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The Future of Research

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Introduction

The research world at the beginning of the 21st century is not much like it was even in the early 1990s. Due to speed and volume, information flow has crossed a phase boundary that contracts the globe to the size of a computer screen. The fall of the Soviet Bloc, the rise of India as an IT (Information Technology) powerhouse, the emergence of China as an international player in commerce, and the newfound vitality of the Southern Hemisphere have effected a flurry of changes in business conduct and product conception and manufacturing. The vast scale of IT-related business systems has brought about a new set of challenges. Changes in the degree of and desire for user-centeredness, changes in how software is produced, the increased modularization of products creating new industrial ecosystems, and the rush toward openness, community building, and social networks as a means of creating wealth have put a different set of forces in play in the research world, a world that has largely remained in the same form since long before these changes. Ironically, the most forward-looking parts of the commercial world would be among the last to change.

In late 2006, the IBM Academy of Technology undertook a consultancy to understand the future of research at IBM and in the IT industry. While the original purpose of the consultancy was to advise management regarding the future of IBM Research, the study group learned a lot about the future of industrial research in general, especially in IT-related fields. This paper is a summary of the results of the consultancy.[1]

Methodology

The question of the future of industrial research in general is very broad. We enlisted a large number of people to help us understand it. These people ranged from scientists and technologists at IBM, researchers and executives at other large industrial research labs, and professors and graduate students in relevant fields at major universities from all over the world. These collaborators spanned a wide range of experience, age, and locale.

The exploration was in two interview-based phases: brainstorming and information-gathering. In the first phase, we asked people to propose questions for us to ask participants in the second phase.

During the brainstorming phase—from January to June 2007—we identified seven topic areas to discuss with seventeen industry experts (four in IBM Research, six in IBM outside of Research, and seven in the industry) and five

[1] None of the material specific to IBM Research is discussed in this paper.

IBM new-hire roundtables in different IBM labs. Before each discussion, we sent the people a list of seed questions, designed to stimulate their thinking. Rather than ask them to answer the seed questions, we asked them to propose questions that we should ask during the information-gathering phase of the process, perhaps inspired by the seed questions. The seed questions covered the following seven topics:

- What is research good for?
- How will the external environment affect industrial research?
- What thresholds will affect industrial research?
- What turning points in the world could greatly change our assumptions?
- How do firms find and retain excellent researchers?
- What role should long-term results play in industrial research?
- What organizational models will be best for industrial research in the future?

We obtained a voluminous response from our interviewees. Some of them focused tightly on helping define questions. Others jumped right to talking about the future of centralized research, different research models, and the role of research within its parent firm. Many took interest in the wider role of industrial research. Should research become involved in larger societal issues, such as global warming, or should it narrow its focus to the parent firm's near-term interests? Should the research labs interact more with academia and, if so, how and to what ends?

Globalization was also a clear theme in the responses. Interviewees mulled over the possibility of globally integrated industrial research. They asked what the role of international labs should be, whether individual teams should span labs, whether virtual teams should form for specific projects when they are not physically together.

Our first round interviewees raised hundreds of issues that we distilled into a final list of questions short enough that our next round of interviewees could answer them all in an hour, but broad enough that we hit all of the important topics.

Ultimately, nine questions addressed IT research in general, grouped under the following themes:

- The research ideal
- The research ecosystem
- Globalization
- The role of industrial research
- The organization of industrial research
- The value and funding of industrial research
- The culture of industrial research

We preceded each question with a short paragraph to explain the setting of the question. For example, we formulated the first question—on the research ideal—like this:

> *Since the beginning of scientific inquiry a number of ways of doing research have been tried: individual researchers working on what interests them, researchers working on targeted, funded projects, on large "grand-challenge" projects, or on national imperative projects.*
>
> ***Q1—Consider this long, wide swath of research. Which research project or result, or which researcher, research group, or research organization do you admire most? Why?***
>
> *If no past research has struck you as ideal or close enough to it, please describe what you would consider an ideal project or result, or researcher, research group, or research organization. And tell us why you think so.*
>
> *In what way—if any—would the aspects you admire most relate to the industrial research setting?*

During the second phase, the team used these questions to interview over 60 industry leaders from both inside and outside IBM—a mixture of people from the seed interviews as well as others. We provided the complete text of the questions to the interviewees beforehand, so that they could have time to think about their answers. Again, we obtained a large volume of responses, from which we looked for both rough consensus and notable disagreements. The phase two interviews took place from September to October 2007 with synthesis during October and November 2007.

Findings

The next sections summarize what we learned from the responses, presented as a representative sample of the range of responses with consensus views noted where they were apparent to us.

Research Ideal

We wanted to know what research institutions in the past—or projects or researchers—people most admired. We hoped this would enable us to contextualize the other answers we got from each individual—perhaps because those answers would be an attempt to recreate the ideal. Instead we found the respondents generally admired research organizations that had more impact on society and on the industry as a whole rather than on their parent firms, whereas their answers to other questions indicated the opposite preference.

Among institutions, three appeared frequently: Xerox PARC (Palo Alto Research Center), Bell Labs, and IBM Research.

Respondents almost universally admired the heyday of Xerox PARC for creating or proving practical many of the most important innovations of modern computing. They also admired PARC both for assembling a large team of excellent researchers who were given a great deal of freedom to innovate, and for bringing together "hard" computer science (systems, software, and networking) with "soft" computer science (the psychology of the user and systems that were easy to use).

Similarly, respondents admired Bell Labs (prior to the AT&T breakup) for its world-class researchers, its freedom, and the enormous impact that its innovations had on the industry, from the transistor to Unix.

IBM Research projects were often cited as well. Notable among these were relational databases—for the rigorous research that started the field and for the long, dedicated work that turned that initial research into an entirely new market—along with Deep Blue, Fortran, and Blue Gene.

Among individual researchers, Donald Knuth was widely admired for his work on algorithms, Ted Codd for his work on relational databases, and Alan Kay for his visionary leadership at Xerox PARC.

Among individual research projects, interviewees frequently cited the Manhattan Project, the U.S. space program, and the creation of personal computing by the Xerox PARC Alto/Smalltalk team. Interviewees admired the "grand challenge" nature of the goals, the support and stability offered by multi-year funding toward their achievement, and the tremendous impact the results had on the world.

In general, the interviewees admired research that was visionary, very challenging, rigorous, and responsible for a huge impact on the world or the industry.

The Research Ecosystem

Every research organization exists in a context of research—an ecosystem of other research organizations, researchers, funding, conferences, and industries. We wanted to find out what the research ecosystem would be like in the near future.

Community / Collaboration / Partnerships: The respondents told us that industrial research will become much more focused on communities, collaboration, and partnerships, fueled by the realization that the nature of

the problems being addressed cannot be handled by in-house researchers only—that the range of expertise, talent, skills, points of view, experience, and knowledge exceed what a single organization can put together itself. Even within a large organization, such as a multinational firm, collaboration will be required across department and division boundaries for the same reasons. In the same vein, there can be many and diverse (potential) stakeholders in any particular research area, and therefore, getting close to them typically requires either collaborating or joining a community.

"Collaboration is good due to the differing focus of industrial and academic research…[there can be] lots of synergy with little overlap." Some respondents brought up issues with working with universities, especially regarding the different tempos of work (universities work more slowly) and IP (Intellectual Property) issues.

Some of the collaborations will be between firms and universities, customers, national labs and other public research organizations, business partners, venture capitalists, and perhaps even competitors. Large consortia and formal partnerships will increase in number.

Globalization: Globalization, the Internet, and the "flattening" of the world are enabling and compelling new models for interaction, collaboration, and work, itself. No one firm, university, laboratory, or country will have a monopoly on talent, creativity, and engineering skill. Through historical and cultural happenstance, different locales will become centers of excellence and expertise in particular research areas, or will have fostered communities of specialized talent. Alternatively, a particular region may have a need or stakeholders interested in a domain or research problem, and these circumstances can make it worthwhile to collaborate with researchers and others from that region. There was a feeling among respondents that the United States government, particularly, and possibly other governments were becoming less interested in funding research—especially basic research—and that in response, firms would seek emerging markets in which to base their research. In short, research money and topics will go where the market money and research talent are.

Moreover, different cultures think and perform research differently. Using these differences in approach, researchers local to a particular regional problem can focus their efforts in a way most likely to solve the need.

These observations imply that firms that can understand and create or adopt effective methodologies for working collaboratively across space and time will have a significant competitive advantage over those that cannot (William Gibson reputedly wrote: "The future is already here. It's just unevenly distributed").

We heard from several respondents that great researchers go where other great researchers are—they do not necessarily stay in their home country. Therefore, centers of excellence are a very useful approach. Skills are the reasons to be in different geographies, not labor arbitrage (moving work to the locale where it can be done most cheaply).

Even without formal globalization directions being set by their organizations, many researchers will be working remote from their labs, and the number of cross-geography and cross-organization projects will grow. Few labs have any formal support today for such remote researchers. It is critical to understand how these changes influence the sociology, methods, and tools for collaboration.

Scale: The respondents painted a complex and confusing picture about the scale of research projects in the future: in some cases large projects will be required to accomplish research goals, but the reality of business measurements generally pushes toward smaller goals (and results).

Scale sometimes affects the way research makes progress. Some market solutions will be so large that they become disaggregated components based on corporate specialization, and therefore an advance that one player in a market desires might depend on progress made by another member of the ecosystem, thus spurring collaborations.

In contrast, constraints on external funding will put pressure on the research ecosystem to populate itself with smaller (and more incremental) projects, and therefore potentially block avenues leading to large-scale solutions.

Move Toward Applied Research: Respondents strongly agreed that research is trending toward more applied—or market-driven or development-focused—research and advanced development. The respondents drew a distinction between "problem-solving" and "solution-providing." The first endeavors to invent a technological solution to a generalized statement of the problem as is typical of academic research. The second, being the more customer driven or market based of the two, provides a solution to the exact problem, using found technology and partial solutions.

Openness: Spurred by rising costs and informed by the success of many open-source communities, industrial research will become more open. Saving money, creating solutions (the above-mentioned "solution-providing" approach) rather than solving problems through the invention of technology, and engendering global collaboration all benefit from an open approach. Moreover, experiences with open source by some firms have shown that being competitive is not compromised by openness. Many times, solving problems can take the form of finding parts of the solution in open communities and putting them together.

Ubiquity of Information and Pace: One of the most influential factors for the future research ecosystem will be the ubiquity of information and the pace with which information becomes available. In the past, for instance, unless he or she attended the conference at which a new result was reported, a researcher on the other side of the globe would need to wait months or even years to get a hold of the paper that reported it. Today, in contrast, a high quality electronic copy of the paper is generally available concurrently with the conference. And, online news reports, blogs, and tweets sometimes begin advertising and dissecting the work even during the live presentation.

The pace of the software industry has greatly accelerated—because computers have become more powerful and because the Web/Net is the preferred deployment and marketing medium. Most of the processes underlying research have gotten a lot faster—computing, publishing, procurement, marketing, and delivery. The industry as a whole and the increased pace of competition are pushing every IT firm to reduce time to value.

What has not gotten faster is human thought and patent review. Similarly, in the past, a 10–20-year lag between invention and commercialization was not a problem because no one was producing solutions any quicker, and therefore, the customer need still existed when the business released the product or solution. Now the tempo has quickened so that sometimes labs embed researchers in the development and delivery team to eliminate intolerable organizational lag. A term one respondent used for removing organizational barriers to the deployment of research was "frictionless research," and it refers to getting value to the market directly from the researchers.

Intellectual Property: Many respondents commented that IP concerns and laws would be important to the future of the research ecosystem. In most cases, IP laws were seen as impediments to get around or posed problems to collaboration (who will own the IP?) that need to be solved, but the respondents did not believe that IP laws should to be eliminated. Rather, the consensus was that the laws should be brought up to date or they should take into account the reality of Net-based collaboration between enterprises.

Layering / Catalysts: Because of the increase in collaboration, the research organization will settle into layers with a core of researchers and experts surrounded at increasing removes by advanced product developers, customers/clients, university researchers, and community members. The purpose of the core or originating research organization will be to act as a catalyst for work rather than as a comprehensive all-in-one shop. Another way to be a catalyst will be with research investments in universities and consortia.

Interdisciplinary: One interviewee observed, "those narrow computing science folks [by themselves] are not so useful to do the research of the future." Several respondents commented that increasingly research will be inter- and

multi-disciplinary, both because the problems will require expertise from different domains and also because the different intellectual approaches brought by researchers in different disciplines will be required due to the complexity of the work and systems being built. In some cases, such multi-disciplinary collaborations could spawn new scientific and engineering disciplines.

One respondent said, “any research institution that builds walls between or within disciplines will fall behind.”

The Role of Industrial Research

Nearly all respondents agreed that an industrial research organization must be connected somehow to the profit-making aspect of its parent firm, and must serve that purpose one way or another, directly or indirectly, with applied or pure research. In some circumstances, this can be achieved by serving a public relations-type role (as some observed to be the case for Xerox PARC), and in other circumstances by requiring researchers to be embedded within product and service groups. Nevertheless, researchers should be able step back and look deliberately at questions confronting them, because research is one job where failure is acceptable. A research organization should keep its parent firm on the leading edge of innovation and “up the ante” on the competition.

Generally, long-term research is important to a firm, and in some circumstances its research organization should step up to provide this, particularly when the firm relies on a stream of new ideas, technology, and science to grow and increase revenue.

But industrial research is part of the larger research ecosystem. Industry is obligated to play its role within that ecosystem, in particular when other funding sources dry up.

Research organizations also typically play larger roles within their parent firms than purely doing research: they educate, communicate, and integrate new ideas—whether spawned within the labs or gleaned from the ecosystem—into the firm and its processes. A research organization should serve as a gateway to outside researchers and ideas—finding relevant research work, bringing it into the parent firm, understanding it, applying it, and integrating it. Such an organization should also help the firm understand the industry and market, and help the firm chart its future strategy and direction. The laboratory can also help with acquisitions—help find them, evaluate them, integrate them, and enliven them. Therefore a well-conceived industrial research organization should house a broader suite of talents and skills than is traditionally thought reasonable in industrial development—skills beyond domain expertise and research acumen.

Some respondents told us that it sometimes makes sense for researchers to do research outside the parent corporation—perhaps for hire. And, contrariwise, some research ideas that could have a major impact should be spun off to enjoy the benefits of the venture-capital environment of high energy and urgency, with the possibility of being bought back.

A research organization should investigate the business, management, and internal practices and expertise of its parent firm. In a world in which businesses often grow by acquisitions, the labs will have to improve their links to the acquisitions as well. Finally, some firms can use its research arm as a place of rejuvenation and renewal for its employees.

The Organization of Industrial Research

We found it useful to distinguish between the ***governance model*** and the ***funding model*** for research. The *governance model* defines how a lab chooses what to do and how to manage the work. The lab needs to choose what it does based on its mission and on the best interests of its parent firm. It is likely that the means of selection and management of exploratory projects and projects done in conjunction with the firm's product or services divisions will differ, because their goals (at least their short-term goals) usually differ.

Understanding the measurement system is a key part of a governance model, since the measurement system should enforce / encourage the behaviors desired. Respondents told us that it is important to understand how to manage different kinds of research projects. Research generally cannot use a traditional development management model, because the model must enable and support breakthrough thinking and exploration, even for short-term focused projects.

The *funding model* defines how the research lab gets funds to keep it operating. Several interviewees told us that some funding should come from the firm's business units for short-term explorations and advancements of products and services, while a large, stable base of funding should be provided, preferably in the form of an investment in the work of the research lab rather than as a "research tax."

The consensus among respondents was that industrial research is most effective when (organizationally) centralized. While there must be some degree of separation between the research organization and the parent firm, the structure should ensure that research provides business value to the firm and its customers. Although decentralization of researchers into development organizations was not thought to be a good idea due to concerns of too great a potential for focus on short-term firefighting and tactical concerns, it was agreed that there should not be any difficult boundaries between research and development.

The most popular definition of “centralized” research was, as one respondent put it, “a globally distributed centralized model” or “quasi-centralized around the world with local centers of competence” or “separate but connected.” Industrial research must embrace globalization and leverage the local knowledge of its labs around the world: that is, local labs should provide a home for local expertise.

The organization of research must enable the flow of innovations, technologies, intellectual capital, and people to and from the product, service, and solution businesses of the firm. Despite a likely separation between research and the rest of the firm, there can be no boundaries. Collaboration and partnerships will be essential, both within the firm and with governments and academia. Collaboration and partnerships will only grow over time in order to amortize the increasing costs of development.

The Value and Funding of Industrial Research

In general, we heard no single ideal formula for how to measure or fund research. A mix of metrics seems to be needed, but it was not clear to the respondents that complete quantification will be the best approach. Research management is really an art form. Metrics need to take into account impact on the firm (on products and services, but also in the form of knowledge, expertise, and image of the firm) and impact on science (papers, patents, professional activities, and external recognition). Metrics must also acknowledge and encourage dramatic leaps forward. Because dramatic leaps (impact on the overall industry) are often not visible until several years after the work is done, ongoing research should not be measured too closely, nor too often. Retrospective analysis of the role played by research in driving changes in industry and academia will be valuable.

On the funding front, a model that mixes various forms of funding was preferred. However, funding must be stable. There needs to be a sizable chunk (30–50%) of unencumbered base funding. Government funding can also help with exploratory work as long as it supports a research agenda that meets the needs of the parent firm. Funding and other resource commitment from the business units ensure that researchers pay attention to the needs of the business. Likewise, some money from customers or from licensing to external parties (including royalties or profit sharing) can align research with clients and the market.

Industrial Research Culture

Culture in a research setting encompasses the following: how projects are selected and defined; the value and acceptance of risk taking; the tightness of control by management and the ratio of manager to individual contributor; how leaders emerge and are treated; how idea-centric, project-centric, or

individual-centric the place is; and whether individuals or groups of individuals can start (small) projects based purely on their interests.

As noted, most respondents commented on the need for an industrial lab to be relevant to its parent firm. An internal research lab's main advantage over outside researchers is that it knows the parent firm's products and business. On the other hand, respondents also valued longer-term research and creativity, including "understanding things deeply even though there is no immediate connection to the business." It was seen as important not to focus on quick results—relevant does not mean behaving like a product or service group. Balance will be essential between relevance to the parent and creative, exploratory, long-reaching research.

A research organization should provide thought leadership and world-class technology to its parent firm. Only a research lab that can support exploratory work can create industry breakthroughs and innovations that enable the creation of new businesses. This requires the lab to take risks for greater impact, to encourage and nurture both focused and exploratory research: "we should have a high tolerance for ambitious, high-risk / high-reward work, as well as for steady sure progress in key areas of importance."

Risk-taking came up over and over again as an essential part of the research culture. "If research really does pay for itself in breakthroughs, then research should be working on risky stuff all the time." There were a number of comments on how to make risk-taking part of the culture and to avoid discouraging it. In particular, failure must "not be penalized—the individuals have to be able to try again." "Failure is acceptable as long as the goal was worthy."

Most respondents felt that positive encouragement of risk-taking will be necessary. "Plans for the next year should include some things that are unachievable, not only things that are clearly accomplishable. That is one way to force people to take risks." We "need to reward potential results, not only actual results." However, some thought that risk-taking should be so fundamental that no rewards should be needed (and that role models would be everywhere). As one respondent put it, "It is not that risk-taking ought to be rewarded. It simply ought to be what we do."

Several people noted the difficulty of both being vital to the company and doing high-risk work. The ideal was seen as "a culture of smart people working together on big problems relevant to the business." "It is essential that the right type of bright people be hired in the first place. They need to be interested in applied research that might have some application to IT someday." The lab should hire the very best, give them freedom, and empower them. Researchers should be "fearful of being too evolutionary." A culture of

excellence was taken as a given: “a culture of excellence and vision, not of increments and simply progress.”

The respondents also mentioned the need for “an environment in which people who work in different ways can be respected and rewarded. Diversity is good.” Diversity has many manifestations. “The culture has to enable people with different characteristics. Some people need lots of freedom, others need to have constraints and boundaries.” “The culture has to respect people of different abilities.” Diversity, according to the respondents, includes researchers from diverse cultures and ethnicities as well as researchers in a variety of disciplines; such broad diversity should be encouraged, not merely tolerated. “We need to have a culture that celebrates the entire spectrum of research activities from exploratory to product implementation.”

Respondents felt that innovation would come from “integrating a variety of research thinkers with different kinds of scenarios at play.” A research lab needs to respect both technical and business skills—separately and together. The culture needs to grow a “set of individuals [who] has a combination of technical depth and business acumen...[but] not all [need have both].” In sum, “people will feel rewarded if they are working in an environment in which they feel comfortable and where all people are respected ([including those who do] short term, strategic, [or] wacky far out stuff)—where all the people have value and contribute in different ways.”

Many respondents mentioned the need for an open, collaborative environment. “You miss an opportunity if you do not go to your neighbor’s door and understand what they are doing.” One interviewee noted, “you cannot force collaboration.... You need to bring people together in events where they can exchange points of view, and find commonalities and areas to collaborate.”

Not surprisingly, bureaucracy was not viewed as good for a research culture—there were calls for “a minimum of bureaucracy.” Planning (or at least too much planning) was viewed as a form of bureaucracy: “over-planning will certainly dampen innovation.” Another type of bureaucracy, bean counting, “discourages good work.”

A research lab must maintain a high quality and productivity standard for its research staff and high standing in the external research community. To accomplish this there must be a steady influx of new ideas into the technical community and strong linkage with academia. Rich university interactions were seen as critical to the industrial research culture. A good lab “should have strong connections to very good and well-aligned[2] university departments, leveraging their resources and influencing their research; it should also monitor

[2] A ***well-aligned*** university department is one whose research interests are similar or the same as those of the collaborating firm.

work done at less aligned departments." The benefit is the "many great ideas out of grad students and programs. They have to reinvent themselves constantly." Our respondents believed that "people should move back and forth from industry to academia." They thought rotations of graduate students and faculty into industrial labs, and sabbatical programs for lab researchers in academia should both be (aggressively) encouraged.

While an industrial lab "should share some characteristics of a university (openness wherever possible, variety of talks, and intellectually stimulating events,...)," it should not become a university. "An industrial research organization should remain separate from educational institutions." Its "strength comes from its connection to its sponsor," and it should have its own "unique culture and aspects based on its parent."

Just as close ties to universities were viewed as essential, so also were close ties between research and development. However, ties to development can be a two-edged sword. On the one hand, respondents wanted "a constant flow between research and the product divisions." On the other hand, there were concerns that being too close to development could cause a research organization to be less ambitious and exploratory. "The great success of the joint programs[3] and connection to the product divisions has perhaps—a bit more than I would have liked—squeezed us out of the adventuresome grand challenges."

Leaders are a critical part of the industrial research lab culture, because leaders set culture. Leaders must ensure that researchers do not lose their connection to real world problems. Our respondents noted, "leadership and talent are still vital and difficult to acquire and keep." The best labs "have an anchor or several anchor researchers," who lead these labs; "leaders and managers need to do research, participate in the work." As one person summed it up, "the right sort of leader to promote the desired culture is open-minded, inspiring, someone who trusts their own instincts, and who has high standards, but isn't bureaucratic or a bean counter. Someone who will always ask 'why?'"

If you want a strong lab, you need to hire the best and the brightest. Customers value world-class researchers; they excite the imagination and lead the way. But how do you recruit them, and how can you retain them? Our respondents felt that "to recruit and retain: reputation, publication, and external talks are the key." The right culture makes recruiting and retention easy. Key aspects are the quality of the research and the people, giving them the freedom and the right connections for impact. "Give them challenging problems and the opportunity to make a huge difference; the opportunity to freely interact with other smart people both inside and outside, and a sense,

[3] A ***joint program*** is a research project conducted in conjunction with a (sponsoring) product or service division of the parent firm.

above all, of empowerment—make them responsible for finding the right ways for them to impact the world."

In addition to all of the above, respondents looked for a special something in the culture. One respondent described the ideal as "vibrant—a culture with a dynamic nature. A culture that says 'I'm doing this, and [my company], and I, and society, will all benefit'." Another said simply, "elitist, small, and special." They felt that a great research lab would feel different from universities or development shops, and would be alive with "an economy of ideas" and opportunities for impact. "When a speaker comes to visit, do most researchers come listen or do they stay in their offices working? If they come to listen in general, then the organization is focused on ideas; if they stay and work, then it is focused on getting things out the door."

Conclusions

Although we concluded this study just as the recession of 2009 was beginning to brew, we believe that the results reflect a realistic view of research at the start of the 21st century. The changes wrought by the flood and pace of information available to firms and researchers, the globalization of the economy, the rise of local centers of expertise, the increasing scale of IT-involved solutions, the intertwining of firms globally brought about by open collaborations and the increasing translucency of corporate walls, and the evolution of the technical means to collaborate at great distances will not be diminished or reversed by business downturns, though the pace of their influence might be slowed by firms focusing on their immediate health.

The findings of this study point toward increased collaboration within and outside the walls of firms, a mixture of exploratory and quick-payoff research, the need for multi-disciplinary research teams, using global talent to solve regional (business) problems, stable funding, creating a world-class research culture that values ideas and welcomes failures when trying to attain worthy goals, and leveraging the focus on problems whose solutions will have real impact that being part of a firm brings.