**Balancing Structure, Partners and Goals to Achieve Strategic Fit in Collaborative Product and Process Development**

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Strategic fit implies a match of the organization's strategy with its environmental context (Zajac, Kraatz and Bresser, 2000; Ju, Chen and Li, 2005). Contingency theory would suggest that the organizational form should reflect the demands of the environment. Lawrence and Lorsch (1967) contend that organizations should and will increase their differentiation to deal with increased environmental uncertainty. Herein lies a paradox for technology alliances.

When organizations must reach across their boundaries to other organizations to collaborate on technology challenges, the differentiation that would support such uncertainty often introduces coordination challenges. We believe this is one of the fundamental reasons that technology alliances are so difficult to sustain over time.

This paper is based on an in-depth study of one industrial consortia, The Abnormal Situation Management Consortium; and a review of three additional consortia for comparison purposes: the McMaster Advanced Control Consortium (MACC), the Microelectronics and Computer Technology Corporation (MCC), and SEMATECH. [2] All four were established to address challenges of technology or process development. Over a two year period, the Penn State team conducted over 25 interviews and participated in over 150 hours of interviews and meetings. Interviews were conducted with ASMC and MACC, whereas we have relied on the published documentation for information about MCC and SEMATECH.

**R&D Consortia**

Consortia represent a unique organizational form, ideally suited for flexibility in approach and fluidity in membership, compared to other forms of collaborative arrangements such as joint ventures or R&D limited partnerships. A consortium is "…two or more companies sharing resources to create a new legal entity in order to conduct cooperative research and development activities" (Olk and Young, 1997, p. 856). Research and development (R&D) consortia emphasize basic or applied research in the early phases of innovation. Advancement of the industry is often the primary goal of a consortium, as much progress can be made when competitors collaborate in the early stages of innovation (Rigatuso, Tachi, Sylvester, & Soper, 1997). Two distinguishing features of consortia include members not being completely detached from their parent companies and changing membership, as some members leave and others join (Evan & Olk, 1990).

A study of 53 successful consortia found that consortia form under either emergent or engineered processes (Doz, Olk, & Ring, 2000). Under an emergent process, consortia form due to changes in the environment (e.g., new governmental regulations, foreign competition) or the presence of similar interests among potential members. In contrast, engineered processes capture the intervention of a triggering entity such as individual or firm champions that draw attention to the need for collaboration. Whereas emergent processes reflect a

bottom-up orientation, engineered processes reflect a top-down orientation. According to Doz et al. (2000), survival of a consortium will depend upon the ability to manage both emergent and engineered formation processes.

Trist (1983) has identified nine phases of R&D collaboration development:

1. Identifying interdependencies
2. Developing shared norms of problem solving
3. Triggering cooperation: the need for a focal entity
4. Selecting participants
5. Making the shadow of the future visible
6. Securing the participants' sustained ability to contribute
7. Learning and adjusting over time
8. Expansion of scope and deepening of commitments.

In this model, the consortium initially focuses on why and how to organize. During this phase, either an individual or group determines that a challenge is beyond the resources or capabilities of a single entity (ASMC and MCC) or a shock to the environment alters the competitive dynamics in such a way that only a collaborative response might be successful (MCC and SEMATECH). Once a purpose is established, the consortium must determine what it seeks to achieve and how it will organize itself to do so. In R&D consortia in the U.S., there is an emphasis on pre-competitive R&D, primarily due to the influence of anti-trust legislation, since most consortia include competitors as members (Brod and Shivakumar, 1997). Pre-competitive research constitutes experimentation, development or testing of technique, development of prototypes and the exchange of research information (Even and Olk, 1990).

In subsequent phases, the consortium must garner support through membership, including both financial support and personal and organizational commitment. It is interesting to note that consortia are joined and supported by organizations, but in reality, it is the organization's personal representative that influences the direction of the consortium and, ultimately, its potential for success. Herein lies yet another paradox for consortia.

Consortium can be solely funded by membership fees or can seek government or other large-donor support. Early large scale support is often critical to provide momentum. In the ASMC, for example, the National Institutes of Standards and Technology provided $16.6 million to launch an aggressive research program aimed at reducing the impact of alarm floods to control rooms, thus improving safety and efficiency in petrochemical operations. This funding also helped ASMC move into the sustainability phase.

The final two phases of Trist's model, learning and adjusting over time, and expanding scope and deepening commitment, are often very difficult for consortia. Adaptation to changing conditions over time lies at the heart of strategic fit (Zajac et al., 2000). To accomplish this, an organization or group must be able to recognize that a change has or is about to occur, must be able to formulate how this change might affect the organization's or group's potential for success, and then must formulate a response that positions the organization or group more favorably.

We suggest that one of the key dimensions to environmental change lies at the heart of the purpose for R&D consortia in the first place. Research and development, to be

successful, has to eventually be translated into some type of product, process or method that can be adopted to yield value to the consortium members. Early research efforts must evolve into technology development and then technology transfer activities that enable individual organizational members to internalize consortium results and outputs. Herein lies the third consortium paradox.

**Three paradoxes in R&D consortia**

We have suggested that there are three paradoxes that consortia face that must be dealt with actively to achieve long term success. First, environmental uncertainty is best addressed by differentiation of the organization. Within the consortium, this implies membership diversity will be beneficial. Here diversity might include expertise and member company structure, size and industry sector background. It might also suggest a diversity of member representatives in terms of skills and backgrounds. Such diversity, though necessary for the long term, actually impedes a consortium in its early stages since it makes goal development more difficult. This diversity also requires more coordination than would a less diverse set of actors. Because consortia act as loose collaborations, issues that increase coordination costs challenge early efforts and drain critical leadership attention away from the real purpose of the consortium.

Secondly, in developing membership, consortia focus on the organizational membership balance, and pay less attention to the individual representing that organization. Yet it is the individual and not the organization that actually "joins" the intellectual activities of the consortium. An organization whose individual representative is passionate about the consortium, its goals, and its importance, will commit himself or herself to the consortium's activities, engaging on a personal and intellectual level. This close member commitment yields synergy between the consortium and the home organization, and increases the chances that the consortium will be beneficial to the member company.

Finally, the rigors of research, development and deployment suggest that the intellectual and leadership needs of the consortium will change over time from a research focus to a technology deployment focus.

Taken together, these three paradoxes suggest that consortium early success is difficult to sustain over time without significant changes to the consortium's leadership, its membership (both organizational and personal), and even its governance. Change management must be build into the consortium's structure, including membership development.

What follows are the high level observations and results from our study. It should be noted that we choose here to focus not on the individual details of each consortia, but rather to emphasize overarching themes. The presentation that accompanies this extended abstract will offer examples from these consortia and from our collective experience in dealing with R&D consortia.

## Themes in R&D Consortia

### 1. Longevity is overrated

In seeking to identify factors that lead to success in consortia, we began with the mindset that a long-lived consortium is a successful one. We continue to espouse this view, but would further qualify it with the recommendation that consortia regularly review goals, objectives, and progress to date. Based on our findings, we believe that longevity is overrated as a success criteria, and instead suggest that a truly successful consortium is one that has a clear understanding of the value it provides and can recognize when it should either change its goals and objectives, reinvent itself or disband. A truly successful consortium lasts as long as it is needed and has an exit strategy to redeploy scarce resources.

### 2. Intangible results are undervalued and underutilized

Our work highlights the importance of intangible benefits that result from participation in a consortium. Unfortunately traditional return on investment (ROI) measures ignore intangible benefits and also undervalue the knowledge gained through failure. To improve recognition and usefulness of intangible benefits, robust knowledge sharing mechanisms must be in place and an open exchange of information is essential. Organizational practices that promote information sharing – and the trust that members must develop to bring information to the table – help establish a positive operating environment.

Motivations to join consortia include the following (Moethe & Quelin, 2001; Rigatuso et al., 1997; Sakakibara, 1997)

- Share complementary knowledge by creating working ties with other companies in the field
- Gain access to new knowledge and know-how
- Eliminate wasteful duplication of R&D efforts
- Improve efficiency by coordinating individual projects and by disseminating knowledge
- Shorten research time as compared to individual companies setting up their own research efforts from scratch
- Share and reduce the costs, risks, and uncertainties of R&D among participants, i.e., leverage research dollars
- Enhance innovative productivity.

Because it is difficult to determine the tangible direct outputs of R&D collaboration, significant advantages are inherent in the cooperation rather than hard outcomes (Rigatuso et al., 1997). For example, a study of 25 R&D managers of 16 firms involved with the EUREKA (Europe-wide, inter-governmental initiative for industrially-oriented) consortium found that the sharing of complementary knowledge and access to new knowledge was the most significant goal for partners. Similarly, whereas firms perceived gaining access to complementary knowledge as the most important and pervasive objective, sharing fixed costs was one of the least important objectives in a study of 237 Japanese government-sponsored R&D consortia in the early stages of R&D (Sakakibara, 1997). In contrasting two primary motivations for joining

consortia, Sakakibara (1997) found that the relative importance of a cost-sharing motive increases with homogeneous participant capabilities and when projects are large, while the relative importance of a skill-sharing motive increases with heterogeneous participant capabilities. Our observations of these four consortia support this.

### 3. Relationship building is a critical leadership need

Initial leadership plays a significant role in the image of the new organization and its ability to overcome the liability of newness. Leaders who are widely respected and well known, and who are admired and charismatic, create valuable relationships and are able to attract quality organizations and researchers. In the four consortia we studied, all four began with or actively searched for a charismatic leader. In creating an environment of trust and momentum, a charismatic leader is an important contributor to consortium success. We note, however, that this charisma must extend beyond personality and into relationship-building and networking. Leaders who take initiatives to span boundaries help broker relationships that support collaborative development.

Leadership is also critical to creating an environment conducive to member sharing of information. Members learn from one another. From a technology development perspective, members learn about implementation and refinements from activities at other company sites. Getting companies to share this critical data is difficult, particularly when the companies are competitors. And yet such knowledge transfer is a critical value-adding component to consortium membership. A leader that focuses on relationship building enhances the likelihood that members will engage in meaningful ways with each other to share valuable knowledge.

### 4. An organizational champion provides structure and continuity

Consortium stability is enhanced by an organizational champion – a company or entity that holds a high and direct stake in the results of the consortium. Such a lead organization can act as the convener of the group and can also provide bridge resources in critical periods. While this champion organization acts as the “glue,” it must be noted that this is not without a coordination cost, which is counter intuitive. An organizational champion ought to reduce the coordination cost for the consortium, however, we observe that consortium members seek to balance the stability that the champion organization brings against the influence that the champion organization exerts. Consortium governance and decision-making practices must balance the champion’s interest with the interests of the membership at large. This often introduces complexity into consensus building, decision-making, and resource allocation processes.

### 5. Membership expertise and longevity must be matched to consortium goals

Within a consortium, a set of homogeneous members encourages goal congruity between individual members and helps focus efforts to critical problems. This is very important with R&D activities. As problems become better understood or solutions mature, a focused homogeneous set of members may reduce the creativity of the consortium and may also reduce its ability to leverage resources.

A related issue involves the openness of the consortium to new members. Once again a set of members who have strong contextual focus as well as strong relationships that have developed over time can be a detriment to consortium growth. Longevity breeds norms and customs, some of which may not be captured in any formal organizational mechanisms. This helps the consortium hang together over time, but can also serve as a barrier to entry for potential members. When a consortium begins to exhibit fewer characteristics of collaborating companies and more characteristics of collaborating individuals, it runs the risk of alienating potential new members.

## Conclusions

While our work focused on one consortium in depth (ASMC), and review of three others, the themes we identify have been found to exist elsewhere in the world (Chi, Ball and Coyne, 2002). Thus we are not speaking of issues in R&D consortia only in the U.S. The challenges of technology alliances revolve around the organizational structure and the people who actually interact to accomplish activities. Balancing the needs of the individual, the needs of the member companies, and the needs of the consortium requires careful consideration of the competing dimensions of organizational satisfaction (ROI) and individual satisfaction. Moreover, trust is an underlying need. Organizational trust can be legally defined through a set of rules of engagement. Individual trust is more difficult and is rooted in conversations and shared activities. When sharing across the consortium is limited, than the value that individuals find declines, and thus the organizational participant value declines.

Figure 1 portrays the stages of technology discovery, development and deployment that are typical in R&D consortia. Here we emphasize the different needs for membership and expertise that must come together in the R&D consortium for success. We begin with discovery where new ideas are created and/or combined to develop solutions to critical problems. Once proven these ideas must be reduced to practice as either technology prototypes of methods that can then be tested. Once tested technology inventions or methods may require modifications or may drive additional research questions prior to full-scale commercialization. Finally the technology or method must be adopted, thus translating it into a benefit for the adopting organization.

We believe that these four stages require very different types of expertise to achieve success. In the early discovery and reduction to practice stages, homogeneous membership of companies and scientific expertise of member representatives helps insure goal congruity and minimizes the coordination required between members since all exhibit similar concerns. As a technology or method is reduced to practice, however, scientific expertise is no longer enough to capture the realities of the operating environment, and new member representatives from companies should be sought.

We also believe that this is a good opportunity for the consortium to begin adding company members, thus increasing heterogeneity. Such diversity of company members is even more important as the consortium seeks to transition the technology or method into sale or use. Multiple inputs as to operating environments are needed. In addition, the consortium should be adding non-technical expertise to help focus the product offering. Finally at the

adoption stage, the consortium must consider technical support. During this stage, the value of the scientific input is limited and instead operations staff and member company management buy-in are critical to success.

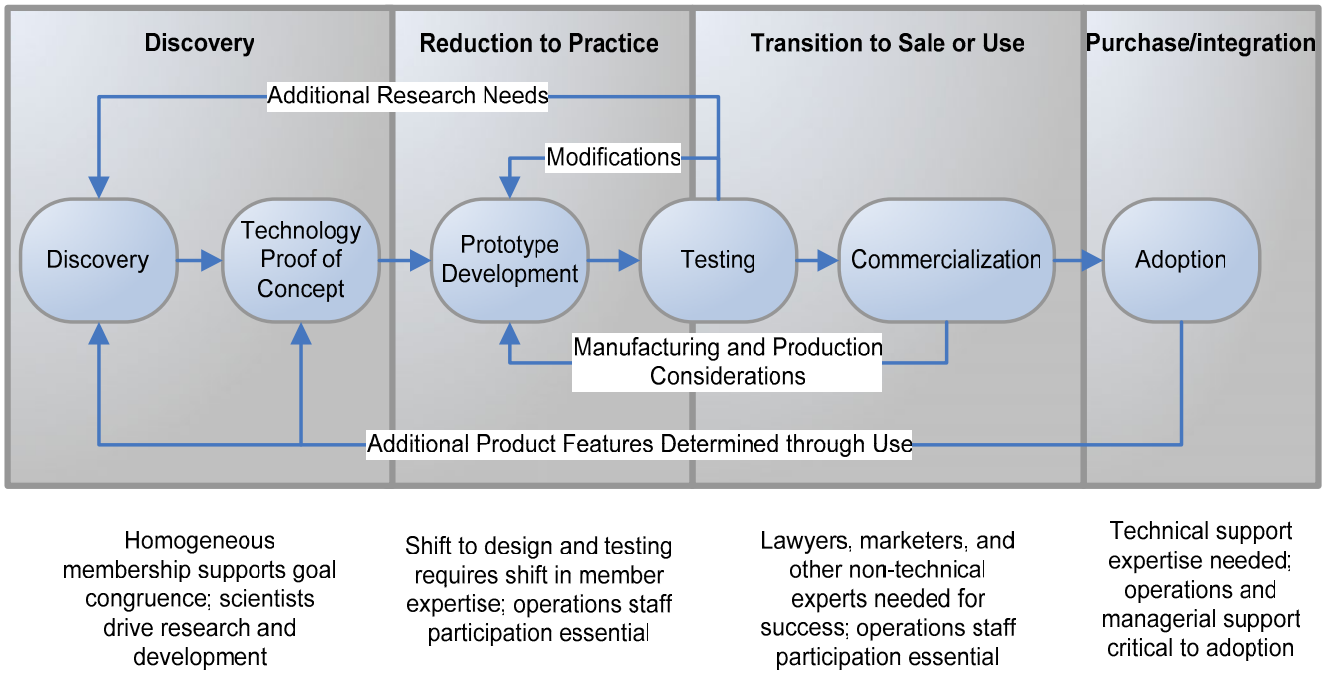


**Figure 1: From Concept to Innovation Adoption**

Thus our work suggests that consortium should think of their organizational structure in a life cycle context. Sustainability is not synonymous with stability. Rather, our work emphasizes the importance planned change and organizational renewal, particularly regarding increasing diversity of membership over time and transition of member expertise from scientific to operational.

These findings have implications for consortia that are trying to create the needed organizational structure to support collaborative activities, and for member companies who seek to participate. Both must carefully consider the way that participation in the consortium facilitates and/or constrains the member's ability to actually transfer technology or methods into operations, thus gaining economic value.

## References


Brod, A. and R. Shivakumar (1997), R&D cooperation and the joint exploitation of R&D, *Canadian Journal of Economics*, 30: 673-684.

Cui, C.C., D.F. Ball and J. Coyne (2002), Working effectively in strategic alliances through managerial fit between partners: some evidence from Sino-British joint ventures and the implications for R&D professionals, *R&D Management*, 32(4): 343-357.

Doz, Y.L., P.M Olk and P.S. Ring (2000), Formation processes of R&D consortia: Which path to take: Where does it lead?, *Strategic Management Journal,* 21(3): 239-266.
Evan, W.M and P.M. Olk (1990), R&D consortia: A new U.S. organizational form, *Sloan Management review,* 31(3): 37-46.
Ju, T.L., S-H Chen and C-Y Li (2005), A strategic contingency model for technology alliance, *Industrial Management + Data Systems*, 105(5-6): 623-645.
Lawrence, P.R and J.W. Lorsch (1967) *Organization and Environment: Managing Differentiation and Integration*, Boston: Harvard Business School Press.
Mote, C. and B.V. Quelin (2001), Resource creation and partnership in R&D consortia, *Journal of High Technology Management*, 12: 113-138.
Olk, P.M. and C. Young (1997), Why members stay in or leave an R&D consortium: Performance and conditions of membership as determinants of continuity, *Strategic Management Journal*, 18(11): 855-877.
Rigatuso, C., T.Tachi, D. Sylvester and M. Soper (1997), Collaboration between firms in information technology, part of Spring 1997 course, "Strategic Computing and Communications Technology," Department of Electrical Engineering and Computer Sciences, University of California at Berkeley.
Sakakibara, M. (1997), Heterogeneity of firm capabilities and cooperative research and development: An empirical examination of motives*, Strategic Management Journal*, 18(1):143-164.
Trist, E. (1983) Referent organizations and development of inter-organizational domains, *Human Relations,* 36(3): 269-284.
Zajac, E.J., M.S. Kraatz and R.K.F. Bresser (2000), Modeling the dynamics of strategic fit: a normative approach to strategic change, *Strategic Management Journal*, 21(4): 429-472.

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