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Strategic and Managerial Implications

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Managing through industry fusion

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1. Introduction

Many industries are becoming "boundaryless" and associated with rapidly changing competitive environments (Bettis, Hitt 1995; Hamel, Prahalad 1994; D'Aveni 1994). The increasing rate of technological diffusion and the globalization of markets are two of the main reasons why firms' environments are becoming more dynamic. New technologies are diffusing across industry boundaries at an increasing rate primarily because of the tremendous increase in access to information through the advances in computers and communications. This "sharing" of technologies among industries creates new competitors from surprising sources. Additionally, the globalization of almost all major industries has increased the rivalry, and hence the rate of innovation, in many industries by introducing players with different knowledge sets, different perspectives of the future, and a different set of industry norms. Partners can be very valuable in this type of setting to help better understand the changing rules of the game (Ohmae 1989).

These changing environmental conditions can create a condition where firms find themselves in industries without clear boundaries as their traditional industry is combined with one or more different industries. This combination, or fusing, of different industries is a condition that is referred to as industry fusion (Bierly, Chakrabarti 1998). A firm whose industry is being fused with another is in a difficult position because it is facing new competitors and a changing industry structure. This appears to be a new phenomenon created by the changing competitive landscape and many industries have not yet entered the industry fusion stage. However, it appears that this will be an increasingly common occurrence in the near future. Examples of industries currently in the industry fusion stage are

(a) the integration of the computer, communications, and entertainment areas,

(b) the integration of the pharmaceutical industry (skill in organic chemistry) with both the biotechnology industry (skill in molecular biology) and the pharmaceutical distribution industry, and

(c) the integration of the many different types of financial services.

In each of these cases there are several critical knowledge areas that are being combined together in complex ways such that the future industry structure will be completely different than the current state. Furthermore, the products of the future are envisioned to be much different than they are today and will rely on knowledge areas that are only just starting to be developed.

Under conditions of industry fusion, traditional approaches to strategic management appear to be inadequate. Specifically, the school of strategy that Mintzberg (1990) refers to as the "positioning" school, which was pioneered by Porter (1980), relies on techniques that are inappropriate during industry fusion. Conducting an industry analysis using the Porter Five Forces model, analyzing one's direct competitors, or establishing and defending a market position can be myopic activities that fail to account for the dramatic changes that lurk ahead. These traditional approaches fail to consider how technological advances, particularly radical and non-linear advances, quickly change industry structures and make "positioning" competitive advantages vulnerable (Lei et al. 1996; D'Aveni 1994). Industry fusion intensifies an already chaotic condition of technological change by introducing new, very powerful competitors from other industries and the history of learning that has evolved in this other arena. The competitors from different industries follow different industry recipes for success (Spender 1989) providing top managers with a different perspective of competition and a different sense of what is considered "fair play". Predicting how technologies will evolve during industry fusion is particularly challenging because it is often the case that many complementary technologies must evolve together. Frequently, these complementary technologies are developed by very different types of firms and it is often difficult to understand and integrate the different technological areas.

The goals of this paper are as follows. First, we intend to illustrate how industry fusion changes the dynamics of competition. There is the introduction of new players with different perspectives who fol-

low a different set of rules; there are new critical success factors mostly based on the ability to develop and integrate different knowledge areas; and competition becomes more complex and takes place on several platforms. Second, we will offer general guidelines how to effectively manage a company through industry fusion, focusing on the importance of knowledge management and the use of partners. Third, we will use the pharmaceutical/biotechnology arena as an example to illustrate specific challenges of managing through industry fusion.

2. Industry fusion and the dynamics of competition

2.1 New players

During industry fusion, the most apparent change to a firm's competitive environment is the introduction of many new, potentially very powerful competitors. This dramatic increase in the number of new players is much different than the gradual flow of new entrants into most existing industries. In most established industries, entrants are usually smaller than the industry leaders, have less bargaining power with suppliers and buyers, and often follow a niche strategy to avoid direct confrontation with the leaders. Under such conditions, the established players in mature industries have many inherent competitive advantages over new entrants including brand recognition, access to distribution channels, economies of scale, and economies of learning (Lieberman, Montgomery 1988). In most mature industries, these advantages are insurmountable and the established market leaders maintain dominant positions for a long period of time (Grant 1998). This is particularly true in an industry with a strong dominant design and high switching costs (Teece 1987).

During industry fusion, firms encounter new players that are much different than their competitors of the past. Some of these new competitors were the dominant players of a different industry, with expertise in different knowledge areas. They probably pursued different avenues of research and development, developed expertise of different supplier and distribution networks, learned different manufacturing techniques, and knew how to compete in a different competitive landscape (i.e., faster or slower rate of technological change,

more or less government regulation). Thus, firms may find themselves at a competitive disadvantage relative to their new competitors in several portions of the value chain.

Spender (1989) illustrated that within an industry an industry recipe develops that can be viewed as a shared set of ideas that become institutionalized and provide a guide to action. The industry recipe can also provide norms for competition so that rivalry does not become destructive and industry profits remain high. For example, different signaling techniques may become commonplace for changes in capacity, price, etc. During industry fusion, the competitors that previously were in different industries will be following different industry recipes and will be following different rules to the game. Thus, competitive actions and responses will be much more difficult to interpret, creating a more chaotic condition.

2.2 New critical success factors

What it takes to be successful during industry fusion may require quite different capabilities than what it takes to be successful in an established industry. First and foremost, to successfully manage through industry fusion, firms must have a clear vision. The underlying assumption for all of its strategic actions will be how top managers envision the future products, customers and competitors after industry fusion. Part of the clarity of a firm's vision will be dependent on its technological know-how and its ability to forecast how key technologies will evolve. However, much of the vision will also rely on instincts and intuitive feelings. For example, Motorola's vision of the future of the telecommunication/computer/entertainment arena is an interrelated complex system where all data is transferred via a sophisticated satellite system. Almost all of the investments in capital and the development of core competencies follow from this basic belief. However, many of its competitors envision most data being transferred by fiber optic cable and believe a satellite system will only be a secondary media. Having a clear vision allows a firm to most efficiently leverage its resources and capabilities, but the accuracy of the vision is what will determine the effectiveness of its long-term strategy. Motorola's success will depend partly on how well it (along with its partners) can develop its satellite system, but also on how well competitors develop alternative systems.

A second critical success factor for firms going through industry fusion is their ability to integrate different knowledge areas (Bierly,

Chakrabarti 1998). The integration of knowledge areas requires efficient communication (encoding, transmission, and decoding) between the experts of the specific areas. The more tacit the knowledge area, the more difficult it will be to communicate and integrate with other areas. In general, knowledge areas may refer to the skill and know-how of many different subjects, including technological and administrative knowledge, expertise of different functional groups (and different specialties within functional areas), knowledge of product and process design, and knowledge of market conditions. Whether a specific knowledge area is either developed internally or acquired externally, a critical issue is to determine what level of understanding of a knowledge area is required by either non-specialists or specialists in another area if the knowledge area is to be successfully integrated into a specialized knowledge area. In other words, how well does the firm (or sect of the firm) have to understand an external knowledge area if it is able to use it? Cohen and Levinthal (1990) claim that for most external knowledge areas to be used effectively, the organization must already possess a considerable level of competence in the area so the value of the technology can be recognized, assimilated, and applied to commercial ends. They refer to this notion as the firm's "absorptive capacity". During industry fusion, knowledge areas from two or more industries must be combined. The firms that can do this best will have a distinct competitive advantage over the other firms. Kogut and Zander (1992) refer to this type of competitive advantage as the "combinative capability" of a firm. This type of capability is particularly challenging during industry fusion because it requires absorptive capacity in very different knowledge areas. In general, firms that do this well will have a broad knowledge base, have an open "learning" environment, and will have experience communicating across disciplines (i.e., cross-functional teams).

A third critical success factor for firms going through industry fusion is their ability to work well with partners and to manage a network of players. It is probably unrealistic to expect a single company to be able to aggressively pursue each of the diverse knowledge areas that are integrated during industry fusion due to the vast amount of resources that would be required to do so. It would also probably be unwise to do so, even if a firm is able, since it could cause confusion and deterioration of core knowledge areas. For example, AT&T attempted to become a leader in many of the critical knowledge areas associated with the fusion of the telecommunica-

tions and computer industries throughout the late 1980's and early 1990's. However, management had difficulty maintaining control over such a diverse group of knowledge areas and they started to lose their competitive advantage in several key areas. In 1996, they decided to reverse their strategy, and split the company into three smaller units so that each group could remain focused in its narrower cluster of core competencies.

Thus, firms must rely on strategic alliances and networks to support their knowledge base (Grant 1996; Hamel 1991; Powell et al. 1996). Therefore, a critical success factor for firms going through industry fusion is their capability of successfully managing these alliances. Specifically, this requires skill in communications, conflict resolution and coordination (Mohr, Spekman 1994). Additionally, it is critical that the firm develops a reputation of being trustworthy (Barney, Hansen 1994).

2.3 More complex competition on several platforms

Industry fusion is often characterized by (a) competition in a wide array of knowledge areas, (b) competition between networks and (c) competition within a network. The superior product in the future will integrate leading technologies from each of the critical knowledge areas. A firm or network that is not competitive in any one of the critical technologies may be blocked from competition. Thus, there is direct competition in each of the knowledge areas and in the ability to integrate the different knowledge areas.

Competition among networks is much more difficult to analyze for several reasons. First, the members of a network can change much faster than a single firm could change its own capabilities. Overnight, a network can change a glaring weakness into a strength by the addition of a new team player. Competitive analysis becomes a much more dynamic process. Second, the most sustainable competitive advantage of a network may be very hard to imitate. As discussed earlier, the most critical capability of a network may be its ability to integrate different knowledge areas. How a specific network successfully accomplishes this task is probably difficult to explicitly determine. Much of the communication in the process will be informal and tacit. Third, comparing leaders in each specific knowledge area may be misleading because many of the technologies may be complementary in nature and influence development of related technologies. A superior position in a specific knowledge

area may be wasted if the complementary areas that are needed to implement the advances are not simultaneously developed (Teece 1987). For example, a revolutionary new computer software program may not be able to be utilized until the current state of hardware is advanced. (Note, the reverse could also be the case where the hardware is limited by the software.)

Additionally, there is frequently competition within a network. Even though the firms within a network are partners, they still jockey their positions trying to improve their strategic leverage relative to each other in an attempt to maximize their profits. Ideally, a firm usually wants to be the center node of the network, which is usually the most powerful position. Power in the network typically is a function of the firm's size, reputation, and expertise in a critical knowledge area. Network centrality and power is often redistributed after different industry events (Madhavan et al. 1998).

3. Managerial functions

3.1 Managing knowledge base and strategies

It is obvious from our preceding discussions that managing the knowledge base of the organization is an important strategic component of the overall corporate strategy for success. It is important here to make a distinction between the tacit and explicit knowledge (Nonaka 1994). The knowledge strategies must include both types of base knowledge.

Although technology has been mentioned as an important component of corporate strategy, little attention has been paid on the empirical data that could lead to effective technology strategy. Maidique and Patch (1982) identified six dimensions in technology strategy:

(1) level of specialization in technology selection,
(2) level of technological competence,
(3) source of technological capability,
(4) flexibility of R&D policy and structure,
(5) level of R&D investment, and
(6) competitive timing.

In their longitudinal study of six major chemical firms in the US, Sen and Chakrabarti (1986) documented the influence of technology in the corporate strategies and concomitant performance. Brockhoff and Chakrabarti (1988) identified four different technology strategies among the German companies. These strategic clusters are:

A. Defensive Imitator: Firms following this strategy emphasize imitative behavior in their technology development program.

B. Process Developer: Firms following this strategy are internally oriented and emphasize process development as their competitive edge.

C. Aggressive Specialist: R&D specialization in certain technological fields is the key component of the strategy.

D. Aggressive Innovators: Firms following this strategy have a broad technology base and a balanced portfolio of product and process innovations.

Knowledge strategies, as defined by Bierly and Chakrabarti (1996a) go beyond what is meant by technology strategy in Brockhoff and Chakrabarti (1988). Knowledge strategy involves strategic choices to be made in the following dimensions:

1. Trade off between internal vs. external learning
2. Trade off between radical vs. incremental learning
3. Speed of learning
4. Breadth of learning.

These four dimensions of knowledge strategies can be manifested in many business decisions involving mergers and acquisitions, joint ventures, formation of strategic alliances, licensing, patent policies, R&D expenditures, product portfolio, etc. Bierly and Chakrabarti (1996a) identified four strategic groups among the US pharmaceutical companies in ethical drugs. They are:

1. Innovators: These firms have highest level of internal learning through R&D, focus on both radical and incremental learning, and are fastest learners.
2. Exploiters: These firms are effective users of technology available and have a broad, but shallow, knowledge base. They have low R&D investment and focus on incremental learning.

3. Explorers: They are characterized by their proclivity to attempt to "hit the home run" with a new block buster drug. They maintain a balance between external and internal learning, but are less aggressive learners.
4. Loners: Firms in this category are ineffective learners, although they do spend money in R&D. They are too focused in narrow technical areas and not able to integrate different streams of knowledge.

Both the technology strategy (Brockhoff, Chakrabarti 1988) and the knowledge strategy (Bierly, Chakrabarti 1996a) have some significance in managing a firm involved in industry fusion. These strategic concepts should help focus a firm in acquisition and integration of knowledge. The concept of "core competence" as proposed by Hamel and Prahalad (1994) provides a compelling argument to narrow the technical fields on which a firm should focus. However, a firm needs to be flexible and adaptive to advances in different but related fields of technology to avoid "core rigidity" (Leonard-Barton 1995). This becomes particularly an important consideration when the industry boundary conditions disappear.

3.2 Integrating different knowledge areas

Other studies in the pharmaceutical industry have shown that corporate performance is linked with the ability to integrate the different knowledge streams (Henderson, Cockburn 1994; Pisano 1994). According to Henderson and Cockburn (1994), "architectural competence - the skill of integrating a wide range of disciplines- and specific expertise in any of these disciplines provide a source of advantage in drug research productivity". The capacity to integrate different knowledge streams becomes important in both internal and external knowledge sources. Pisano (1994) illustrated the importance of integration at different stages of drug development.

Integration of knowledge across disciplinary and organizational boundaries requires effective interface management. Effective interface management may involve structure and management process involving both personal and impersonal instruments (Brockhoff et al. 1996). The following issues should guide the choice of the management instruments:

1. Level at which the interface problem occurs.
2. The type of exchange that should be considered.
3. The reason for creating an interface has to be considered.
4. Task characteristics, such as complexity, frequency, repetition, standardization, etc. are to considered.

Interface at the project level often involves uncertainties about both the ends and the means. An explicit discussion about the various uncertainties may facilitate interface among the various organizational entities involved. This will specifically help identify the information needs.

Integration of knowledge across different boundaries requires the contribution of special people such as champions, sponsors etc. According to Chakrabarti and Hauschildt (1989), "during the life of a project different people assume different informal and semiformal roles which supplement and complement the communication channels and decision making loci". The effectiveness with which people in these roles perform will determine the success of the innovation.

As Brockhoff et al. (1996) have shown, these roles change over time as the scope of an innovation project is broadened with increasing participation of different organizational units. The role requirements are different for these positions. For example, the champion of an innovation must have high level of tolerance for ambiguity, excellent communication skills, political astuteness and a good understanding of the strategic issues. A technical expert needs good technical knowledge and many not require those other skills to the extent, as the champion needs.

3.3 Broadening the knowledge base using partners

Firms often face the dilemma of broadening the knowledge base as opposed to focus on a few product and market areas. Hamel and Prahalad (1994) have provided a very compelling case for focusing on the core competence of an organization. This becomes particularly important when a firm has to allocate its scarce resources among various projects and entities. During the late seventies and early eighties, we have seen a fast trend in mergers and acquisitions leading to the growth of diversified conglomerates. The idea of core competence has since then helped the managerial trends of downsizing, diversification and outsourcing. Leonard-Barton (1995) has voiced the concern over "core rigidity" which is derived from

4. The pharmaceutical/biotechnology area

4.1 Changing environment - industry fusion

To illustrate the dynamics of industry fusion, we will discuss the fusion of two industries: the pharmaceutical industry and the biotechnology industry. During this industry fusion, the knowledge base of the pharmaceutical industry, which is based on knowledge in organic chemistry, needs to be integrated with the knowledge base of the biotechnology industry, which is based on knowledge in molecular biology. In both of these dynamic industries, industry fusion is also occurring in other areas. The biotechnology industry is also fusing with the chemical, agriculture, waste disposal and energy areas; the pharmaceutical industry is also fusing with the pharmaceutical distribution industry. In each of these cases there are several critical knowledge areas which are being combined together in complex ways such that the future industry structure will be completely different than the current state. Furthermore, the products of the future are envisioned to be much different than they are today and will rely on knowledge areas that are only just starting to be developed.

In the past, pharmaceutical companies, relying on their expertise in chemistry and pharmacology, used random screening to discover an effective new drug. Thousands of different chemical compounds would be tested to see if any would have a desirable effect, with minimal adverse side-effects, combating a specific disease. Usually the focus of researchers was on the symptoms of a disease; often how the drug actually worked was not well understood. Success in this environment was based on knowledge of organic chemistry and pharmacology and the ability to efficiently screen thousands of chemical compounds. Typically, a pharmaceutical company would test over 10,000 compounds to find a single drug that may work. Capabilities in marketing and large-scale manufacturing, access to a large distribution system, and name recognition were also critical success factors. The integration of knowledge across the different activities was not particularly important; it was not necessary to fully understand why a group working in another area made their specific decisions.

Since the early 1990's, almost all drugs have been discovered by following a rational drug design, an approach that relies on the structural analysis of target molecules and the deliberate design of agents that affect their function. Many successful drugs are enzyme inhibitors that block specific receptors associated with a certain disease. The inhibitor can be viewed as the "key" that fits the "lock", which is the receptor. Thus, if one understands the detailed nature of the receptor, than inhibitors can be designed that will block the functioning of the receptor. Essentially, the researcher becomes the locksmith who must find the best key for the lock. The successful locksmith must have a strong background in molecular biology, to understand the design of the receptor, and in chemistry, to understand how different drugs will react with the receptor. Indeed, rational drug design requires the integration of knowledge from many different disciplines, including molecular biologists, biochemists, physiologists, chemists, pharmacologists and experts in very specialized fields related to the specific drug. In other words, successful drug design requires the combination of the traditional knowledge base of pharmaceutical companies with the knowledge base of biotechnology companies.

Powell et al. (1996) characterized biotechnology as a competence-destroying innovation, from the perspective of established pharmaceutical companies. For the established pharmaceutical companies to be successful at the rational drug design process, they must "unlearn" the processes associated with random drug screening. What Tushman and Anderson (1986) described is typical of most competence-destroying innovations, the competitive advantages of the established players are diluted and may actually become liabilities. The door is opened for new, smaller players to enter the field who are not wedded to the "old" technology. In the case of drug development, the door is opened for the hundreds of small biotechnology firms to compete with the previously unapproachable pharmaceutical firms. The biotechnology firms have the advantage of being the leaders in research, especially at the basic science level. However, the biotechnology firms also have the same competitive disadvantages as many other players from emerging areas: they lack capabilities in large-scale manufacturing and marketing. Additionally, even though Tushman and Anderson (1986) illustrated this rarely occurs, the established pharmaceutical companies appear to be dramatically transforming themselves in response to this competence-

destroying innovation, primarily due to the strong leadership of technically sophisticated senior management (Zucker, Darby 1997).

4.2 Changing industry structure

Over the last several decades, the pharmaceutical industry was one of the most profitable sectors in the U.S. economy, primarily due to its attractive industry structure (McGahan 1994). The industry structure was stable with large companies like Merck, Lilly and Abbott maintaining leadership roles for many years. Direct competition was mitigated by the arrangement of each company focusing on a few therapeutic classes and the effectiveness of the patent system. Buyers did not pressure companies to lower prices, allowing the companies to maintain high profit margins. Additionally, industry entry barriers were high, limiting new competition. Specifically, the established firms spent very large sums on both R&D and marketing. The Office of Technology Assessment of the U.S. Congress estimated that the average amount spent on R&D for each new drug introduced in the 1980's was over $200 million and the drug approval process usually took about 12 years (Office of Technology Assessment 1993). In the U.S., the drug approval process conducted by the Food and Drug Administration (FDA) included three phases of clinical trials: Phase I tested clinical safety, Phase II tested drug efficacy, and Phase III tested for adverse effects from long-term use. Incredibly, most pharmaceutical companies spent even more money on marketing than R&D, developing strong ties with the doctors and pharmacists. Thus, the "old" industry recipe for success was that bigger was better - spending large amounts in R&D and marketing would lead to high profits. This rationale led to mergers of large pharmaceutical firms (e.g., Bristol-Myers and Squibb, SmithKline and Beecham) with the stated purpose being to gain size in both R&D and marketing.

However, the pharmaceutical industry has undergone dramatic changes recently. Two of the most significant changes to the environment have been (a) increased price pressure by managed care networks and the government, and (b) the change from random drug screening to rational drug design, described above. The increased price pressure has forced firms to focus on improving efficiencies throughout the organization. Effort placed on improving operating efficiency in manufacturing and distribution help to reduce costs, but the primary area where large cost savings can be achieved is the

improvement of R&D efficiencies. Some pharmaceutical companies have also attempted to reduce this price pressure by acquiring their own managed care providers, led by the Merck acquisition of Medco Containment Services.

The use of a rational drug design approach to new product development has changed what it takes to be successful in the drug industry. Now, the critical success factors are a broad knowledge base and the ability to integrate the broad knowledge base (Bierly, Chakrabarti 1996a). Specifically, pharmaceutical firms must have access to and the ability to use the tools and knowledge set of the biotechnology firms. All pharmaceutical firms have realized that this integration of the skills from the biotechnology area is required for future success. Some firms, like Eli Lilly, SmithKline Beecham and Merck, have actively pursued biotechnology for many years, but others, such as Abbott, Upjohn and Warner-Lambert, have just recently realized that it is not a feasible strategic position to have no ties to biotechnology. For example, Bristol-Myers Squibb, historically a passive player concerning biotechnology, recently established an External Science and Technology group within its R&D division to provide access to external developments. In a short time period the group formed strategic alliances with four biotechnology companies: Cadus Pharmaceutical Corp., SEQ Ltd., Genzyme Transgenics and Agracetus Inc.

The simultaneous need to make R&D more efficient and the need to have access to a broad array of knowledge areas have increased the reliance on external sources of knowledge. Since these technological fields are evolving at such a fast rate and involve different resources, it is very difficult to remain cutting-edge in the wide array of knowledge areas by developing all of the technologies in-house. It is more efficient and allows for more strategic flexibility to work with partners (Bierly, Chakrabarti 1996b). Acquiring other companies or relying on partners can be effective substitutes to innovation (Hamel 1991; Powell, Brabtley 1992; Barley et al. 1992). A mid-range position between these two options, an equity position in the partner, can be effective in helping transfer knowledge and increasing control, while still allowing the biotechnology company to keep its autonomy (Pisano 1989; Bierly, Kessler 1998). Relying on external learning allows companies to focus more on what they do best, without being shut out of advances in other areas. However, relying on external learning also makes the company more vulnerable. In-

deed, at no time in the past did pharmaceutical companies entrust the development of critical technologies with outsiders to this extent.

Some pharmaceutical companies (e.g., Lilly) have attempted to integrate the biotechnology and traditional chemistry knowledge areas by the acquisition of small biotechnology companies and the subsequent development of an in-house biotechnology division. The advantages of this approach are that

(a) the pharmaceutical company maximizes its control over the smaller biotechnology company,

(b) the pharmaceutical company is able to land the top scientists of the biotechnology company (assuming they do not leave), and

(c) this arrangement allows for the smoothest transfer of knowledge, since the biotechnology scientists will be working directly with the researchers of the pharmaceutical company (Pisano, 1991).

However, these attempts have frequently been unsuccessful for a variety of reasons. First, pharmaceutical and biotechnology companies are difficult to integrate because they have dramatically different cultures, organizational structures and control mechanisms. Biotechnology companies tend to be much smaller and entrepreneurial with loose, decentralized structures designed to promote creativity and brainstorming. Pharmaceutical companies are more hierarchical and their research projects are more focused and calculated. These organizational designs are both appropriate because both technologies are different in nature: biotechnology is a more abstract, emerging technology, whereas chemistry is more mature. Second, after a pharmaceutical company buys a biotechnology company, many of the most talented researchers initially with the biotechnology firm leave to avoid working for such a large company with a rule-driven atmosphere. This is a major problem since the value of the biotechnology company is primarily in the intellectual capital of the employees. Third, the acquisitions are expensive and may not produce the desired results because the biotechnology firm may be working on issues that are only applicable to a narrow area of research and can not be expanded to other, more profitable areas. Fourth, since many pharmaceutical companies do not have expertise in the biotechnology area and the knowledge associated with biotechnology is mostly tacit and abstract, they overestimate the likelihood of new drug development.

For these reasons, almost all pharmaceutical companies rely on a complex network of partners to develop these diverse knowledge areas, even if they have their own large internal R&D facility (Barley et al. 1992; Powell. Brantley 1992). Expertise in specific knowledge areas can be accessed through biotechnology companies, university researchers, and consultants. Nowadays, there are even several deals with two large pharmaceutical companies doing joint research (e.g., Upjohn and Tanabe), which was rarely done before. Thus, the industry recipe for success has changed. Bigger is no longer necessarily better. Success goes to the company that can (a) access expertise in key, critical areas, (b) understand the significance of major breakthroughs in each of these areas, and (c) has the capability to integrate these different knowledge areas. The integration stage is particularly challenging because the experts in the different fields frequently speak a different technical "language", have different educational backgrounds, and interact infrequently. Since there is a limited number of firms with access to some specific technologies, there is competition to form alliances. Reputation and a perception of trustworthiness are important attributes to attract partners. Firms that act opportunistically and are not trustworthy may find it difficult to find partners in some critical knowledge areas, which may be detrimental to effective innovation (Powell 1998). Randall Tobias, Chairman and CEO of Eli Lilly and Company, summarized the beliefs of many in the industry concerning the importance of partnerships in his 1998 Keynote Address at his company's Annual Shareholder's Meeting:

"It is Eli Lilly's intent to maintain our top-tier position and to keep raising it to the next level of performance. We have pledged to do this by outgrowing our competitors through a constant stream of innovation. What that means, very simply, is that we've got to generate new molecules, and launch attractive new products, at an unprecedented pace ... Incremental improvements alone will not be enough to sustain top-tier performance. Real innovation is what counts ... We will continue to grow this in-house capability, but naturally, we must invest selectively. The life sciences today are so rich with potential that no singe entity can hope, or afford, to own all the new tools, the techniques, the ideas that are available. That is one of the reasons I continue to believe that size alone does not impart a competitive advantage in this industry ... The path we have chosen aims to enhance and complement our own skills, to take Lilly's proven ability to innovate and to multiply it dramatically. That is why we are pursuing strategic collaborations with other scientific organizations. Lilly has one of the richest "partner portfolios" in the industry. To date, we are engaged in more than 100 research and licensing agreements, 37 of which were initiated in 1997 alone. But this move toward increased collaboration is a new and important strategy in our drive for constant innovation. Within just a few years, we anticipate up to half of our new molecules will originate beyond our own walls. This projection, far from implying weakness in our scientific capabilities, actually serves to validate Lilly's expertise. Our

world-class scientists are a magnet for other researchers with great ideas ... Once we've established our partnerships, we work to make them better. True collaboration requires a degree of openness and risk-taking that, in the past, might have made us uncomfortable. But we're learning to be faster, smarter and less bureaucratic, and this has been noticed not only by our partners but by our own employees as well. The ability to be a good collaborator, a partner of choice, if you will, is rapidly becoming a key competitive advantage for Lilly ... Collaboration and partnering add greatly to the richness of Lilly's scientific base... they are subtly reshaping our culture, making us a company that's more flexible, more open and more willing to take intelligent risks."

4.3 Strategic response: The case of Ciba Geigy and Chiron

The case of Ciba-Geigy and Chiron illustrates how one company deals with difficulties associated with industry fusion. Ciba-Geigy (which recently merged with Sandoz to become Novartis) was a large Swiss pharmaceutical company with a conservative, formal culture. Since the early 1980's Ciba-Geigy identified the need to develop expertise in biotechnology to complement its strength in the traditional pharmaceutical fields of research. However, they were continually unsuccessful in attempts to develop working relationships with small US biotechnology companies. Specifically, they repeatedly had culture conflicts and communication problems. Being separated by such a large distance also made working conditions difficult. Chiron, one of the largest and most successful biotechnology companies, was the only partner that Ciba conducted joint research with successfully and comfortably.

Ciba realized that it did not have skill, or could not tolerate, dealing with most researchers in the biotechnology area and decided to take another approach. In November 1994, Ciba paid $2.1 billion to increase its stake in Chiron from 4% to 49.9%. The primary purpose of this deal was to improve Ciba's strategic position with the biotechnology industry, not necessarily just access to Chiron's knowledge base. Ciba intended to use Chiron as the intermediary to the rest of the biotechnology industry. Chiron had strong ties to other researchers at universities and other small biotechnology companies, and obviously possessed the absorptive capacity to interpret, understand, and apply these external knowledge sources. More importantly, they had the type of organizational culture that allowed them to deal with the biotechnology researchers. Without Chiron, Ciba had great difficulty trying to access these knowledge sources. This strategy of using an intermediary/interpreter proved very successful

for Ciba. For example, in May 1995 Ciba-Geigy, Chiron and New York University collaborated on the development of a new approach for the optical mapping and sequencing of genes (Fisher 1995). In the deal Chiron interacts directly with NYU researchers and is granted an exclusive worldwide license to the technology. Ciba-Geigy receives a sublicense from Chiron to use the technology for its own research purposes.

The Ciba-Geigy/Chiron alliance seemed to work for a couple of reasons. First, Chiron effectively balances the need for a loosely structured, entrepreneurial culture with a clear sense of direction and focus. Their strong leadership fosters creativity, but only within certain boundaries - a situation described as "managed chaos" (Perry 1995). Second, Ciba-Geigy understood that for Chiron to be successful in its intermediary role, it had to remain autonomous and not be pressured to be controlled like a typical pharmaceutical company. Ciba-Geigy took a very "hands-off" approach and allowed the alliance to be loose and flexible. Both companies relied on mutual trust to develop a successful partnership. This must have been particularly hard for Ciba-Geigy to do after it already encountered so many disappointments with deals with other biotechnology companies. This example clearly illustrates how companies must be flexible in their management style during industry fusion to ensure that different knowledge areas can be integrated efficiently and effectively.

5. Conclusion

We have presented an argument about industry fusion, a phenomenon that leads to development of new industries through merging of technology and market conditions. At the heart of the industry fusion lies the development of some architectural innovations changing the boundary conditions of an industry. The important lesson for the industry fusion is that the rules of competition change as new guidelines and standards of performance evolve. This blurs the distinction between competitors and a collaborator. In the telecommunication industry, for example, AT&T and Nokia are partners in the cellular telephone, but may be competitors in other areas. The traditional view of dealing with one's competitor on an adversarial fashion may not be prudent, as one may have to partner with the same competitor in the near future. This may seem to be confusing and may necessi-

tate a certain level of strategic equivocality in dealing with one's competitors and collaborators.

Industry fusion dictates emphasis on creativity and ability to integrate different streams of knowledge in developing product and market opportunities. Rapid advances in information technology for example have created great opportunities in new services and products for many industries. We have provided some detailed information about the pharmaceutical industry integrating the advances in biotechnology. Integration of different knowledge streams requires a culture of organizational learning and development of internal technical capability to absorb external technologies.

Past strategies and procedures may create some hindrance. It is not easy to change the technological trajectories as firms develop their core competence in certain fields and consequently become entrenched in them. Firms have squandered away great opportunities as their past trajectories of growth and development did not match the new opportunities. Developing a strategic flexibility is more important in this dynamic environment.

The dilemma of specializing in certain core competence areas as opposed to broadening the technological base is a real problem. Here the management has to weigh the risks involved in the decisions and follow a course of action that will offer an acceptable level of risk while it would not foreclose the future opportunities. There are many mechanisms by which the risks may be shared among strategic partners and exploit the technology generated outside one's own organization. Outsourcing technology through various means, such as licensing, joint venture, acquisition, etc. may be effective means, if one implements them properly. Capability for organizational learning for innovation and creativity becomes the ultimate core competence to survive in such dynamic competitive environments.