated succinctly by famed baseball player Yogi Berra: “It ain’t over ’til it’s over!”⁹ A research project will generally not have achieved its full impact at the end of the contract with the university. The inward representation of the research results, which begins during the project’s period of active research, must therefore be maintained and even strengthened after the research has been completed. The project manager must take responsibility not only for this representation but also for ensuring the research is appropriately considered for possible action — successful completion of the project is a prerequisite for impact, but it by no means guarantees it, and the project manager typically needs to be proactive in taking the steps to make this happen.

Theory Versus Practice

Some companies were extraordinary in how they trained and rewarded project managers to facilitate research collaboration with a university, to strengthen internal awareness of the project’s progress and results and to ensure the results were evaluated by all relevant stakeholders. In other environments, however, even though company managers were aware of the value of the above practices, they paid little or no attention to implementing them. At one company, for example, all interviewees stressed the importance of informal technical communications and personal relationships, but the company briefing on managing university research made almost no reference to activities to develop such relationships.

The message from this study thus goes beyond identifying the seven practices. Merely talking a good game is not sufficient. What is needed is execution and follow-up of the actions: longer-term projects, continuing relationships, assigning project managers who make the contract feel like a partnership and enabling these managers to invest the time and effort to generate effective knowledge flows between the university and the company.

We understand the difficulties. The professionals who perform this function well are almost always needed for other jobs, the cost of their time is high and there is difficulty in capturing and defining the benefits for a given project. However, implementation of these seven practices can lead to

collaborations that create and deliver substantial value for a company.

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