

# FIVE

**COLLABORATIVE STRATEGIES:  
GOOD SCIENCE PLUS BAD  
MANAGEMENT EQUALS BAD SCIENCE**

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*I*n today's environment, multi-institutional research collaborations offer attractive opportunities to build dynamic and productive enterprises that can deliver otherwise unobtainable research outcomes. Successful collaborations result when the primary focus on research is complemented by equally serious attention to research management. Multi-university alliances can create an exceptional environment for research productivity if managed effectively and robustly, and if creatively attentive to the best that modern management techniques have to offer. Research management is the primary focus of this chapter.

The chapter begins with a broad review of the context that frames the rationale, the opportunities, and the necessities fueling the growing attractiveness of collaborations in university research. The rest of the chapter deals more directly with management issues critical to two distinctly different stages in the life cycle of a multi-institutional consortium. The processes used to design and plan a new collaboration that is meant to be nationally competitive are substantially different from the skills and techniques that will sustain and improve the operation of the collaboration once it is a going concern.

This chapter is intended neither to be a paper about research management nor a recipe for research management techniques. Instead, the ideas presented are meant to provide insights to academic researchers about how new or different management approaches can help realize significant research goals in the collaborations they are developing or are already managing.

The references to the management literature provide entry points to a rich resource of actual managerial experiences and illuminate the fundamental meaning of those experiences. Since that meaning and those experiences may be directly relevant to improving the processes used in a multi-institutional consortium, I have included a larger number of references than I actually discuss.

## **AN OVERVIEW OF MULTI-INSTITUTIONAL COLLABORATIONS**

Multi-institutional research collaborations involving universities, companies, or government have become more common in recent years. They are coming to be seen as effective organizational structures to cope with the escalation in the scale, complexity, and resource intensity of research opportunities. Research collaborations are particularly valuable when the outcomes produced would otherwise have been beyond the reach of any one of the collaborative partners. Well-managed collaborations demonstrate the truth of the old adage that the whole is greater than the sum of its parts.

American industry has been more active in establishing consortia than has academia. The collaborative forms used by industry—from those between individual companies focused on a particular product, process, or material to industry-wide efforts addressing fundamental issues of broad interest—have, in effect, been a test bed to discover what works and what doesn't. A key insight has been to recognize that the "best practice" management techniques harvested from the breadth of collaborative experience in the private sector are often transferable to research collaborations managed by universities. Conversely, industry has little doubt that treating the manage-

ment of multi-institutional collaborations with benign neglect can put the whole enterprise at risk.

The undeniable appeal of a consortium established at the right time and for the right purposes cannot be generalized to justify all consortia at any time for all purposes. Collaborations, just like any collective effort of two or more people, discover it is always easier to find ways to fail than ways to succeed. Of course, collaborations are never undertaken in anticipation of failure. Not believing in the possibility of failure, however, can by itself almost ensure that collaborative results will be less than could have been realized. Such a result is a more subtle, and less visible, form of failure than outright total collapse. Pollyanna notwithstanding, ill-considered collaborations can be enormously wasteful of time, talents, and resources.

### **IMPORTANCE OF MULTI-INSTITUTIONAL COLLABORATIONS TO UNIVERSITIES**

Attention to the values of research collaborations by higher education seems to be growing. And it is no wonder. Multi-institutional collaborations can accomplish what would otherwise be impossible to do. Neither the most resource-rich campus nor the most highly regarded research faculty can obtain or successfully organize the scale of resources needed to fully pursue many of today's research opportunities.

Campus-level motivations for consortia are many. Perhaps a university wants to expand its research portfolio as new collaborative funding opportunities are identified. A university may find itself able to pioneer or dominate in new research areas that would previously have been beyond its grasp. Or successful collaborations may help buffer the university against changes that are rapid or unexpected, reduce the problems of coping with the consequences of key faculty departing for greener pastures, and increase the university's public and political visibility. One, somewhat whimsical, rationale for interest in consortia may be that no university would wish to have its research portfolio described with the motto adopted by Rochester

Electronics, a firm selling discontinued semiconductor devices: “Leaders on the trailing edge of technology.”<sup>1</sup>

Universities seldom have resources sufficient to satisfy their current needs, much less the resources needed to position themselves adequately for whatever research future they eventually must deal with. That future includes the challenge of coping with new factors even less under their direct control than today’s research conducted by their own faculty. One example already confronts the changes in the form, function, and expectations of industrial research that have directly impacted university research. Industrial research support that had become customary and expected has disappeared, sometimes almost overnight. At the same time, industries began to provide support that formerly would never have been imagined by either the sponsor or the university.

A good measure of the importance of this growing interest in research alliances is the variety of groups that have examined multi-institutional consortia. For example, the National Science and Technology Council issued a report in 1999 that called for the renewal of the federal government-university research partnership for the 21<sup>st</sup> century.<sup>2</sup> The Business-Higher Education Forum established a University-Industry Research Collaboration Initiative to “... review issues such as ownership of intellectual property, freedom to publish research findings, patent and license policies, and organizational culture and communication.”<sup>3</sup> The “Industry-University Research Collaborations: Report Of A Workshop,” co-sponsored by the Industrial Research Institute, the Government-University-Industry Research Roundtable, and the Council on Competitiveness, is another expression of broad national interest in research collaborations at policy levels in the private and public sectors.<sup>4</sup>

There are many papers and books about collaborations. While each has its own focus, collectively they map the possibilities, the problems, and the texture, feel, taste, and smell of collaborative activities. Representative papers are those by Haskins,<sup>5</sup> Senker,<sup>6</sup> Inkpen,<sup>7</sup> and Marshall.<sup>8</sup>

## EXTERNAL TRENDS AFFECTING MULTI-INSTITUTIONAL COLLABORATIONS

The climate for university research has been impacted by changes and the rates of those changes in the rest of society. University research has not yet fully had to deal with the kinds of changes in research norms, expectations, and practices that industrial research has been forced to accommodate to for nearly two decades. A number of new trends also could have a significant impact on changes in university research practices. Zero latency and the knowing/knowledge divide illustrate two potentially important pressures for change.

### **Zero-Latency**

The rapidity with which “just-in-time” concepts have gone from a curiosity in manufacturing inventory control to an established practice in the private sector has mirrored broader changes that are less visible. The eminently sensible logic of having what you need only when you need it is now a dominant organizing principal for a significant share of American business. It has served well, from building cars in Detroit to stocking shelves in Wal-Mart. The concept has been generalized as a drive for zero latency: the instant availability of whatever is needed to complete the next step of any process. Zero latency has become a goal in organizations where minimizing capital used for facilities, equipment, material, or staff frees that capital for more productive investment elsewhere.

The choices administrators face about investing university resources in research are similar to those faced by their peers in Detroit, Michigan, or Bentonville, Arkansas. Universities, willingly or not, consciously or not, are now applying their own versions of free-market principles of risk-adjusted resource allocation to their research investment decisions.

While an exaggeration meant to emphasize the point, the drive to eliminate latency in university research can help explain the source of some of the confusion and stress experienced by those parts of the university research enterprise that are of interest to profit-making companies. The tension between an industry sponsoring a

project and the investigator over how quickly the research data will be available for company use is but one example.

In order for university research to move toward producing economically valuable results in a breathtakingly short period of time, the historical sequence for research must be better focused. Collecting data, analyzing them to produce information, and synthesizing that information to produce knowledge is a standard description of the research process. Integrating that knowledge to produce intelligence, and finally applying that intelligence to produce economic value, extends the concept of research as historically practiced on American campuses. In “normal” research, each step is separated from the next by a period of latency. Any pressure to reduce this latency, an essentially invisible part of the research process, will inevitably constrain or change the research process itself.

As so often is the case when changes loom, zero latency is a concept most easily supported when it is a requirement placed on others, rather than oneself. Though researchers may well see zero latency and research as mutually exclusive, no bright line separates them. Zero latency provides a good example of how the research community can find itself both resisting and accommodating new ideas that seem so obviously appealing elsewhere in the economy, yet are so antithetical to historic patterns of current academic research practice. Multi-institutional research collaborations among universities with limited experience in working effectively with other institutions are, unfortunately, fertile grounds for new management enthusiasms. In this circumstance, the only nearly certain outcome any new technique such as zero latency will produce is the need to deal with unanticipated consequences.

### **The Knowing/ Knowledge Divide**

Readjusting the balance between knowing and knowledge is a fundamental change now underway in American universities. Scarbrough addresses this issue in the broader context of the “... inherent conflict between ‘knowing’ as part of a work experience and ‘knowledge’ as an economic commodity.”<sup>9</sup> This conflict frames some of the still unresolved tensions to be found in university research.

The act of knowing the unknown has long been one way to define the bedrock idea of university research. The uses, if any, to which those research results were then applied were usually separated in time and place from the actual act of the research. Such separations were usually viewed as a virtue of the research. This barrier is now frequently breached.

The primacy of knowing as an intellectual process through a professional academic career has been supplanted in many fields by the recognition that knowledge in and of itself is an economic commodity. The free market economy is necessarily biased toward promptly realizing the economic value of such commodities. As soon as the free market becomes capable of harvesting the economic value of a new technology or discovery, knowing becomes knowledge. As a natural consequence, zero latency begins to exert its demands and research takes on the characteristics of a commodity product. Even the use of the word commodity imposes a particular interpretation of events. Premium, high-value products compete on a wide variety of value-added characteristics; price itself may have little or no impact on the decision to purchase. In contrast, commodity products compete primarily on price alone.

Researchers have been the beneficiaries of a long-held public view of research as a premium product. For many years and in many fields, the cost of research was not the central issue, especially when the research could be cast, even tenuously, as satisfying broad national purposes such as defense or health. The results of research carried out under the substantial external pressures imposed in recent years have shown that research can be subject to many of the same commodity-like considerations that discipline other parts of the economy. For example, increasing pressures on university researchers to avoid, reduce, and eliminate costs have brought a discipline to the conduct of research not previously seen. In this context, research alliances can argue their relatively greater cost-control effectiveness, even in the face of such economic pressures.

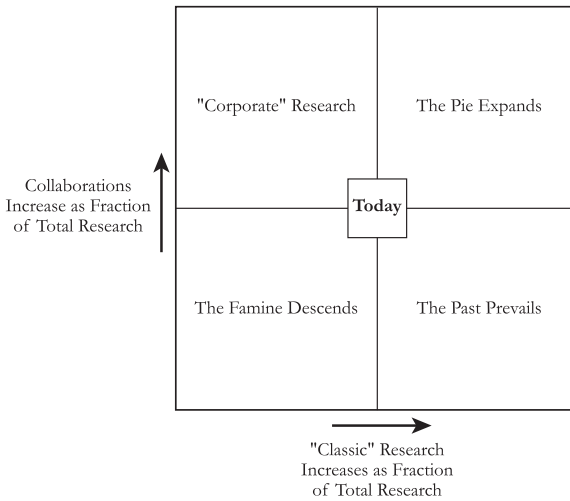
## PLANNING FOR UNIVERSITY-BASED COLLABORATIONS

The growth of collaborative research on campus may change the relative balance between classic and collaborative research. The dynamics of allocating campus research resources will change as one type of research becomes relatively more significant (however an individual campus judges such a value-laden word). Finding a way to organize thinking about these changes focuses decision makers at the strategic level rather than at the tactical level. A visual way to recognize and discuss campus-wide implications of changing the balance between classic and collaborative, or corporate, research is illustrated in Figure 1.

The box at the center of this figure represents the present-day relationship [may not be balanced] between "classic" research and "corporate" (collaborative) research on a campus. Moving up from the "Today" cell reflects an increase in campus research taking place within collaborations. Moving right from the same center box demonstrates an increase in the amount of classic research. Each of the four cells defines a possible research future for a campus. Each cell represents a future materially different from the other three, and from the present. An instant, and nearly visceral, understanding of those differences, and the consequences flowing from each of them, is meant to be captured by the label in each box. In strategic planning in the private sector each phrase labeling a cell becomes the title for a story line that describes a "future history." Done with care, such scenarios can provide a good understanding of the consequences to a university that finds itself in that particular cell.

In the upper right-hand corner ("The Pie Expands"), the simultaneous increase of collaborative activity and classic research activity might easily account for a broad renaissance of that university. In the lower right-hand quadrant, where classic research is expanding at the same time collaborations are decreasing, the story could be titled "The Past Prevails." In direct contrast, a university experiencing a decrease in its classic research activity and a substantial increase in multi-institutional research activities could occupy the cell labeled "Corporate Research." In the final quadrant on the lower left,

Figure 1. The Balance between Corporate and Classic Research



collaborative research and classic research both decrease. The story here could be titled “The Famine Descends.” If that future happens, university research will have severely contracted because of the dominant control of external factors. The only extramural research still able to thrive under this bunker mentality would be work so critical to some public agency or private company that funding would be found.

The value of these aggregate labels lies in the ease with which all players can agree to a common understanding of the campus research circumstance. That common perspective gives an organizing coherence for campus planning for the future.

With a strategic context established, a thoughtful examination of the six questions below can help a university Chief Research Officer think about some of the factors shaping the future of research on campus. The process of considering these questions, for surely there will seldom be any definitive answers, can help the campus begin to map its research future. A university intent on maintaining or improving its national research ranking cannot avoid thoughtfully considering these questions:

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- Over the next 5 years, what issues related to research will be most critical? Some issues may be specific to one particular research area; others may have campus-wide impact. In either case, the intent is to isolate those issues that are on the critical path to the desired future.
- What have peer institutions done over the last 3 years to shape their ability to thrive? While inter-institutional research competition is an acknowledged fact of life, few universities conduct serious analysis of a competitor's actions and then premise some of their own actions on that analysis.
- What have you done that will improve your overall competitive position? To a Chief Research Officer scarcely able to survive today's firefights, such a question may border on the absurd. Yet the Chief Research Officer must act with the future of campus research in mind, no matter what time and resources are available.
- Over the next 3 years, what could your competitors do to improve their position relative to yours?
- What could be done to move your institution ahead in the same period? Actions must be taken, even if done for no other reason than to protect and defend an existing position. Taking no action accepts the reality that the university's relative research position can only degrade over time, unless the institution's key competitors are similarly passive (an unlikely and dangerous assumption to rely on).
- Against the backdrop of the questions raised above, what contributions can multi-institutional collaborations make that will maintain or improve the university's competitive research position?

## CHOOSING AMONG TYPES OF COLLABORATION

Collaborations can vary widely in their scale and in the type of management necessary for their successful operation. Large research centers, such as the Engineering Research Centers funded by

the National Science Foundation, represent a significant investment in capital and operating costs on the part of the federal government and others. The level of this investment and the high profile that such centers have on campus lead quite naturally to the recognition that high-quality research management techniques or professional research managers are required.

At the opposite end of the spectrum are small collaborations that may more closely resemble a classic research model. For example, a few professors may see the advantages in shared use of unique or expensive instruments. The principal investigators may well view their management responsibilities as the price they must pay to do the research itself. Their research self-interest (at least in the short run) is then best served by only selectively using optimal management techniques.

Between these two extremes are multi-university collaborations that share few of the characteristics of either large centers or small-scale alliances. Yet this class of collaborations could easily become the dominant force in university research in the future. Good management for these consortia will pay dividends for the researchers themselves and for the university or funding agency administrators accountable for performance.

There are at least six different ways to visualize joint ventures for collaborative research. The first is the no-collaboration collaboration. For instance, two faculty members could create the appearance of collaborating as a way to meet an externally imposed need or to satisfy an individual want. Such collaboration is a marriage of convenience, never consummated, never annulled. In order to create the gloss of apparent multi-institutional research, they may agree to cite each other as participants on their individual research proposals. In contrast, the one-time collaboration is a quid-pro-quo exchange, a service offered for a service rendered. An investigator could perform a service for another researcher in a one-time exchange that meets both their needs. For example, a researcher with a unique piece of equipment may agree to carry out an analysis of a material developed by another researcher. Joint benefit could take the form of a jointly authored paper.

In the arms-length collaboration, each party has a continuing, though limited, need to be met and a contribution to offer. Here we first see the essence of a true collaboration: creating new values together. Groups with similar research interests could, for example, pool their unique resources for a limited time or a limited purpose. In the arm-in-arm collaboration, similar groups pool complementary resources for ongoing work that creates new value. Each group is motivated to collaborate because each recognizes how unlikely or impossible it would be to produce the desired results by themselves.

The hand-in-hand collaboration is built on the premise that there are benefits to be realized and applied to a research opportunity from the integration of seemingly unrelated resources. Each prospective member must meet two main conditions: an interest in the research product of the proposed consortium and the research competence needed to realize that product. Members may owe their allegiance to very different disciplines or institutions. Their assumptions about the research process, their experiences of working with others, and even their standards of what comprises research excellence may vary substantially. Despite all of which, the motivation to join the consortium is the possibility that groups so different can meld their research competencies to produce unique research values and to pioneer completely new research areas. If no similar concatenation of skills exists elsewhere, their monopoly position can give them an immense and continuing competitive advantage.

In parallel with consortia established to capture the benefits of a particular line of research, the value of a new kind of consortium is coming into focus. This is the partnership-of-competitors collaboration. A single university, a group of universities in a given locale, or a geographically independent group of universities establish a Research Services Provider (RSP). The essence of its mission would be to provide other research institutions or consortia with services that offer lower cost, more convenience, better quality, or faster turnaround. Whether the service provided is research or research support, the RSP is essentially offering a research service as a commodity. The more effective the RSP, the higher the barriers to entry for other universities that later attempt to offer the same services.

## MANAGING RISK

Any collaboration is, by its very nature, risky. Future risks must be analyzed and evaluated before they can be minimized, eliminated, or buffered against. Residual risks then need to be compared with prospective benefits. Collaborations bring the imperative for a comprehensive risk analysis into sharp focus.<sup>10</sup> Some of these risks will be common to all proposals, while others are unique to collaborations in general or to a particular collaborative proposal. This difference underscores the need for both a collaboration-level analysis of risks and a university-level analysis, each presumably best carried out under the supervision, respectively, of the prospective Principal Investigator and the Chief Research Officer. Only a careful inventory will identify research risks inherent in the money, capital equipment, personnel, and processes to be committed to an alliance.

Some risk-related issues, such as intellectual property rights, may become geometrically more complex as consortial membership grows. Other challenging aspects of risk management for multi-institutional collaborations are in areas generally unknown in the risk analysis of “conventional” research. Typical issues to be addressed include the identification and resolution of conflicts of interest between and among members; the responsibilities and accountabilities of individual member institutions for tangible assets under their control that are seen by other members as being the property of the consortium as a whole; the consequences when member commitments for resources needed by the entire consortium are not met; and the joint liability of all for actions of one member.

Other risks are less susceptible to resolution. How, for example, can limits on independent behavior by any one member in areas related to the collaboration be structured so that one partner is not viewed by the rest of the partnership as acting more like a competitor than a partner? How should the alliance handle messy intangibles such as an enhanced national reputation for all members that may be due primarily to one member’s collaborative activity? What disruptions of non-collaboration campus research will result from the resource demands of the collaboration? What happens to the

collaboration when an individual who is key to the collaboration leaves one of the member institution?

Because of the path-breaking nature of many risk-related questions about collaborations, it may be useful to organize an analysis of risk around nine general questions that should be considered before negotiating a research collaboration. First, how can a university's singular competency be deployed to deliver value to the consortium without simultaneously diluting its value to its "home" university? Second, what types and degrees of dependence on others in the collaboration are acceptable? In the first flush of enthusiasm in any new relationship, little attention is usually paid to thinking about the increase in vulnerability that is the natural corollary of any partnership. Perhaps the answer is best found by trying to understand what resources would be available to handle the consequences to the alliance when one member is no longer willing or able to meet its previously promised commitments.

Third, how can opportunism by partners in the consortium be contained? To not enter a consortium primarily because of concerns that the other members will expropriate the economic values produced by the collaboration is as counterproductive as assuming that no such appropriation could occur among scientists intent on their science.

Fourth, under what conditions and by what process will new institutional members be added to the consortium? How will the calculus of risk and benefit be worked out, especially if new members, however critical their contribution is viewed as being, face few of the risks already confronted by the rest of the membership? Will new members be expected to somehow pay their share of the real costs already borne by the membership?

Fifth, under what conditions will the collaboration dissolve? Making this question legitimate to discuss will help better define and resolve other issues concerning day-to-day operational concerns. Not asking the question carries with it the implication that the collaboration is a creature in perpetuity.

Sixth, how will the value of results flowing from the research be determined? By what process will those values be distributed

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among the members? Should it be in proportion to financial investment, to number of staff, to responsibility for the key creative action, to the risk exposure assumed, or some other criterion?

Seventh, will each member of the collaboration be able to do what it promises? Not only is the question relevant with respect to the team's research capabilities, but also with respect to the member's abilities to deliver competent management. The need is to distinguish between present-day hope and future reality, between potential benefits and likely benefits. This judgment cannot be the singular responsibility of the doers of the research, especially when the consequences of any of their unmet and naïve expectations may be visited on the university whose resources are at risk.

Eighth, how likely is it that outside competition able to do the work faster, cheaper, or better will threaten the collaboration? It is an understandably happy prospect to plan a collaboration certain to enjoy monopoly status. But it seems only prudent to base a university's decision on whether to join a consortium partly on a careful evaluation of how well positioned others are to trump the asserted uniqueness of the proposed alliance. Might a competitor alliance get there first?

Finally, what opportunity costs will the researchers and the university incur as a result of this collaboration? From each institution's perspective, will the benefits lost because of other opportunities foregone be more than made up for by benefits thought likely from investing those same resources in the alliance?

## CONSTRUCTING THE COLLABORATIVE AGREEMENT

Investing the time to write and negotiate a viable agreement that defines major issues for a collaboration is time well spent. A formal consortial agreement may be most useful when the impulse is to claim that no agreement is necessary. Memories that can be fallible or self-serving and unexamined assumptions that can be wrong are slender reeds on which to lean for the effective operation of a serious collaboration.

A consortial agreement that has been negotiated with openness, care, and luck may come close to a “Nash equilibrium.” In such an agreement, all parties recognize that further negotiation will not improve the results for all collaborative members because any improvement for one now comes at the expense of another. To the extent that the agreement is then the best possible for all, incentives to sabotage the agreement by independent action are reduced.

The agreement permits, favors, or prohibits specific activities in order to realize the outcomes desired. The University Relations Committee of the Industrial Research Institute has noted that successful collaborations, like successful companies, “... have explicitly defined and rewarded roles that facilitate knowledge capture, refinement, retrieval, interpretation, and use.”<sup>11</sup>

The terms of a collaborative agreement, like those for any successful common endeavor, are undergirded by a set of shared values and assumptions. In the best of circumstances, members of the collaborative team will recognize, nurture, and live by the terms of the agreement, in part because they almost unconsciously have lived in the shadow of similar homilies and truisms in their interactions with others since childhood. In other circumstances, when teams deny, ignore, or are oblivious to one or more of these fundamentals, the consortium pays the price.

These values, assumptions, truisms, and homilies lead to a checklist for the agreement. First, common objectives and hopes are essential. The collaboration must cite strategic goals and concrete objectives and the process to revise them. Why would anyone be willing to invest their professional reputation in a collaboration without explicit descriptions of what is to be done and how members will know when it has been done? The very obviousness of this need is, unfortunately, its Achilles’ heel. The unspoken belief in a common agreement about research purposes may seem so obvious that teams feel almost embarrassed to raise the key issues. The consequence is that words assumed to have common meanings become undefined code words standing for a presumed consensus on goals and objectives that are never actually discussed.

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Another truism is that real needs demand real commitments. The collaboration must allocate both resource commitments and benefits in an equitable manner. Said more crisply, there is no free lunch. In no reasonable research partnership would one partner provide the only commitments of resources while sharing the benefits of outcomes with others bringing nothing to the table. Member perception that an equitable balance in commitments exists is a basic requirement for a harmonious collaboration. Everything hinges, obviously, on the definitions of resource and commitment. However finally defined, commitments have meaning only when responsibility for accountability and timing is assigned. Consortial members responsible for making good on their commitments must be identified, when and how the commitment will be satisfied must be specified, and what recourse the membership will have when and if commitments are not honored must be spelled out.

A third truism is that risks are real and risk sharing is vital. The collaboration must balance risk exposures. The risks borne by individual institutional members must be equitable, not necessarily identical, and distributed with an eye for commitments and capabilities. The need for striking a balance in shared risks has a rationale similar to balancing commitments across the membership. Not only is there no free lunch, there is also no risk-free multi-institutional research alliance.

Since good relationships fuel success, the collaboration must establish carefully structured inter-organizational and interpersonal communication channels that build strong and productive relationships among teams. Effective communication channels will specify provisions for the timely identification and resolution of all serious problems before they become disabling. This statement seems so simplistic as to border on the obvious. But collaborations fail from ignoring its truth. It is precisely the relentless pursuit of effective communication skills in individual staff and robust communication process within and between teams that make successful collaborations possible.

The truism that mutual trust demonstrates strength also needs to be recognized. Collaboratives must explicitly specify accept-

able and unacceptable behavior in the areas most likely to create disabling misunderstandings. For example, the conditions under which one member discloses details of one its critical competitive advantages to its fellow members must be defined. How can such disclosures benefit the collaboration without loss of the advantage to the member? Trust is built; it is not dictated. Only the gradual accumulation of experience working together within the partnership will eventually lead to trust sufficient to rely on.

Another truism is that individual accountability produces results. The collaboration must describe effective and equitable governance that identifies the key decision makers at each member institution; designate specific individual responsibilities, authorities, and accountabilities; empower the internal Executive Committee; and establish effective external oversight through one or more external advisory groups.

Finally, it's nice to have friends. The collaboration must find high-level institutional champions to protect and promote the enterprise. The value to the multi-institutional collaboration of allies in each member institution who operate at levels of key decision-making authority is inestimable. Careful work will be needed to identify, recruit, and benefit from the services of institutional champions.

## **MANAGING THE BUILDING AND OPERATION OF MULTI-INSTITUTIONAL COLLABORATIONS**

### **Managing the Manager's Process**

Exaggerating for the sake of contrast, there are two opposite views of the management of research. In one, management is seen as a cost to be minimized and a necessity to be endured. In the other, management is recognized as an investment intended to create research competitive value and an opportunity to be seized. Whichever the view and whether recognized or not, individuals and teams acting on their beliefs about management will have fundamental impacts on the productivity of their consortium.

Good management, like good science, is an artful blend of wit and wisdom, of tools and processes, and of insights and seren-

dipity. The art comes from choosing the right blend of possible actions when no lock-step sequence of actions is obvious. The best managers, like the best scientists, recognize and act on patterns they see before others do.

Even casual readers of the popular press have been exposed to the ever-changing tide of fashionable management techniques such as Total Quality Management, re-engineering, and benchmarking. The very existence of these sometimes mutually exclusive schools of thought demonstrates that management practices move ceaselessly into and out of management fashion. The work by Malone and his colleagues at the MIT Center for Coordination Science reviews their efforts to go behind the veil of buzzwords to understand management process at a fundamental level.<sup>12</sup>

Good managerial skills and sensitivities of senior research managers of multi-institutional collaborations can increase the chance that their collaborative research will be done well, on time, and on budget. Creating effective multi-institutional research collaborations often requires management skills that are different both in kind and degree from the managerial skills usually expected of researchers in the past. However unfamiliar academic researchers are with these skills, they have become part and parcel of research management in industry and, to some extent, in federal laboratories. Much like good ideas in any field, they have the undeniable attraction of being obvious once realized, and low cost or no cost in their application.

Managers of research collaborations have the opportunity to identify and apply "best practice" techniques of modern management. Used with wit and care, these practices can help minimize their chances of failure. While such an outcome is obviously hoped for by the collaboration's management, these techniques serve more optimistic purposes by maximizing the chances that the collaboration meets or exceeds the expectations that motivated its establishment.

The willingness and the ease with which researchers believe in the value of these skills is partly a function of the culture existing both in their particular discipline and in the agencies on which they depend for funding. For example, experimentalists in high-energy physics have long been accustomed to participating in multi-institu-

tional and multi-researcher collaborations because of their dependence on very expensive machines. Such participation has necessarily meant that successful senior researchers have developed and applied a broader range of management skills than required of equally successful researchers in fields where single-investigator research is still possible.<sup>13</sup>

Pursuing a strategic research direction, forestalling a competitor's initiative, or establishing a research consortium all require making choices among alternatives. Most managers prefer to see themselves, and to be seen, as making rational decisions based on logic and available evidence. Scientists, given their rigorous training in the scientific method, surely share this preference when in a managerial role. Marching from one logical step to the next has an undeniable appeal. Yet experienced managers recognize that their decision making is more often than not profoundly shaped by factors lying completely outside the envelope of any simplistic or singular management method. For that matter, science itself seldom proceeds by the unswerving application of a lockstep scientific method. Scientists do not do good science by recipe. Nor do managers succeed by managing by recipe.

The work by Hammond explores in some detail the hidden psychological traps that can play a disproportionately important role in decision making.<sup>14</sup> The first of three traps is called the Anchoring Trap in which "... the mind gives disproportionate weight to the first information it receives." The second trap is the Status-Quo Trap in which decision makers display "... a strong bias toward alternatives that perpetuate the status quo." The final trap is the Framing Trap, in which ultimate decisions are made likely or important just by the way that the problem or the opportunity is originally framed. (Other useful papers in this general area are those by Shaw,<sup>15</sup> Sahlman,<sup>16</sup> Sharpe,<sup>17</sup> Williamson,<sup>18</sup> Kelly,<sup>19</sup> Miller,<sup>20</sup> and Quinn<sup>21,22</sup>).

### **Managing Processes and People**

The Principal Investigator and the staff of a collaboration can work together only within the universe bounded by their abilities and their styles. In one conceptual framework, leadership can be char-

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acterized as a blend of two distinct styles. In one, managers use supportive techniques, in the other they apply directive techniques. Managers whose style is highly directive are practicing a top-down form of management. While much less fashionable that it used to be, this hierarchical style is still perfectly appropriate in particular circumstances. For example, when a staff member new to the collaboration does not have the skills or the experience necessary to carry out a particular activity, strongly directive behavior on the part of the manager may well be the only option.

A managerial style characterized by low directive behavior and low supportive behavior is a good definition of a manager who delegates. Low directive behavior and high supportive behavior characterizes a manager whose style is to share in support with his or her staff. And finally a manager who is simultaneously highly supportive and highly directive can be described as having a selling or coaching style.

Managing the collaboration well means managing process well. To do it right, managing process begins with a comprehensive management framework robust enough to describe the full range of management issues likely to be faced by the collaboration. For each individual issue, the next layer of detail lays out the actions needed to resolve them. The framework also arrays the issues in relationship to one another as an aid to setting priorities and to allocating the resources needed to carry out the action. The work of Garvin is particularly effective at framing these issues.<sup>23</sup> Managers will be involved in direction setting, negotiation and selling, and monitoring and control. The entire organization will be involved in various work processes, behavioral processes, and change processes. In some processes managers by themselves will be the primary actors to formulate and carry out the work required. Other processes will involve staff from the entire organization.

Kanter brings life to the concept of consortial management by her use of personal relationships as a metaphor.<sup>24</sup> She organizes her examples about the process needed to develop a collaboration around stories of selection, courtship, getting engaged, and setting up housekeeping. In her view, collaborations work best when mean-

ingful integration between members occurs at five levels: strategic, tactical, operational, interpersonal, and cultural.

An interesting management initiative with good potential to be of use to university multi-institutional collaborations is the web-based “Best Practices Manual.”<sup>25</sup> Staff from several of the Engineering Research Centers at various American universities supported by the National Science Foundation (NSF) prepared the document. Though carefully noted as not being an NSF publication, it has been created as a “how-to” manual for staff of existing or prospective university-industry research centers. (A selection of papers exploring management and organizational issues include Schaffer<sup>26</sup> and Dodgson<sup>27</sup>.)

## **BUILDING INTER-TEAM COMMUNICATION**

Building strong and effective relationships within and between research teams unused to working together is a considerable challenge even in the best of circumstances. When teams have little or no experience working with any outside group the problems only increase. Alliances among different institutions can further complicate the challenge if either their physical separation precludes casual face-to-face interactions or their organizational cultures differ in their assumptions and policies about how teams “ought” to work together.

The difficulties that can be encountered in multi-institutional research collaborations never seem to increase either gracefully or arithmetically, especially when further complicated by teams coming from distinctly different disciplinary or experience backgrounds. Management decisions made in a profit-driven company, in a budget-driven federal laboratory, or in an academically driven university are unlikely to use comparable processes or reach similar decisions even when starting with comparable input.

It can be immensely difficult for the teams in a collaboration to pay sufficient early attention to management-oriented activities that are seemingly off-purpose and not relevant to research. Yet these activities are fundamental, necessary, and pivotal for eventual research success. Even one collaborator unwilling to invest the time early in a

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collaboration to build good communication can derail the possibility that the remaining collaborators can do so.

Collaborating slowly but surely is a behavior to be admired, but probably seldom seen in new collaborations. Visiting other collaborators early and often can be prompted by the needs to discuss and refine the research agenda. The goal of visits early in the life of the collaboration is effective communication and teamwork. Getting to that goal is no more straightforward and linear a process than is research. Such visits help to tease out the compatibilities and disconnects that are sure to exist when members of any research team, accustomed to their own rhythm of working primarily with one another, begin to build mutually satisfying relationships with members of other teams. False starts, fumbles, and stumbles must be experienced both to be believed and to reach the point where research progress isn't hobbled by talking past one another. As the different teams in the collaboration begin the long process of learning to work together they must relentlessly spotlight commitments, risks, and promises. Disagreements must be noticed, acknowledged, and resolved.

### FOSTERING INTER-PERSONAL COMMUNICATION

The strength of any collaboration lies in the skills and experience of its individual members, especially the personal chemistry that fuels their ability to work productively together. The individual members of any collaboration most likely to thrive in collaborative research will be those able to tolerate ambiguity, negotiate fairly, communicate openly, resolve all problems promptly, do what they say, fail gracefully, and learn eagerly.

The paper by Manzoni and Barsoux reviews with what ease, and with what self-justification, managers can create the conditions that lead to the failure of one or more of their staff.<sup>28</sup> The pity is that failure of any staff member is almost certainly the least of the manager's intentions and would be vigorously denied if the possibility were pointed out. The authors review the nature of the relationship between a manager and a staff member and show ways to establish a relationship that can benefit both parties.

Communications between a manager and those who report directly to him/her can be freighted with baggage none intends to be there. None may even recognize the impact it can have. The paper by Argyris very concisely illustrates the dangers in defensive communications.<sup>29</sup> Managers can hobble themselves by defensiveness and even by good management practice applied in the wrong context.

Organizations act through their policies, practices, actions, and the culture they support to shield individuals from accountability. In addition to the pernicious effects such patterns have on the individual, the team itself is denied the benefit of experience. Defensive behavior on the part of individual team members or, for that matter, the team itself, can be one of the elements that undermines the potential success of a research collaboration. Most team members, being human, act almost automatically to minimize their vulnerability, their risk, the possibility of their embarrassment or humiliation, and any appearance of their incompetence. Research team members act to avoid these results, as Argyris has noted, by trying to maintain unilateral control, trying to maximize winning and minimize losing, trying to suppress their negative feelings, and trying to be as rational as possible.

## **THE ROLE OF CHAMPIONS**

The value to a collaboration of having one or more high-level institutional decision makers serving as champions for the consortium is often overlooked. Such an individual or individuals can pay unanticipated dividends over the life of the consortium. Champions are carefully recruited for their level of authority in the institutional member of the alliance, their position, and their self-interest in the success of the collaboration. Such champions can defend and enhance the collaboration at policy and decision-making levels that would never be open to the Principal Investigator.

Once motivated and informed, such champions can build and sustain relationships with their peers at institutions that are also consortial members. Their assistance will aid in meeting objectives and commitments by increasing the likelihood that commitments

made by the university will be met as promised. They can help monitor performance, resolve critical path issues, and serve as an early alert both for opportunities and for threats to the consortium.

In the best of all situations, the champions can serve as coaches to the collaboration's leader. In no sense is this mentoring role meant to imply that the head of the collaboration lacks some critical skill. Rather, the "champion" can act as a sounding board to the leadership, offering counsel from a position not involved in the day-to-day turmoil of the alliance, yet from a base of knowledge and experience that can contribute to the overall chances of success.

Once again, the balance of power and authority is a delicate one. An institutional champion has no command authority for decisions about the collaboration, nor should any be needed. Conversely, the alliance leadership would be willfully obtuse to ignore the observations of such individuals. They don't have to be obeyed, but they do need to be taken seriously. And the champion must be seen by others to be taken seriously by consortial senior management.

### **THE ROLE OF GOVERNANCE**

All collaborations, especially those that are highly visible on campus or in the outside world, benefit from a governance structure that is a source of focused and unbiased insights and advice that would otherwise be difficult or impossible to obtain. Establishing an Executive Committee composed of principals from each consortium member provides a straightforward way to review plans, budgets, processes, and results. The committee is usually a comfortable way to reach consensus on critical-path issues. Issues likely to be divisive if unilaterally decided by the Principal Investigator can often be resolved with less rancor by a properly constituted committee. Done properly, a delicate balance is struck in which the committee neither has, nor needs, actual decision-making authority.

An external advisory committee made up of senior decision makers from all of the institutions participating in the collaboration and from relevant outside organizations has proven invaluable where they have been established with due care and employed effectively. It

is, unfortunately, all too easy to find advisory committees with members whose self-interests or friendships with consortial managers immediately undercut the value of the committee. Even when appropriate members are appointed, it is not uncommon to find committees that seem somehow threatening to the collaboration management. In these cases, committees may seldom be called into session. Or meetings can be trivialized by agendas that ignore major issues. Or results of committee work are ignored by management.

With careful appointments, advisory committees have unique roles that can benefit collaborations. Because of their affiliations and the breadth of their personal experiences, committee members can review and monitor plans, budgets, and results in ways that consortial staff cannot. They can perform an annual confidential review of the performance of the Principal Investigator. In addition to the value such reviews can have for the individual reviewed, they can also reassure the institutional members of the consortium and its funding sources that the consortium seems to be on track and that no unpleasant surprises seem likely to arise. Members of the committee can also assist leaders of the consortium to access individuals who occupy key positions at levels not usually accessible to the Principal Investigator. In similar fashion, doors can be opened into organizations outside the boundaries of the common experience of the collaborative team.

The experience of the National Science Foundation with Industrial Advisory Boards for their industry/university cooperative research centers demonstrates the value of such external committees. NSF requires member industries to agree to annual memberships. Besides the obvious value of the funding such memberships provide, each industry must choose annually whether to renew its membership. This simple requirement provides a more powerful feedback signal about the value of the collaboration than almost any other, primarily because the decision to renew is so public an expression of satisfaction with the consortium. Collateral benefits to the National Science Foundation also include opportunities for input about the state of the collaboration; this input is then delivered in meetings not attended by Center staff.

## THE CONSORTIAL ACCELERATION NETWORK (CAN) TEAM

A perennial challenge for any large organization is to find ways for one part of the organization to benefit from the hard-won experience of individuals and teams in other parts of the same organization. This problem is exacerbated in universities by the jealously protected independence of professorial research and the concomitant balkanization of disciplines and departments. While by its very nature a consortium breaks down many of these barriers for the research it carries out, walls of tradition and institutional inertia still limit the timely transfer of effective managerial processes and practices. As a result, research management lessons already learned in one part of the campus become lessons to be unnecessarily relearned elsewhere on campus.

Establishing a campus-wide Consortial Acceleration Network (CAN) team can help ensure that the management practices used by a consortium are the best possible, not just minimally sufficient. CAN team involvement in the development of competitive new collaborative proposals can help establish a competitive advantage for the university. Bringing common practice to the development of proposals can help reduce risks and uncertainties otherwise faced by proposals prepared only by the researchers themselves. The same kind of team can also better ensure that operational consortia consistently use state-of-the-art management. Properly used, the university CAN team can contribute to both the efficiency and the effectiveness of a university research operation.

However attractive the possibility of good results are, the CAN team cannot thrive on those possibilities alone. University senior administrators must be seen to actively support it. The Chief Research Officer must see it as a priority. Meaningful resources must be allocated to it. Those assigned to the CAN team must see it as personally advantageous to their careers. And managers of prospective or existing consortia must regard it as a resource so directly advantageous to them that they compete for its services with other on-campus research units.

A CAN team can be a powerful tool for a Chief Research Officer intent on protecting and enhancing the national reputation of the campus for research excellence. It offers a competitive advantage in an era when such advantage is both valuable and increasingly hard to find. A university that defines its competitive advantage in its array of unique core competencies both in research and in organizing and delivering a core competency in research management will have a distinct advantage.

Many of the management issues dealt with in preparing a strong multi-institutional proposal (or in helping an existing collaboration submit a proposal) will be one-time issues in the eyes of the Principal Investigator, yet will be issues faced repeatedly by the research office. How best can the lessons learned from these repeated activities be collected? How can that information be organized so that it is retained and refined rather than constantly reinvented? And by what mechanisms can that knowledge be delivered to consortial leadership teams when they need it and in a form that satisfies their needs without exacting a cost that exceeds the benefit of the service provided?

A Chief Research Officer can charter a CAN team to bring organizational resources to bear on priority research management problems and opportunities. A CAN team acts as a research management process incubator for the entire campus. CAN team members may be members of the university staff or they may be brought in from the outside. Internal CAN team members may be members of the research office staff itself, may be faculty members with skills appropriate to the needs, or may be other on-campus practitioners recognized for their best-practices skills. The quality of services delivered will be the best possible when team members compete for an assignment because it is professionally satisfying work and beneficial to the individual's career, and the team itself is widely recognized on campus for its contributions. Coercing people to be members of a CAN team as added-duty assignments with little acknowledgment for their contribution will reap what is sown. In some cases, it may be necessary to engage individuals outside the university as CAN team members to fill gaps. Teams of consultants or companies may offer

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the right blend of services. In any case, the more regular the service of CAN team members, the higher the quality of service delivered.

There will be a natural tendency for the CAN team to be judged primarily on its abilities to put out fires. Well designed and well used, CAN teams will put out fires, but also prevent them and help create new values. CAN teams can best serve consortia with proactive managers. In some cases, the Principal Investigator and senior staff will require minimal assistance because they have sufficient range of skills and experience. In other cases, a CAN team that is both broader and deeper in its skills and experience may provide a larger proportion of the work required to resolve the issue. The essential criterion of success is whether a CAN team improves research management.

CAN team activities, from proposal development to consortium operation, will be limited by needs, imagination, wit, will, and resources. At the broadest level, a CAN team can facilitate organizational development, conflict resolution, strategic planning, and evaluation. Assistance may include helping consortium management under threat of imminent loss of funding by its supporting agency; helping develop and negotiate a consortial agreement; identifying and recruiting high-level on-campus champions; providing advice about the internal executive committee; helping design, recruit, and effectively utilize the external advisory committee; drafting the management plan; and reviewing the entire proposal. The CAN team can also upgrade management activities by providing short and focused training for the Principal Investigator and key staff members in areas of immediate relevance (such as proposal development) and on topics designed to build their long-term management “intellectual capital.” It can serve as an on-call management coach for the Principal Investigator to provide confidential assistance in topical problem areas. It can also assist consortium management to realize maximum benefit from advisory committee activities, as well as provide the advisory committee with advice. At the consortial staff level, the team can help build good communication skills and processes within the on-campus team and between consortial member teams. Realistically, the CAN team has little or no role to play in developing the research

agenda, other than possibly facilitating the strategic planning process. By serving as the repository of the “what works and what doesn’t” lessons in research management, the team can provide opportunities for cross training staff with similar responsibilities in different collaborations (for example, by calling periodic meetings among administrative assistants).

## **RESOLVING PROBLEMS**

Most of the problems faced by consortia are already familiar: costs higher than budgeted; time lags and latencies longer than expected; complexities greater than initially imagined; unanticipated opportunity costs emerging; goals and objectives confused, ignored, or changed unilaterally; critical commitments over-promised or under-delivered; problems and failures ignored; individual authority or accountability sabotaged or not established; research suffocated by management and organizational processes; key researchers departing; research effectiveness declining through the accumulation of small insults; communication between individuals and teams degrading through inattention; collaboration staff members proven to be the wrong people in the wrong place at the wrong time; managers managing ineffectively; intercultural disconnects between and among teams unseen or ignored; or institutional members withdrawing their membership, their commitments, or their support.

Avoiding these problems when possible or resolving them when necessary is the manager’s job.

The kinds of actions useful to help avoid and resolve problems form a set of maxims, a checklist for good managers. The first maxim comes from Tom Peters, whose first book helped create the tidal wave of changes in management the country began to absorb in the 1980s. His notion is powerful because it seems so counterintuitive: fail faster. Efforts that fail inform later actions. Decisions delayed may well be decisions nonetheless. Every manager discovers many ways to fail, from which good managers distill ways to succeed.

Second, handle the problem, then fix the system. In the heat of day-to-day management turmoil it is easy to focus on one or the

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other without having the perspective to see the value of doing both in the order listed.

Third, don't shoot either the messenger or the wounded. In the frenzy to do something, anything, even if it's wrong, the messenger and the wounded can be seen as irresistible targets. Only later may the sacrificial ritual be recognized for what it was.

Fourth, everyone needs to be involved to fix the system. Under pressures of too little time and the perceived imperative to "do something," unilateral managerial actions can be very appealing. Imposing solutions may work in the short term, only to be seen later as having undermined broad consensus by being unnecessarily unilateral. The best managers will be able to distinguish between a true imperative for immediate action and a false imperative, or at least learn from their experience. Less successful managers can easily remain oblivious to their wrong choices and their downstream consequences.

The fifth piece of guidance is to systematically review failures and successes. Failure analysis can often be a low-value, pro-forma exercise undertaken to satisfy convention. The thought of analyzing success can easily be seen as a waste of time by many managers; while analyzing failure may threaten careers. But both are essential for success.

Sixth, hold managers accountable for actions and results. The personal accountability of managers for outcomes has never been in doubt, though its consistent application for reward or punishment waxes and wanes over time and from one organization to another.

Finally, be brazen about lessons learned. Managers of multi-institutional collaborations need to be nearly obsessed with communicating lessons learned throughout the collaboration. Some people learn best when information is presented verbally, others learn through pictures, and still others through printed words. Pressed by time, managers can mistakenly persist in the belief that communicating a message once by one means is sufficient, despite evidence even in our own learning experience that it seldom is.

## CONCLUSION

Multi-institutional, multi-disciplinary research consortia are undervalued and minimally explored in today's university environment. The ever larger tides of change in university research, the flux of opportunities and needs, may (will!) lead to a higher valuation and greater exploration of the place of consortia in higher education's research portfolio. A successful consortium will be composed of institutional members and staff who recognize that the value of their mutual need to work together is significant and outweighs the very real costs associated with the consortium. They have a shared history of surviving conflicts. They have a common desire to press forward to meet objectives that are recognized by all. Institutional members routinely meet their commitments to provide funds, staff, or other resources. The staff comes to notice and rely on trust that widens and deepens in visible ways. A common recognition grows that what they have mutually developed makes possible actions that would not otherwise have been taken. Finally, there will be recognition internally and externally that individual responsibility, authority, and accountability are the threads that have been woven together to become the very fabric of the collaboration. The best research managers then will heed the advice of leaders across the world and across time: each will rush to the front to lead their consortium staff the way they are already going.

## ENDNOTES

1. See <http://www.rocelec.com/default.htm> (as of 28 May 2000).
2. See [http://www.whitehouse.gov/WH/EOP/OSTP/html/999\\_14\\_4.html](http://www.whitehouse.gov/WH/EOP/OSTP/html/999_14_4.html) (as of 21 May 2000).
3. See “University-Industry Research Collaboration Initiative” at <http://www.acenet.edu/about/programs/Programs&Analysis/BHEF/initiatives/uni-ind/home.html> (as of 9 September 1999).
4. “Industry-University Research Collaborations: Report Of A Workshop” (1995). Co-sponsored by the Industrial Research Institute, the Government-University-Industry Research Roundtable, and the Council on Competitiveness. Duke University, November, pp. 28-30.
5. Haskins, Mark, Jeanne Liedtka, and John Rosenblum (1998). “Beyond Teams: Toward an Ethic of Collaboration” in *Organizational Dynamics*, Spring, pp. 34-50.
6. Senker, Jacqueline and Margaret Sharp (1997). “Organizational Learning in Cooperative Alliances: Some Case Studies in Biotechnology” in *Technology Analysis & Strategic Management*, Vol. 9, No. 1.
7. Inkpen, Andrew C. and Kou-Qing Li (1999). “Joint Venture Formation: Planning and Knowledge-Gathering for Success” in *Organizational Dynamics*, Spring, pp. 33-47.
8. Marshall, Edward M. (1995). *Transforming The Way We Work: The Power of the Collaborative Workplace*, American Management Association, New York.
9. Scarbrough, Harry (1999). “Knowledge as Work: Conflicts in the Management of Knowledge Workers” in *Technology Analysis & Strategic Management*, Vol. 11, No. 1, pp. 5-16.
10. Simons, Robert (1999). “How Risky Is Your Company?” in *Harvard Business Review*, May-June, pp. 85-94.
11. “A Report On Enhancing Industry-University Cooperative Research Agreements” (1995). The University Relations Committee of the Industrial Research Institute, Washington, DC.
12. Malone, Thomas W. et al (1999). “Tools for inventing organizations: Toward a handbook of organizational processes” in *Management Science*, Volume 45, No. 3, pp. 425-443.

13. The American Institute of Physics “Study of Multi-institutional Collaborations” explores these issues in more depth. See <http://www.aip.org/history/reports/rpt1.htm> (as of 21 May 2000).
14. Hammond, John S., Ralph L. Keeney, and Howard Raiffa (1998). “The Hidden Traps In Decision Making” in *Harvard Business Review*, September-October, pp. 47-58.
15. Shaw, Gordon, Robert Brown, and Philip Bromiley (1998). “Strategic Stories: How 3M Is Rewriting Business Planning” in *Harvard Business Review*, May-June, pp. 41-50.
16. Sahlman, William A. (1997). “How to Write a Great Business Plan” in *Harvard Business Review*, July-August, pp. 98-108.
17. Sharpe, Paul and Tom Keelin (1998). “How Smithkline Beecham Makes Better Resource-Allocation Decisions” in *Harvard Business Review*, March-April, pp. 45-57.
18. Williamson, Peter J (1999). “Strategy as Options on the Future” in *Sloan Management Review*, Spring, pp. 117-126.
19. Kelly, Kevin (1997). “New Rules for the New Economy” in *Wired*, September, pp. 140 et seq.
20. Miller, J. A., P.M. Norling, and J.W. Collette (1997). “Research/Technology Management” in *Encyclopedia of Chemical Technology*, Fourth Edition, Volume 21, pp. 264-291.
21. Quinn, James Brian (1978). “Strategic Change: Logical Incrementalism” in *Sloan Management Review*, Fall, Volume 20, No. 1, pp. 7-21.
22. Quinn, James Brian (1980). “Managing Strategic Change” in *Sloan Management Review*, Summer, Volume 21, No. 4, pp. 3-20.
23. Garvin, David A. (1998). “The Processes of Organization and Management” in *Sloan Management Review*, Summer, pp. 33-50.
24. Kanter, Rosa Beth (1994). “Collaborative Advantage: The Art of Alliances” in *Harvard Business Review*, July-August, pp. 96-108.
25. See [http://www.erc-assoc.org/manual/bp\\_index.htm](http://www.erc-assoc.org/manual/bp_index.htm) (as of 21 May 2000).
26. Shaffer, Robert H. and Harvey A. Thomson (1992). “Successful Change Programs Began with Results” in *Harvard Business Review*, January-February, pp. 80-89.

## COLLABORATIVE STRATEGIES

27. Dodgson, Mark (1999). “What Role for Management in Science?” in *Technology Analysis & Strategic Management*, Vol. 11, No. 2, pp. 133-141.

28. Manzoni, Jean-Francois and Jean-Louis Barsoux (1998). “The Set-Up-To-Fail Syndrome” in *Harvard Business Review*, March-April, pp. 101-113.

29. Argyris, Chris (1991). “Teaching Smart People How To Learn” in *Harvard Business Review*, May-June, pp. 99-109.