Chapter Eight

Collaboration Strategies

Ending HIV? Sangamo Therapeutics and Gene Editing

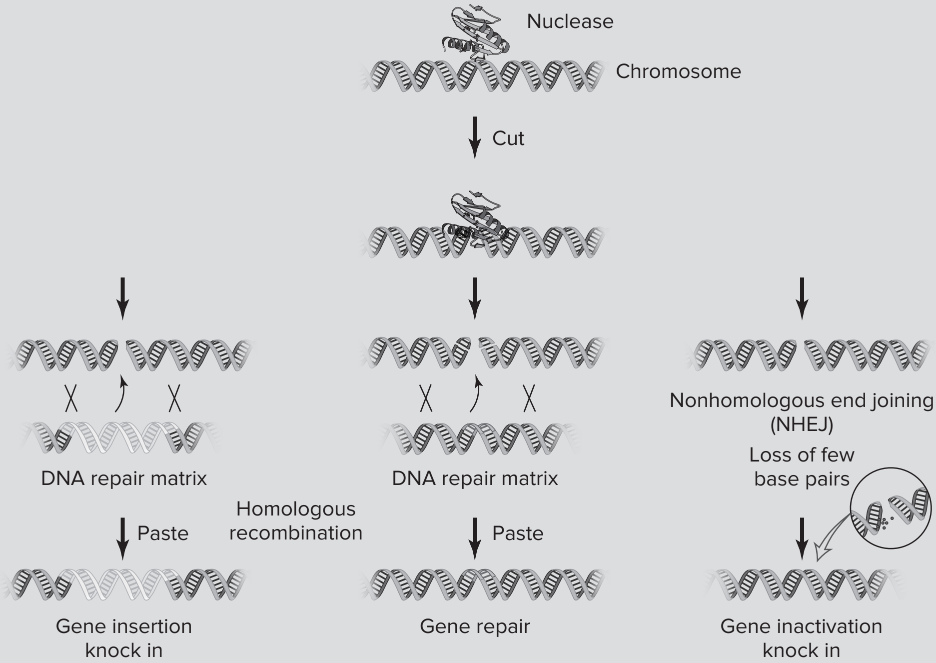
In 1995, Edward Lanphier founded Sangamo Biosciences for the purpose of developing zinc-finger nucleases (ZFNs), a technology that could edit the genetic code of a living individual to correct genetically based diseases (e.g., hemophilia, sickle cell anemia, Huntington's disease, and many others) or to confer genetic resistance to non genetically based diseases.

ZFNs work by cutting the DNA in a chosen spot. The cell then typically attempts to repair the cut by either by polishing the two ends of DNA and sealing them back together or by copying the corresponding section of DNA in the other half of the chromosome pair. Since many diseases occur because of a gene on a single half of the chromosome pair, this "homologous substitution" from the other chromosome corrects the faulty gene. Alternatively, scientists can even provide a template gene sequence that they want to use to substitute for the cleaved portion of the DNA (see Figure 1).

Gene editing offered a radical new way to cure or prevent diseases, but it required a significant amount of R&D work both to develop ZFNs that were precise and reliable enough to safely edit human genes and to develop a delivery mechanism that would ensure the ZFNs penetrated enough of an individual's cells to make a difference. Clinical trials to establish the treatment's safety and efficacy to get FDA approval would also be a huge hurdle to overcome.

Since none of Sangamo's products were commercially available yet, the company was entirely reliant upon grants and funding from partners for its survival. Though the company's ZFN technology had been overshadowed in the press by CRISPR-Cas9 in the last few years, interest in ZFNs appeared to be heating back up. In early 2018, Gilead Sciences signed a $3 billion deal with Sangamo to develop a ZFN-based method of harnessing a patient's own immune system to battle cancer,[a] and Case Western University had received an $11 million grant from the U.S. National Institute of Health work with Sangamo on its HIV program.[b] The company was already almost a year into Phase II testing of one of its HIV programs—was Sangamo at the precipice of curing HIV? And if so, did it make more sense to try to commercialize the drug alone or to work with a partner?

FIGURE 1
Gene Editing with Nucleases



Correcting Monogenic Diseases

Monogenic diseases are diseases that are caused by a defect in a single gene. One example is hemophilia. People with hemophilia lack sufficient clotting factors in their blood, resulting in them bleeding longer after an injury. Internal bleeding, in particular, can cause significant damage and be life threatening. Individuals with hemophilia need regular infusions to replace the clotting factor in their blood. Sangamo's ZFN treatment offered the hope of a cure, rather than lifelong treatment.[c] Sangamo had already demonstrated that its ZFN method for treating hemophilia worked in mice and was preparing to file an application to begin clinical trials. Sangamo also had developed treatments for sickle cell anemia and beta thalassemia, also monogenic diseases. Normally, patients with sickle cell anemia or beta thalassemia require lifelong care or bone marrow transplants, at great expense and risk. Sangamo, however, had shown in the laboratory that its treatment could knock out the *BCL11A* gene causing these diseases.

Another example of a monogenic disease is Huntington's Disease (HD). HD is a devastating neurologic disease in which people lose their motor coordination, cognition, and memory. The disease is progressive and usually fatal within 10–20 years of onset. The disease is a result of a mutation in a single gene, the huntingtin gene that results in a greater-than-usual number of repeats of the CAG DNA sequence, resulting in a mutant form of the huntingtin protein accumulating in cells. Most individuals inherit only one copy of the faulty gene, and it takes only one copy to produce the disease. Furthermore, 50 percent of the children of an HD sufferer also inherit the disease. Though previous research had explored ways to decrease the huntingtin protein in cells, it turned out that the normal form of the protein is essential, and mice lacking the normal huntingtin protein died before birth. Sangamo, however, developed a ZFN method to identify and "turn off" only the faulty gene. This meant that an individual would have only one operational copy of the gene which would continue to produce the normal form of the huntingtin protein.

Whereas there were treatments available that could at least stop or slow the progression of hemophilia, sickle cell anemia, and beta thalassemia, there were no such treatments for Huntington's—nothing had been found that could halt its progression. Thus, Sangamo's presentation of promising results for its HD treatment was big news—its success could mean the difference between life and death for sufferers of HD.

Drug Development and Clinical Trials

Drug development is hugely expensive and risky. Most studies indicate that it costs at least $1.5 billion and a decade of research to bring a new Food and Drug Administration (FDA)–approved pharmaceutical product to market.[d] The statistics on drug development costs are, in fact, an understatement because they do not fully account for the costs of the many failed drugs that are abandoned earlier in the development process. In the pharmaceutical industry, only one out of every 5000 compounds tested makes it to the pharmacist's shelf, and only one-third of those will be successful enough to recoup the investment in researching and developing the original 5000 compounds. Accounting for investment in failed drug efforts suggests that the cost of drug development is much higher than is typically reported. A study of R&D spending and new drug approvals published in *Forbes* in 2012, for example, found that firms spent over $6 billion per approved drug (see Table 1).[e,f]

Most studies suggested that the biggest cost in drug development was the cost of clinical trials—a cost that is borne by the sponsoring organization (usually the company that developed the drug). To be approved by the FDA in the United States, most drugs have to go through several phases of trials. First, in *preclinical studies,* the company will usually assess the safety and efficacy of the drug using animals. In *Phase 0* trials, a single dose (smaller than what would be used to provide the therapeutic treatment) is given to a small number (10 to15) of human subjects to evaluate what the drug does to the body. If successful, the drug may be entered into *Phase 1* clinical trials, whereby the drug is given to a somewhat larger group of people (20 to 80) to evaluate its safety, determine dosage ranges, and identify side effects. Phase 1 trials are primarily to assess the safety of the drug. In *Phase 2* trials, the drug is given to larger groups of people (100 to 300) to evaluate its effectiveness and further evaluate its safety and side effects. Finally, in *Phase 3,* the drug is given to very large groups of subjects (1000 to 3000) to confirm its effectiveness compared to alternatives and gather still further information on its safety.

TABLE 1
Research Spending and New Drug Approvals[g]

Company	Number of Drugs Approved	Total R&D Spending 1997–2011 ($Mil)	R&D Spending Per Drug ($Mil)
AstraZeneca	5	58,955	11,790.93
GlaxoSmithKline	10	81,708	8170.81
Sanofi	8	63,274	7909.26
Roche Holding	11	85,841	7803.77
Pfizer	14	108,178	7727.03
Johnson & Johnson	15	88,285	5885.65
Eli Lilly & Co	11	50,347	4577.04
Abbott Laboratories	8	35,970	4496.21
Merck & Co Inc	16	67,360	4209.99
Bristol-Myers Squibb Co	11	45,675	4152.26
Novartis	21	83,646	3983.13
Amgen Inc	9	33,229	3692.14
AVERAGE	**11.58**	**66,872.33**	**6199.85**

Finally, if the drug successfully makes it through Phase 3 clinical trials, the sponsoring organization can apply for a New Drug Approval from the FDA. The entire process typically takes at least 10 to 12 years, costs hundreds of millions of dollars, and the vast majority of new drug projects do not make it through the process successfully.

Competing Technologies

As if drug development was not risky enough, Sangamo also faced the threat that its ZFN technology would be rendered obsolete by other gene editing alternatives. In early 2018, two other gene editing alternatives were gaining traction: TALENs (transcription activator-like effector nucleases), and CRISPR-Cas9 (clustered regularly interspaced short palindromic repeats). TALENs are like ZFNs in that they are special nucleases that identify and bind to a specific part of the DNA and cut the genome at a desired spot. The main difference between the two is how they identify the right DNA binding location. By 2018, ZFN technology was more mature and better developed, but TALEN technology was considered more straightforward to design treatments with, and thus many considered it to have an advantage in the longer term.[h] According to Stephen Ekker, director of the Mayo Addiction Research Center at the Mayo Clinic Cancer Center, while ZFNs had established the proof of principle for genome-editing technology, "TALENs . . . do most of what ZFNs do, but cheaper, faster and better."[i] On the other hand, TALEN molecules were larger, which made them more difficult to deliver to chosen regions of the body (a particular challenge was getting gene editing nucleases past the blood–brain barrier for treatment of diseases such as Huntington's). Since both technologies had advantages and disadvantages, their sponsors would have to race to get effective treatments to market ahead of each other.

CRISPR-Cas9 was somewhat different. CRISPR technology harnessed a natural defense system of bacteria that has evolved to recognize and eliminate foreign DNA, giving bacteria "adaptive immunity." CRISPR was even more simple and efficient than TALENs, fueling enormous excitement over its potential. CRISPR-Cas9 was so simple and inexpensive, in fact, that high school and college students were learning to do gene editing in school. However, because CRISPR used a very short RNA sequence to guide its activity, some people worried that its effects wouldn't be precise enough—that is, it could result in "off target" cleavages—a highly undesirable result!

As of early 2018, CRISPR appeared to be the front runner, but a lengthy patent battle over rights to the CRISPR technology, along with the ease at which anyone could work with CRISPR had created some uncertainty about who would benefit financially from the technology. Sangamo's ZFN technology was patented and had higher technological barriers to entry. These two traits posed both benefits and costs to the development of ZFN technology.

Sangamo's Partnerships

Biotechnology firms could spend years earning only losses while they developed their treatments. Sangamo was no exception—it had yet to make any money from sale of its products. All of its revenues came from research grants and collaboration agreements, and it outspent those revenues in R&D, accumulating losses in each year. This highlights the challenging nature of drug development: Though the company had developed ground breaking treatments that could radically improve the lives of several different patient populations, it was financially quite vulnerable.

As of 2018, Sangamo had only 182 full-time employees; it did not have the resources to do its own clinical testing, manufacturing, or marketing. For these stages of drug development, Sangamo would be reliant on partnerships with much larger firms. In addition to the partnerships with Gilead and Case Western University, Sangamo also had partnerships with Pfizer, Bioverativ, and Shire Pharmaceuticals.

Pfizer was a New York City–based company with $53 billion in sales and almost 100,000 employees. It was one of the largest pharmaceutical companies in the world. In May of 2017, Sangamo had entered into an R&D alliance and exclusive licensing agreement for Sangamo hemophilia A gene editing treatment. The deal included upfront payments and royalty payments worth about $545 million. Then in early 2018, Sangamo and Pfizer announced they had also signed a $162 million deal to work together to develop a treatment for the genetic version of amyotrophic lateral sclerosis (Lou Gherig's Disease).[j] Pfizer had clinical testing, manufacturing, and sales capabilities all over the world.

Bioverativ, a spinoff of Biogen, was a Waltham Massachusetts–based biotech firm with about 400 employees. Bioverative was working with Sangamo on treatments for sickle cell anemia and beta thalassemia. Under the terms of the deal, Bioverative would give Sangamo $20 million upfront and Sangamo would be responsible for performing all of the R&D on the treatments until they could be proven to work on humans. Then Bioverative would take over with clinical trials, manufacturing and marketing, and Sangamo would get milestone payments of up to $300 million and double digit royalties if the products earned sales. In early 2018, Bioverativ was acquired by the French pharmaceutical company Sanofi. With more than 110,000 employees, Sanofi was slightly larger than Pfizer and also had clinical trials, manufacturing, and distribution capabilities all over the world.

Shire was one of the United Kingdom's largest specialty biopharmaceutical companies with just over $15 billion in revenues and about 22,000 employees in 2017. One of its main products was Lamivudine, an antiretroviral therapy used to treat HIV. Though the company earned the majority (70 percent) of its sales in North America, it had direct operations in about 30 countries and sold products to more than 50 countries. Shire was known for being a highly acquisitive company, having acquired NPS pharmaceuticals, ViroPharma, Janssen Pharmaceuticals, and Advanced BioHealing just in the last few years. Its two most well-known drugs were treatments for attention-deficit/hyperactivity disorder (ADHD): Vyvanse and Adderall.

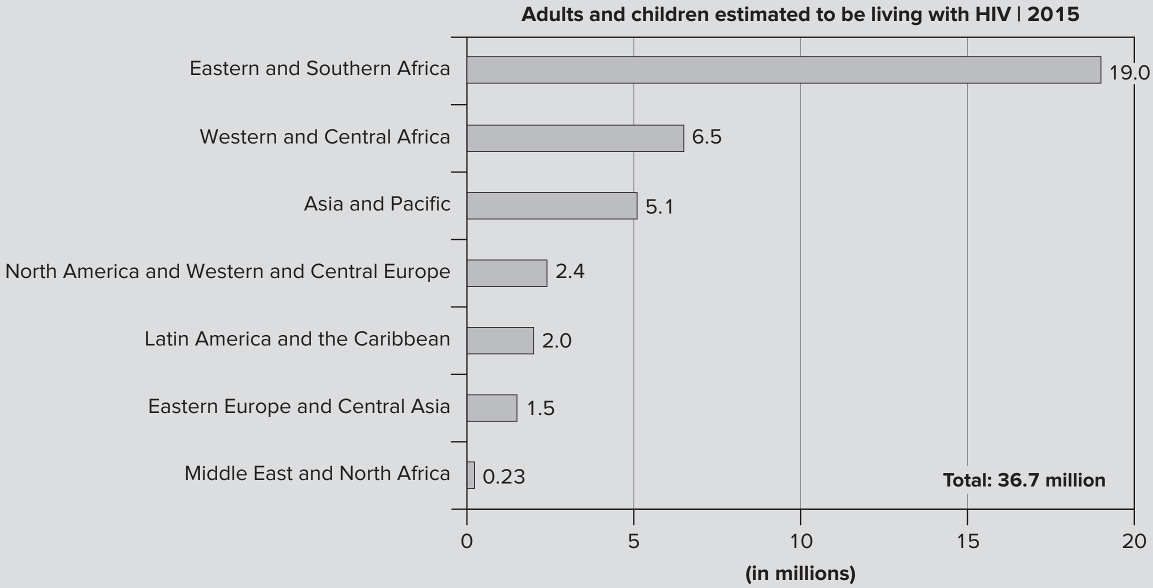
In January 2012, Sangamo entered into an agreement with Shire AG to further develop its ZNF treatments for hemophilia, Huntington's disease, and other diseases. Like the Biogen deal, Shire agreed to pay Sangamo an upfront fee, plus milestone fees of up to $213.5 million for each of seven targets.[k] However, in 2015 the firms revised their agreements so that Sangamo would have exclusive worldwide rights to the hemophilia treatments and Shire would have exclusive rights to the Huntington's disease treatments.[l]

A World-Changing Opportunity: Creating Immunity to HIV

One of the most exciting potential applications of ZFNs was creating a treatment that could cure HIV. In 2015, approximately 37 million people were living with HIV/AIDS worldwide Figure 2. However, a small percentage of people have a mutation in their *CCR5* gene—a gene that makes a protein found on the surface of cells. The mutation makes it difficult for HIV to enter their cells. Individuals receive their genes in pairs—one on a specific chromosome from one parent, and another on the paired chromosome from the other parent. Individuals with one copy of the mutated gene have some protection against HIV infection and experience a less severe form of the disease if infection occurs. Individuals with two copies of the mutated *CCR5* gene are typically immune to HIV. These gene mutations appear in up to 20 percent of people of European descent (scientists hypothesize that the gene mutation conferred resistance to the Bubonic plague or smallpox epidemics, leading this gene to be more prevalent in populations of people that survived such epidemics). People with the mutation appear to suffer no health problems from the mutation.

FIGURE 2
HIV/AIDS Worldwide, 2015

Source: *UNAIDS*.



The potential for exploiting the *CCR5* mutation gained widespread attention when a study published in 2011 revealed that an AIDS patient with leukemia had received a bone marrow stem cell transplant from a donor with the *CCR5* mutation and subsequently appeared to be cured of AIDS. After the bone marrow transplant, the patient was able to discontinue all antiretroviral therapy and the virus did not reappear in his blood.[m]

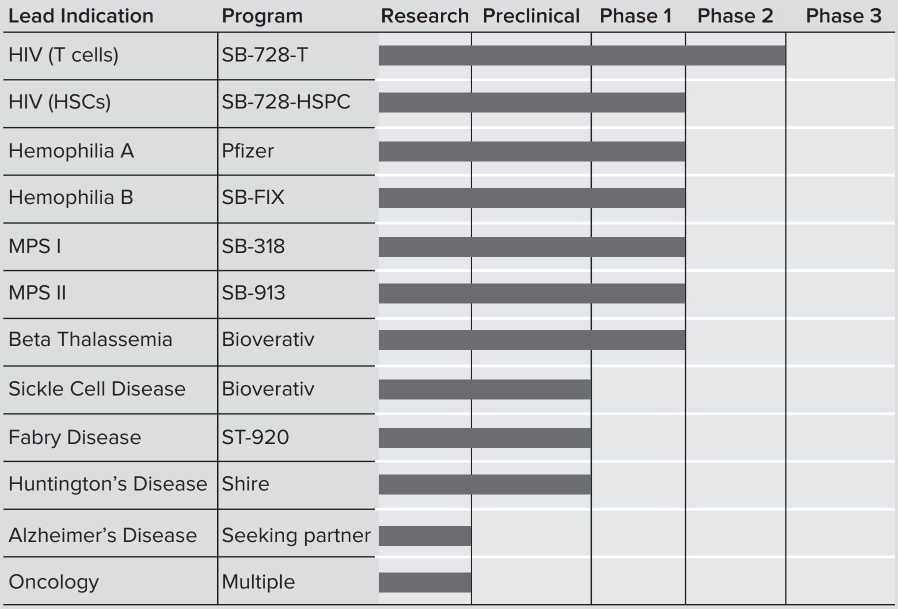
Finding a bone marrow match with a *CCR5* mutation is extremely unlikely, and getting a bone marrow transplant is risky. Sangamo thus decided to use its ZFN gene editing technology to develop a simpler method by which individuals could be given the mutation. Early results released by Sangamo in 2014 were promising: The treatment appeared to be well-tolerated and reduced the viral load of several patients who had been taken off of their antiretroviral therapy for 12 weeks during the study.[n] However, the percent of cells showing the mutation declined over time, which meant further work needed to be done to find a way to modify enough of the patients' genes for the therapy to be a reliable and permanent treatment.

The Future . . .

Sangamo clearly had a lot on its plate. It had revolutionary treatments in clinical trials for several major diseases, including the potential to create a cure for HIV Figure 3. In the short term, its business was focused on developing treatments

FIGURE 3
Summary of Sangamo's Research Programs and Drug Pipeline

Source: www.sangamo.com



through early-stage clinical trials that it would hand over to partners who had deeper pockets and were better positioned to conduct late stage clinical trials, production, and marketing. However, in the long run, Sangamo wanted to be able to do all of its own clinical testing, production, and marketing, to better capture the value of its innovative technologies. Sangamo had no revenues from actual products—only grants from research foundations and cash from upfront fees paid by its licensing partners. It was also spending over $65 million a year on R&D, and posting huge losses, year after year. Sangamo thus had to carefully weigh the pros and cons of developing its HIV treatment alone.

Discussion Questions

1. What were the pros and cons of Sangamo pursuing its gene editing programs alone versus working with a partner?
2. Does the HIV program offer any special opportunities or challenges?
3. What do you think Sangamo should do regarding the HIV program? Should it license the technology to a large pharmaceutical? Should it form a joint venture with another biotech or pharma company? If so, who?

[a] Mishra, M., "Sangamo in $3 Billion Gene-Editing Deal with Gilead," *Reuters,* (February 22, 2018).

[b] Suttell, S., "Case Western Reserve, California Tech Company Receive $11 million NIH Grant," *Crain's Cleveland Business* (February 7, 2018).

[c] Hersher, R. 2012. A whole clot of hope for new hemophilia therapies. *Nature Medicine.* February 2.

[d] *See* Joseph A. DiMasi & Henry G. Grabowski, *The Costs of Biopharmaceutical R&D: Is Biotech Different?* 28 Managerial & Decision Econ. 469, 469 (2007).

[e] M Herper, *The Truly Staggering Costs of Inventing New Drugs. Forbes,* February 10th (2012).

[f] According to a study by the Manhattan Institute for Policy Research, the majority of the drug development expense is due to the extremely costly and time-consuming process of clinical trials: If analysis is limited to drugs that are ultimately approved by the FDA, Phase 3 clinical trials represented over 90 percent of the total cost of development (*Project FDA Report,* Manhattan Institute for Policy Research, No. 5, April 2012).

[g] Herper, M. 2012. *The Truly Staggering Costs of Inventing New Drugs. Forbes,* February 10.

[h] Gaj, T, Gersbach, CA, Barbas, CF III, "ZFN, TALEN, and CRISPR/Cas-based methods for genome engineering," *Trends Biotechnol,* 31:397–405, July 2013; Pennisi, E, "The CRISPR Craze," *Science,* 341:833–6, August 23, 2013.

[i] J.M. Perkel. 2013. Genome editing with CRISPRs, TALENs, and ZFNs. *Biocompare,* August 27th.

[j] A. Keown, "Sangamo, Pfizer Deepen Relationship with New $162M ALS R&D Pact," *Biospace,* January 3, 2018.

[k] Renauer, C. 2014. How Sangamo BioSciences, Inc. is partnering to success. *The Motley Fool,* January 29th.

[l] Sangamo press release, 2015.

[m] Allers, K, Hugger, G, Hoffman, J, Loddenkemper, C, Riger, K, Thiel, E & Schneider, T. 2011. Evidence for the cure of HIV infection by CCR5Δ32/Δ32 stem cell transplantation. *Blood,* 117:2791–9.

[n] 2014. Gene editing of CCR5 in autologous CD4 T-cells of persons infected with HIV. *New England Journal of Medicine*, 370:897–906.

OVERVIEW

Firms frequently face difficult decisions about the scope of activities to perform in-house, and whether to perform them alone as a solo venture or to perform them collaboratively with one or more partners. As mentioned in Chapter Two, a significant portion of innovation arises not from any single individual or organization, but instead from the collaborative efforts of multiple individuals or organizations. Collaboration can often enable firms to achieve more, at a faster rate, and with less cost or risk than they can achieve alone. However, collaboration also often entails relinquishing some degree of control over development and some share of the expected rewards of innovation, plus it can expose the firm to risk of malfeasance by its partner(s). In this chapter, we will first consider the reasons that a firm might choose to engage in collaborative development or might choose to avoid it. We will then review some of the most common types of collaborative arrangements and their specific advantages and disadvantages.

REASONS FOR GOING SOLO

A firm might choose to engage in solo development of a project for a number of reasons. First, the firm may perceive no need to collaborate with other organizations—it may possess all the necessary capabilities and resources for a particular development project in-house. Alternatively, the firm may prefer to obtain complementary skills or resources from a partner, but there may be no available partner that is appropriate or willing to collaborate. A firm might also choose to develop a project as a solo venture if it is concerned that collaborating would put its proprietary technologies at risk, or if it seeks to have full control over the project's development and returns. Furthermore, a firm's solo development of a technological innovation might give it more opportunities to build and renew its capabilities.

1. Availability of Capabilities

Whether a firm chooses to partner on a project is largely determined by the degree to which it possesses all of the necessary capabilities in-house and the degree to which one or more potential partners have necessary capabilities. If a firm has all of the necessary capabilities for a project, it may have little need to collaborate with others and may opt to go it alone. Furthermore, if a firm finds that it lacks certain required capabilities but there are also no potential partners with such capabilities, it may be forced to develop the capabilities on its own.

For example, in the late 1970s Monsanto was interested in developing food crop seeds that were genetically modified to survive strong herbicides. Monsanto's Roundup, a powerful herbicide, had been introduced in 1974 and had been remarkably successful. However, Roundup killed almost all plants that it came into contact with and thus had to be applied with great care. If crops could be developed that were genetically modified to resist Roundup, the herbicide could be used more easily and in larger quantities. The biotechnology industry was still quite young, so there were no appropriate partners from which to acquire the necessary technologies. Monsanto decided to pursue the opportunity as a solo internal venture and declared that biotechnology was its new strategic focus.[1] In 1983, Monsanto successfully developed its first transgenic plant, but it would not be until 1995 that it would have its first genetically modified crop seed, Roundup Ready soybeans, approved for commercialization.[2] Though many environmental groups opposed both Roundup and the genetically modified Roundup Ready crops, the combination was enormously successful. By 2002, more than 130 million acres worldwide were planted with Monsanto's Roundup Ready soybean, corn, cotton, and canola seed.[3]

2. Protecting Proprietary Technologies

Firms sometimes avoid collaboration for fear of giving up proprietary technologies. Working closely with a partner might expose the company's existing proprietary technologies to the prying eyes of a would-be competitor. Furthermore, the firm may wish to have exclusive control over any proprietary technologies created during the development project. Consider Sangamo's decision about whether to collaborate in its development of a gene editing approach to curing HIV as described in the opening case. While collaborating would give Sangamo needed cash and access to valuable testing, manufacturing, and marketing capabilities, it did not possess, collaborating also meant that it would have to share the profit, control, and reputational effects from developing the treatment.

alliance
Alliance is a general term that can refer to any type of relationship between firms. Alliances may be short or long term and may include formally contracted agreements or be entirely informal in nature.

3. Controlling Technology Development and Use

Sometimes firms choose not to collaborate because they desire to have complete control over their development processes and the use of any resulting new technologies. This desire might be for pragmatic reasons (e.g., the new technology is expected to yield high margins and the firm does not wish to share rents with collaborators) or cultural reasons (e.g., a company's culture may emphasize independence and self-reliance). Both of these reasons are demonstrated by Honda in the development of its hybrid-electric vehicle, the Insight. While other auto manufacturers were enthusiastically forming **alliances** to collaborate on automobile design and the development of more efficient manufacturing processes, Honda was very cautious about forming collaborative relationships. Honda's decision not to join the Alliance of Automobile Manufacturers, the industry trade group that leads the fight against tougher fuel and emissions standards, had both pragmatic and cultural reasons. From a pragmatic standpoint, Honda worried that participating in the trade group would limit its discretion over its development of environmentally friendly automobiles, an area where Honda intended to be the market leader. This decision was reinforced by Honda's culture that emphasized retaining complete control over the firm's technology development and direction. This is illustrated by Honda President Hiroyuki Yoshino's statement, "It's better for a person to decide about his own life rather than having it decided by others."[4]

4. Building and Renewing Capabilities

Firms may also choose to engage in solo development even when partnering could save time or money because they believe that development efforts are key to building and renewing their capabilities. Solo development of a technological innovation challenges the firm to develop new skills, resources, and market knowledge. As noted in Chapter Seven, the potential for creating and enhancing the organization's capabilities may be more valuable than the innovation itself. This is aptly demonstrated in a quote from Walt Gillette of Boeing about the development of the Sonic Cruiser: "Industry experience indicates that if the company doesn't create a new airplane every 12 to 15 years, the needed skills and experience will be gone. Too many of the people who created the last new airplane will have retired or moved on to other companies, and their skills and experience will not have been passed on to the next generation of Boeing employees."[5]

Though there are several reasons a firm might choose to stick with solo development, there are also many reasons for firms to engage in collaborative development, and collaboration appears to be on the rise. In the next sections, we will discuss the advantages of collaboration and the strengths and weaknesses of various types of collaboration.

ADVANTAGES OF COLLABORATING

Collaborating on development projects can offer a firm a number of advantages, including faster speed to market, greater flexibility, learning capabilities from other firms, and building a coalition around a standard.

1. Acquiring Capabilities and Resources Quickly

It is not unusual for a company to lack some of the complementary assets required to transform a body of technological knowledge into a commercial product. Given time, the company can develop such complementary assets internally. However, doing so extends cycle time.[6] Instead, a company may be able to gain rapid access to important complementary assets by entering into strategic alliances or licensing arrangements.[7] For example, when Apple was developing its LaserWriter, a high-resolution laser printer, it did not possess the technological expertise to produce the printer's engine, and developing such capabilities in-house would have taken a long time. Apple persuaded Canon, the market leader in printer engines, to collaborate on the project.[8] With Canon's help, Apple was able to bring the high-quality printer to market quickly.

2. Increasing Flexibility

Obtaining some of the necessary capabilities or resources from a partner rather than building them in-house can help a firm reduce its asset commitment and enhance its flexibility. This can be particularly important in markets characterized by rapid technological change. High-speed technological change causes product markets to rapidly transform. Product life cycles shorten, and innovation becomes the primary driver of competition. When technology is progressing rapidly, firms may seek to avoid committing themselves to fixed assets that may rapidly become obsolete. They may choose to become more narrowly specialized and to use linkages with other specialized firms to access resources they do not possess in-house.

3. Learning from Partners

Collaboration with partners can be an important source of learning for the firm. Close contact with other firms can facilitate both the transfer of knowledge between firms and the creation of new knowledge that individual firms could not have created alone.[9] By pooling their technological resources and capabilities, firms may be able to expand their knowledge bases and do so more quickly than they could without collaboration.

4. Resource and Risk Pooling

One primary reason firms collaborate on a development project is to share the costs and risks of the project. This can be particularly important when a project is very expensive or its outcome highly uncertain.[10]

5. Building a Coalition around a Shared Standard

Firms may also collaborate on a development project when such a collaboration would facilitate the creation of a shared standard. For example, as of early 2018, there were four major electric vehicle charging standards competing in the market: CHAdeMO (used by most of the Japanese electric vehicle manufacturers), SAE Combined Charging System (used by most of the major European electric vehicle manufacturers plus General Motors and Ford in the United States), GB/T (used by Chinese electric vehicle manufacturers such as BYD, SAIC, and Dongfeng), and Tesla Supercharger (used by Tesla). Globally, in 2018 there were about 7000 CCS charging stations, 16,639 CHAdeMO charging stations (mostly in Japan and Europe), 8496 Tesla Superchargers (mostly in the United States), and 127,434 GB/T charging stations (all in China). In late 2017, Daimler, BMW, Ford, and Volkswagen group announced they would form the Charging Interface Initiative (CharIN) to collaborate on building CCS charging stations, hoping to build momentum for the standard. Tesla, meanwhile, had hedged its bets by releasing its patents on the Supercharger standard so that others could adopt it, and joining both the CharIN and CHAdeMO alliances. Furthermore, Tesla had created adapters for its vehicles for both the CHAdeMO and GB/T standards.[11]

TYPES OF COLLABORATIVE ARRANGEMENTS

Collaboration can include partnering with suppliers, customers, competitors, complementors, organizations that offer similar products in different markets, organizations that offer different products in similar markets, nonprofit organizations, government

joint venture
A partnership between two or more firms involving a significant equity stake by the partners and often resulting in the creation of a new business entity.

licensing
A contractual arrangement whereby one organization or individual (the licensee) obtains the rights to use the proprietary technology (or trademark, or copyright, etc.) of another organization or individual (the licensor).

organizations, universities, or others. Collaboration can also be used for many different purposes, including manufacturing, services, marketing, or technology-based objectives. In North America, as many as 23 percent of all alliances are for research and development activities, compared to 14 percent in Western Europe and 12 percent in Asia.[12]

Collaboration arrangements can also take many forms, from very informal alliances to highly structured **joint ventures** or technology exchange agreements (**licensing**). The most common forms of collaborative arrangements used in technological innovation include strategic alliances, joint ventures, licensing, outsourcing, and collective research organizations.

Strategic Alliances

A strategic alliance is a temporary relationship that can take many forms. It can be formalized in a contract or an informal agreement. It can be a short-term agreement or a long-term agreement, and it can include an equity investment made by the partners in each other (termed equity alliances, discussed later in the chapter). Most alliances (with the exception of joint ventures that establish a new legal subsidiary) are considered temporary agreements, and thus offer a good way for firms to flexibly combine their efforts and resources. Firms may use strategic alliances to access a critical capability that is not possessed in-house or to more fully exploit their own capabilities by leveraging them in another firm's development efforts. Firms with different capabilities necessary for developing a new technology or penetrating a new market might form alliances to pool their resources so that collectively they can develop the product or market faster or less expensively. Even firms that have similar capabilities may collaborate in their development activities in order to share the risk of a venture or to speed up market development and penetration. Large firms might form alliances with small firms in order to take a limited stake in the smaller firm's development efforts, while small firms might form alliances with large firms to tap the larger firm's greater capital resources, distribution and marketing capabilities, or credibility.[13] For example, many large pharmaceutical firms have allied with small biotechnology firms for their mutual benefit: The pharmaceutical firms gain access to the drug discoveries of the biotechnology companies, and the biotechnology companies gain access to the capital resources, manufacturing, and distribution capabilities of the pharmaceutical firms.

Through an alliance, firms can establish a limited stake in a venture while maintaining the flexibility to either increase their commitment later or shift these resources to another opportunity.[14] Firms can use alliances to gain an early window on emerging opportunities that they may want to commit to more fully in the future. Alliances also enable a firm to rapidly adjust the type and scale of capabilities the firm can access, which can be very valuable in rapidly changing markets.[15]

Alliances are also used to enable partners to learn from each other and develop new competencies. Alliance partners may hope to transfer knowledge between the firms or to combine their skills and resources to jointly create new knowledge. However, alliance relationships often lack the shared language, routines, and coordination that facilitate the transfer of knowledge—particularly the complex and tacit knowledge that is most likely to lead to sustainable competitive advantages.[16] To use alliances for learning requires a serious commitment of resources, such as a pool of dedicated people willing to travel between the home firm and partner firm, test-bed facilities, and active

FIGURE 8.1
Technology Alliance Strategies

Source: Y. Doz and G. Hamel, 1997, "The Use of Alliances in Implementing Technology Strategies." In M. L. Tushman and P. Anderson, *Managing Strategic Innovation and Change*, 1997.

	Individual Alliance	Network of Alliances
Capability Complementation	A GE-SNECMA alliance	B Corning Glass alliances
Capability Transfer	C Thomson-JVC alliance	D Aspla

procedures for internalizing what has been learned.[17] Alliances can thus also be costly. They require monitoring and coordination. There is also a risk of partners taking the firm's intellectual property for their own advantage.[18]

Yves Doz and Gary Hamel argue that it is useful to categorize a firm's alliance strategy along two dimensions.[19] The first dimension is the degree to which alliances practice **capability complementation** versus **capability transfer**. The second dimension is whether the firm manages each alliance individually or manages a collective network of alliances (see Figure 8.1).

capability complementation
Combining ("pooling") the capabilities and other resources of partner firms, but not necessarily transferring those resources between the partners.

capability transfer
Exchange of capabilities across firms in such a manner that partners can internalize the capabilities and use them independently of the particular development project.

In quadrant A are firms that forge an individual alliance to combine complementary technologies or skills needed for a project. For example, in the mid-1970s, General Electric (GE) and SNECMA (a French jet engine producer) formed a joint venture called CFM International to develop a new jet engine. The venture would combine GE's F101 turbojet with SNECMA's low-pressure fan expertise to create a powerful and fuel-efficient engine. Because the F101 was considered a sensitive military technology by the U.S. Air Force, the venture was set up to carefully avoid the exchange of proprietary technology between the firms. GE would build the F101 portion as a sealed "black box," which could then be shipped to a separate assembly location. The resulting engine, the CFM-56, became the most successful jet engine in the history of aviation.[20]

In quadrant B are firms that use a network of alliances to combine complementary skills and resources. For example, Corning, known primarily as a producer of glass products, has created a web of alliances with partners that have complementary skills in order to extend its glass technology into fields as diverse as medical products, computer products, and fiber optics. Instead of attempting to internalize its partners' technologies, Corning views its relationships with its partners as a form of extended enterprise that forms a flexible and egalitarian network of independent businesses.[21]

In quadrant C are firms that use individual alliances to transfer capabilities between them. Doz and Hamel provide the example of the alliance between JVC and Thomson. While both companies produce VCRs, Thomson wanted to glean product technology and manufacturing expertise from JVC, whereas JVC needed to learn how to penetrate the European market from Thomson. Both sides perceived an equitable opportunity for gain from exchanging capabilities.

In quadrant D are firms that use a network of alliances to exchange capabilities and jointly develop new capabilities. The collective research organizations described later in the chapter (including Aspla and the National Center for Manufacturing Sciences) are examples of alliance networks in which a formal body has been created to govern the network. These organizations are designed to enable their member organizations to collectively create, share, and utilize knowledge. In building an alliance portfolio, managers should think carefully about competitive effects, complementing effects, and network structure effects. First, if multiple alliances are serving the same strategic needs, there is a risk of redundant resources investment, or competitive conflict between partners. The costs and benefits of this should be carefully weighed as alliance partners could become adversaries. Second, complementary alliances can be super-additive if carefully managed. For example, a pharmaceutical firm might be using an alliance to develop a drug target with one partner, and another alliance to develop a delivery method for that same drug, enabling it to bring the product to market faster.[22] In this situation, the benefits of each alliance are accentuated by the benefits of the other. Finally, managers should consider how their portfolio of alliances positions them in the web of relationships that connects their firm, their partners, and their partners' partners.[23] Such networks can be very influential in the diffusion of information and other resources, and being positioned well in an alliance network can confer significant advantages (see the Research Brief on "Strategic Positions in Collaborative Networks" later in this chapter).

The opportunities and flexibility that can be gained through using alliances can come at a cost. The potential for opportunism and self-interest exists for all parties of an alliance due to limited levels of mutual commitment.[24] Studies suggests that between 30 percent and 70 percent of alliances fail by neither meeting the goals of the partners nor delivering the operational or strategic benefits for which they were intended.[25] Firms need to be constantly on guard to ensure that the alliance does not inadvertently result in giving too much away to a potential competitor. According to Doz and Hamel, while collegiality between partners can facilitate trust and communication, *too much* collegiality may be a warning sign that information gatekeepers within the firm are not being sufficiently vigilant.[26] Employees at all levels should be regularly informed about what information and resources are off-limits to the partner, and the firm should stringently monitor what information the partner requests and receives.[27]

Joint Ventures

Joint ventures are a particular type of strategic alliance that entails significant structure and commitment. While a strategic alliance can be any type of formal or informal relationship between two or more firms, a joint venture involves a significant equity investment from each partner and often results in establishment of a new separate entity. The capital and other resources to be committed by each partner are usually specified in carefully constructed contractual arrangements, as is the division of any profits earned by the venture.

For example, in April of 2018, Tencent Holdings (a Chinese multinational conglomerate that specializes in Internet-related services such as social media, music streaming, mobile games, and more) announced it was forming a joint venture which

Chinese state–owned Changan Automobile Company to develop Internet-connected autonomous driving technology that would utilize artificial intelligence. Tencent would invest 102 million yuan (about $16.2 million) for a 51 percent share of the venture, and Changan would invest 98 million yuan for the remaining 49 percent share. Changan had already completed a 2000 kilometer road test from Chongqing to Beijing, and said it had received clearance to start testing autonomous vehicles on public roads in the U.S. state of California.[28]

Licensing

Licensing is a contractual arrangement whereby one organization or individual (the *licensee*) obtains the rights to use the proprietary technology (or trademark, copyright, etc.) of another organization or individual (the *licensor*). Licensing enables a firm to rapidly acquire a technology (or other resource or capability) it does not possess. For example, when Microsoft realized it had lost precious time to Netscape and needed to get a Web browser to market fast, it licensed the software it needed to produce Internet Explorer from Spyglass Inc. Microsoft also bought several companies (including Vermeer Technologies, Colusa Software, and eShop Inc.) to provide other Internet utilities.

For the licensor, licensing can enable the firm's technology to penetrate a wider range of markets than it could on its own. For example, Delphi Automotive, a supplier to the automotive industry, had developed a software program that can simulate various aspects of machining, including turning, milling, and drilling. The software enabled manufacturers that do high-volume machining to identify ways of improving their machining processes. Delphi had developed the software for its own use, but then realized it could make more money by licensing the software to others.[29]

Licensing a technology from another firm is typically much less expensive for a licensee than developing a new technology in-house. As discussed in earlier chapters, new product development is both expensive and risky; through licensing, a firm can obtain a technology that is already technically or commercially proven. Though it is often presumed that a technology available for license is an unlikely source of advantage (because it is typically available to many potential licensees), Procter & Gamble's experience shows that this need not be the case. Through its "Connect and Develop" program, it focuses on sourcing ideas and technologies external to the firm that it can then add value to in its labs. Thus, while a licensed technology provides the foundation for a new product, the product that arrives to market typically draws on the deep (and difficult to imitate) expertise and other resources P&G possesses.[30] This approach is emblematic of the "Open Innovation" approach now being used by many firms.[31]

Licensing agreements typically impose many restrictions on the licensee, enabling the licensor to retain control over how the technology is used. However, over time, licensees may gain valuable knowledge from working with the licensed technology that can enable them to later develop their own proprietary technologies. In the long run, the licensor's control over the technology may erode.

Sometimes firms license their technologies to preempt their competitors from developing their own competing technologies. This can be particularly important if competitors are likely to be able to imitate the primary features of the technology or if the industry has strong pressures for the adoption of a single dominant design (see Chapter Four). By licensing out the technology to potential competitors, the licensor gives up the ability to earn monopoly rents on the technology. However, doing so may prevent potential competitors from developing their own proprietary technologies. Thus, licensing enables a firm to opt for a steady stream of royalties rather than gambling on the big gain—or big loss—of having its technology compete against others for market dominance.

Outsourcing

Firms that develop new technological innovations do not always possess the competencies, facilities, or scale to perform all the value-chain activities for the new innovation effectively or efficiently. Such firms might outsource activities to other firms.

contract manufacturing
When a firm hires another firm (often a specialized manufacturer) to manufacture its products.

One common form of outsourcing is the use of contract manufacturers. **Contract manufacturing** allows firms to meet the scale of market demand without committing to long-term capital investments or an increase in the labor force, thus giving the firm greater flexibility.[32] It also enables firms to specialize in those activities central to their competitive advantage while other firms provide necessary support and specialized resources the firm does not possess. Contract manufacturing further enables a firm to tap the greater economies of scale and faster response time of a dedicated manufacturer, thereby reducing costs and increasing organizational responsiveness to the environment.[33] For example, when Apple redesigned a screen for its iPhone just weeks before it was due on the shelves, it was able to call a foreman at a Chinese factory it was working with, who woke up the 8000 workers sleeping in dormitories. The workers were given biscuits and tea, and immediately started a 12-hour shift fitting glass screens into beveled frames. Within 96 hours, the plant was manufacturing more than 10,000 iPhones a day. "The speed is breathtaking," an Apple executive noted. "There's no American plant that can match that." Whereas Apple directly employs 43,000 people in the United States and 20,000 people in other countries, an additional 700,000 people work for Apple's contractors, engineering, building, and assembling Apple products. In response to a query from U.S. President Barack Obama of "What would it take to make iPhones in the United States?" Steve Jobs replied, "Those jobs aren't coming back." Apple executives noted that the vast scale of overseas factories, and the flexibility, diligence, and industrial skills of their workers had outpaced American counterparts. But in response to criticisms about what this had done to employment in the United States, the executives explained, "We sell iPhones in over a hundred countries. . . . Our only obligation is making the best product possible."[34]

Other activities, such as product design, process design, marketing, information technology, or distribution can also be outsourced from external providers. For example, large contract manufacturers such as Flextronics and Solectron now often help firms design products in addition to manufacturing them. Companies such as IBM or Siemens will provide a company with a complete information technology solution, while United Parcel Service will take care of a company's logistics and distribution needs. Outsourcing can have a number of downsides, however. Reliance on outsourcing may cause the firm to forfeit important learning opportunities, potentially putting it at a disadvantage in the long run.[35] By not investing in development of in-house capabilities, a firm might not develop many of the skills and resources related to its products that enable the development of future product platforms. The firm risks becoming hollow.[36] In fact, Prahalad and Hamel argue that Korean firms such as Goldstar, Samsung, and Daewoo have explicit missions to capture investment initiative away from potential competitors by serving as contract manufacturers for them. This allows the Korean firms to use would-be competitors' funds to accelerate their own competence development, while the competitors' competencies erode.[37]

Outsourcing can also impose significant transaction costs for a firm.[38] Contract manufacturing, for example, requires a well-specified contract: Product design, cost, and quantity requirements must be clearly communicated and generally specified up front. The contracting firm may also have to go to great lengths to protect itself from having any proprietary technology expropriated by the contract manufacturer. In addition, the contract manufacturer may bear significant costs in ramping up production for a particular firm, and must therefore specify the contract to avoid being held up by the contracting firm after the manufacturer has made investments specific to the contract.[39]

Collective Research Organizations

In some industries, multiple organizations have established cooperative research and development organizations such as the Semiconductor Research Corporation or the American Iron and Steel Institute.[40] Collective research organizations may take a number of forms, including trade associations, university-based centers, or private research corporations.

Many of these organizations are formed through government or industry association initiatives. For example, the National Center for Manufacturing Sciences (NCMS) was formed in 1986 by the U.S. Defense Department, the Association for Manufacturing Technology, the Manufacturing Studies Board, General Motors, and 20 other manufacturing companies. Its purpose was to promote collaborations among industry, government, and academic organizations. By 2012, the center had 175 U.S., Canadian, and Mexican corporate members. Typical NCMS projects involve 15 to 20 organizations and run for two to four years.[41]

Other collective research organizations have been formed solely through the initiative of private companies. For example, in 2002, six Japanese electronics manufacturers (Fujitsu, Hitachi, Matsushita Electric Industrial, Mitsubishi Electric, NEC, and Toshiba) set up a collective research company called Aspla to develop designs for more advanced computer chips. Global competition had driven down margins on chips, resulting in major losses for many of the major Japanese electronics makers. Furthermore, research in advanced chip designs had become extremely expensive. The collaborative research organization would enable the companies to share the development expense and help the Japanese semiconductor industry retain its competitive edge. Each of the companies initially invested 150 million yen ($1.3 million) in the organization, and plans were for each to contribute about $85 million annually toward joint research.[42] The Japanese government also agreed to contribute $268 million.

CHOOSING A MODE OF COLLABORATION

Figure 8.2 summarizes some of the trade-offs between solo internal development and various modes of collaboration. Solo internal development is, on average, a relatively slow and expensive way of developing a technology. The firm bears all the costs and

FIGURE 8.2
Summary of Trade-Offs between Different Modes of Development

	Speed	Cost	Control	Potential for Leveraging Existing Competencies	Potential for Developing New Competencies	Potential for Accessing Other Firms' Competencies
Solo Internal Development	Low	High	High	Yes	Yes	No
Strategic Alliances	Varies	Varies	Low	Yes	Yes	Sometimes
Joint Ventures	Low	Shared	Shared	Yes	Yes	Yes
Licensing In	High	Medium	Low	Sometimes	Sometimes	Sometimes
Licensing Out	High	Low	Medium	Yes	No	Sometimes
Outsourcing	Medium/High	Medium	Medium	Sometimes	No	Yes
Collective Research Organizations	Low	Varies	Varies	Yes	Yes	Yes

risks, and may spend considerable time learning about the new technology, refining its designs, and developing production or service processes to implement the new technology. However, a firm that engages in solo internal development retains total control over how the technology is developed and used. Solo internal development also offers great potential for the firm to leverage its existing competencies and to develop new competencies, but offers little to no potential for accessing another firm's competencies. Therefore, solo internal development might make sense for a firm that has strong competencies related to the new technology, has access to capital, and is not under great time pressure.

Because strategic alliances can take many forms, the speed, cost, and degree of control they offer vary considerably. Some strategic alliances may enable a firm to relatively quickly and cheaply gain access to another firm's technology, but give the firm a low level of control over that technology. Other strategic alliances might be aimed at utilizing the firm's own technology in a broader range of markets, which can be fast and cost-effective, and still enable the firm to retain a considerable amount of control. Most alliances offer opportunities for leveraging existing competencies or developing new competencies. Strategic alliances may or may not offer potential for accessing another firm's competencies, depending on the alliance's purpose and structure.

By comparison, a joint venture is much more structured. While a joint venture typically involves developing a new technology and can take almost as long as solo internal development, it may be slightly faster due to the combination of the capabilities of multiple firms. Joint ventures enable partners to share the cost of the development effort, but they must also share control. Because joint ventures typically entail a long-term relationship between two or more firms that results in the development of a new product or business, joint ventures offer great potential for leveraging a firm's existing competencies, developing new competencies, and accessing its partners' competencies.

Joint ventures may be more appropriate than a strategic alliance or solo internal development when the firm places great importance on access to other firms' competencies.

Licensing in technology offers a fast way to access a new technology that is typically lower in cost than developing it internally. The firm typically has limited discretion over what it can do with the technology, however, and thus has a low degree of control. Depending on the firm's capability mix and the nature of what it has licensed, licensing can sometimes offer the potential of leveraging a firm's existing competencies, developing new competencies, and accessing another organization's competencies. For example, many potential drugs or medical therapies are first developed in university research centers or medical schools. Pharmaceutical and biotechnology firms then license the right to explore whether the discovery has potential as a commercially viable medical treatment using their own drug development, testing, and manufacturing capabilities. Licensing the promising compounds or therapies enables the pharmaceutical and biotechnology firms to obtain drug targets quickly, thus helping them keep their pipelines full. It also helps the firms focus their development efforts on projects that have already demonstrated some treatment potential.

Licensing can also be a good way for a firm to obtain enabling technologies that are necessary for its products or services, but that are not central to the firm's competitive advantage. For example, while producers of digital cameras need to be able to incorporate batteries that are long-lasting, light, and affordable in their camera designs, most camera producers do not perceive battery power as being central to their competitive advantage, and thus rely on externally sourced technology to meet this need. Licensing can also be an effective way for a firm that lacks technological expertise to gain initial market entry and experience that it can later build upon in developing its own technological capabilities.

Licensing out a technology offers a fast way for a firm to extend the reach of its technology that is nearly free and offers the potential for royalties. The firm relinquishes some control over the technology, but also retains a moderate amount of control through restrictions in the license agreement. Licensing out a technology explicitly leverages the firm's existing competencies by enabling the technology to be deployed in a wider range of products or markets than the firm participates in itself. It offers little opportunity for developing new competencies, however. Sometimes licensing out a technology is a way of accessing another firm's competencies, as when a firm uses licensing to expand its technology into products or markets in which it has little expertise.

When a firm outsources design, production, or distribution of its technology, it is intentionally giving up a moderate amount of control to rapidly gain access to another firm's expertise and/or lower cost structure. While the firm pays to outsource activities, it typically pays less than it would to develop the capability of performing those activities in-house, and it gains access to those activities more quickly than it could develop them in-house. While outsourcing offers little opportunity for building new competencies, it can leverage the firm's existing competencies by enabling it to focus on those activities in which it earns its greatest returns. For example, Nike's strategy of outsourcing nearly all its athletic shoe production to contract manufacturers in Asia enables Nike to focus on its competitive advantages in design and marketing while tapping the lower labor and capital costs of its manufacturers. Thus, outsourcing might sometimes be appropriate for (*a*) firm activities that are not central to its competitive advantage, (*b*) activities that would cause the firm to give up crucial flexibility if performed in-house, or (*c*) activities in which the firm is at a cost or quality disadvantage.

Participation in a collective research organization is typically a long-term commitment rather than an effort to rapidly access capabilities or technology. As with strategic alliances, the nature of a firm's participation in a collective research organization can take many forms; thus, cost and control can vary significantly. Collective research organizations can be very valuable ways for the firm to leverage and build upon its existing competencies, as well as to learn from other participating organizations. Though collective research organizations may not yield immediate returns in the form of new products or services, participating in collective research organizations can be extremely useful in industries that have complex technologies and require considerable investment in basic science. By pooling their knowledge and effort, firms in collective research organizations can share the cost and risk of basic research, while accelerating the rate at which it yields useful new solutions.

CHOOSING AND MONITORING PARTNERS

Gaining access to another firm's skills or resources through collaboration is not without risks.[43] It may be difficult to determine if the resources provided by the partner are a good fit, particularly when the resource gained through the collaboration is something as difficult to assess as experience or knowledge. It is also possible that a collaboration partner will exploit the relationship, expropriating the company's knowledge while giving little in return. Furthermore, since managers can monitor and effectively manage only a limited number of collaborations, the firm's effectiveness at managing its collaborations will decline with the number of collaborations to which it is committed. This raises the possibility of not only diminishing returns to the number of collaborations, but also negative returns as the number of collaborations grows too large.[44] These risks can be minimized if the company limits the number of collaborations in which it engages, chooses its partners very carefully, and establishes appropriate monitoring and governance mechanisms to limit opportunism.[45]

Partner Selection

The success of collaborations will depend in large part on the partners chosen. A number of factors can influence how well suited partners are to each other, including their relative size and strength, the complementarity of their resources, the alignment of their objectives, and the similarity of their values and culture.[46] These factors can be boiled down to two dimensions: resource fit and strategic fit.[47]

Resource fit refers to the degree to which potential partners have resources that can be effectively integrated into a strategy that creates value.[48] Such resources may be either complementary or supplementary. Most collaborations are motivated by the need to access resources the firm does not possess; such collaborations are based on the combination of complementary resources. Most of the examples in this chapter have entailed complementary resources, such as the combination of Apple's computer technology with Canon's printer engine technology, or the combination of Sangamo's gene editing technology with the clinical testing and manufacturing expertise of larger biotechnology and pharmaceutical firms. Other collaborations seek supplementary stocks of resources that are similar to those possessed by the firm. The pooling of supplementary resources can enable partners to achieve market power or economies of scale. For example, British Petroleum and Mobil consolidated many of their operations in Europe to gain economies of scale and lower their cost structure.[49]

Strategic fit refers to the degree to which partners have compatible objectives and styles. The objectives of the partners need not be the same as long as the objectives can be achieved without harming the alliance or the partners. Not knowing a partner's true objectives or forging an alliance with a partner with incompatible objectives can result in conflict, wasted resources, and forfeited opportunities. Das and Teng provide an example of an alliance forged between General Motors and South Korea's Daewoo. While GM desired to use the alliance to drive down costs on its existing automobile models, Daewoo's objective was to develop new technologies and design new models. The alliance ultimately failed because of the incompatibility of GM's cost orientation and Daewoo's R&D orientation.[50]

Firms can also evaluate potential partners using many of the same tools used to evaluate the firm's own position and strategic direction (for a review of these, see Chapter Six). This includes assessing how collaboration with the partner is likely to impact the firm's opportunities and threats in its external environment; its internal strengths, weaknesses, or potential for sustainable competitive advantage; and the firm's ability to achieve its strategic intent.

Impact on Opportunities and Threats in the External Environment

Assessing the collaboration's impact on the firm's opportunities and threats includes asking such questions as:

- How would the collaboration change the bargaining power of customers or suppliers?
- Would the collaboration impact the threat of entry? For example, is the partner likely to become a new competitor? Does the partnership raise barriers to entry for other potential entrants?
- Would the collaboration impact the firm's position vis-à-vis its rivals?
- Would the collaboration influence the availability of complementary goods or the threat of substitutes?

Impact on Internal Strengths and Weaknesses

Assessing the collaboration's impact on the firm's strengths and weaknesses includes asking such questions as:

- How would the collaboration leverage or enhance the firm's strengths? Does the collaboration put any of those strengths at risk?
- How would the collaboration help the firm overcome its weaknesses?
- Is the collaboration likely to yield a position of competitive advantage that is difficult for competitors to imitate? Is such a competitive advantage achievable without collaborating?
- Would the collaboration leverage or enhance the firm's core capabilities?
- Is the collaboration likely to impact the firm's financial strengths or weaknesses?

Research Brief Strategic Positions in Collaborative Networks[a]

A growing body of research suggests that a firm's position within a collaborative network influences its access to information and other resources, and its influence over desired outcomes. For example, a firm with a highly central position in the network is typically expected to have access to a greater amount of information and to be able to access that information more quickly than a firm in a more peripheral role. A firm that occupies a key brokerage role in a network (e.g., a firm that serves as a bridge between two otherwise disconnected groups of firms) is thought to benefit both by having exposure to diverse information (assuming the two groups of firms have quite distinct information resources) and by occupying a key gatekeeping position that controls the flow of information between the two groups. A firm's position within the network may also serve as a valuable signal to other potential partners about the value of its resources. For example, if a firm is young or small but has alliances with important and innovative firms, these alliances can serve as reputation endorsements when the quality of the firm is otherwise difficult to assess.[b] Such endorsements may enhance the firm's likelihood of receiving financing or attracting other important alliances.

Consider Figure 8.3, which shows the "main component" (the largest connected group) of the global technology collaboration network in 1998 (based on R&D alliances, cross-technology transfer agreements, and cross-licensing agreements formed from 1996 to 1998, as reported by SDC's alliance database).[c] The large group on the top of the network is mostly composed of organizations in industries whose underlying technology is electronics-based (computer hardware and software, communication equipment and service, transportation equipment, etc.), and the group on the bottom is dominated by organizations in the chemical and medical-based industries (pharmaceuticals, chemicals, health services, medical equipment, etc.). This grouping also includes a large concentration of educational organizations (primarily universities). As can be seen, some firms (e.g., IBM, Toshiba, Eli Lilly) have significantly more alliances than others. The number of links an organization has in a network is known as its "degree centrality." In general, the degree centrality of an organization tends to be strongly related to its size and prominence. The size and prominence of an organization help to determine how attractive it is to potential partners, and only large organizations typically have the resources necessary to manage a large number of alliances. An organization does not, however, have to be large or prominent to occupy a key brokerage position. Brokerage refers to how crucial an organization is to the transmission of information or other resources through the network. It is often measured with "betweenness centrality," which is the number of times an organization lies on the shortest path between other pairs of organizations. The three organizations with the highest betweenness centrality scores in this network are IBM, Eli Lilly, and PPD (Pharmaceutical Product Development Inc., a contract research organization). PPD had only three alliances during the 1996 to 1998 time period, but Figure 8.3 shows just how important those alliances were to the overall connectivity of the network. IBM's link to PPD and PPD's link to Eli Lilly provide a bridge from the center of the electronics group to the center of the chemical/medical group. This link is one of only three observed bridges between the two groups, and is the most central of those three.

There is still considerable debate about the relative benefits of centrality and brokerage. While many scholars argue that highly central firms have the greatest access to information and influence over information transmission, others argue that highly central firms are constrained by their many relationships to other organizations and suggest that it is better to occupy a brokerage role. There are similar debates about brokerage—while a broker is likely to have access to diverse information and serves as a key gatekeeper for the transmission of information

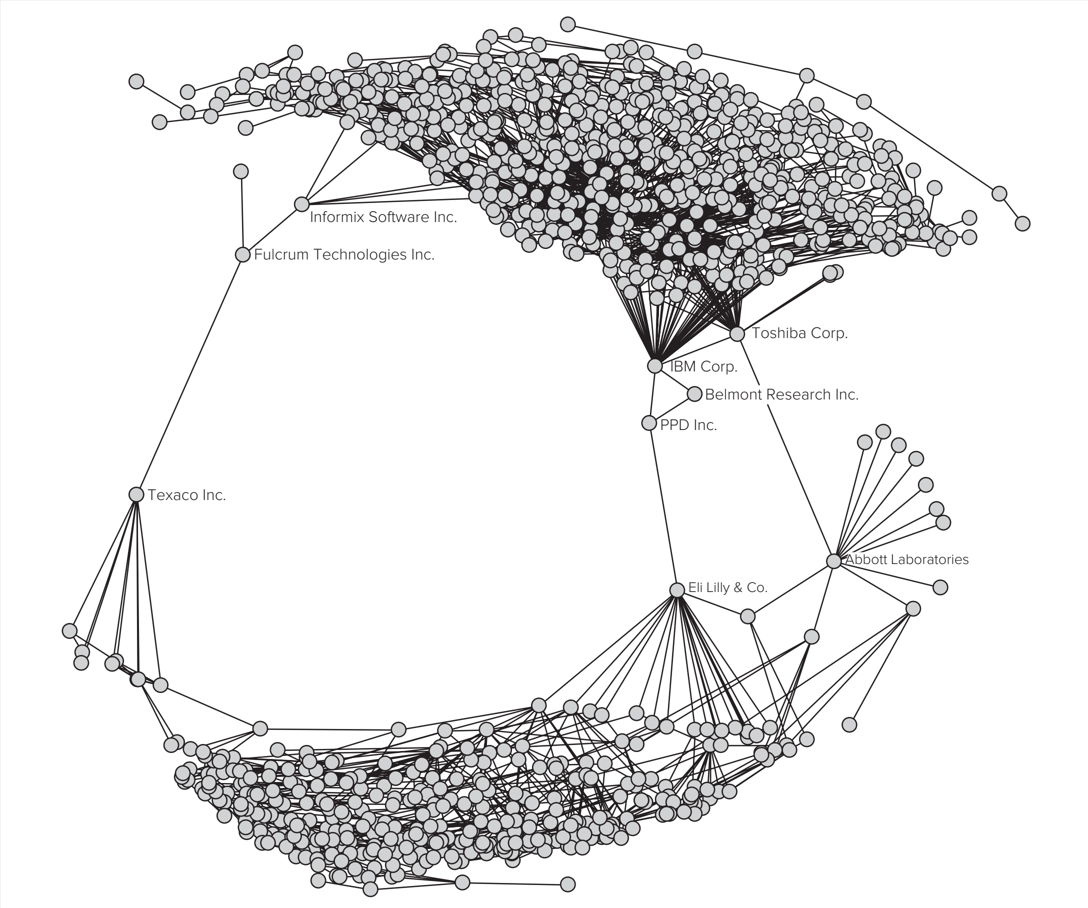
continued

concluded

FIGURE 8.3

The Global Technology Collaboration Network (Main Component) in 1998[d]

Adapted from Schilling, "The Global Technology Collaboration Network: Structure, Trends, and Implications."



between otherwise disconnected groups, it is unclear to what degree brokers typically benefit from this position. Some have argued that brokers can have difficulty assimilating and utilizing such diverse information, and that it might be better to be fully embedded in one group rather than be the only bridge between multiple groups. In other words, it might be better to have a relationship with a broker than to be the broker. There generally is consensus, however, that it is less desirable to be isolated (i.e., not connected to the network) or in a "pendulum" position (i.e., have only one link, and thus hang from the network like a pendulum).

[a] Adapted from M. A. Schilling, "The Global Technology Collaboration Network: Structure, Trends, and Implications," New York University working paper, 2009.

[b] T. Stuart, "Interorganizational Alliances and the Performance of Firms: A Study of Growth and Innovation Rates," *Strategic Management Journal* 21 (2000), pp. 791–811.

[c] Adapted from Schilling, "The Global Technology Collaboration Network: Structure, Trends, and Implications."

[d] Ibid.

Impact on Strategic Direction

Assessing the fit of the collaboration with the firm's strategic direction includes asking such questions as:

- How does this collaboration fit with the firm's statement of strategic intent?
- Is the collaboration likely to help the firm close any resource or technology gap between where it is now and where it would like to be?
- Are the objectives of the collaboration likely to change over time? How are such changes likely to be compatible or incompatible with the firm's strategic direction?

Partner Monitoring and Governance

governance
The act or process of exerting authority and/or control.

alliance contracts
Legally binding contractual arrangements to ensure that partners (a) are fully aware of their rights and obligations in the collaboration and (b) have legal remedies available if a partner should violate the agreement.

equity ownership
When each partner contributes capital and owns a specified right to a percentage of the proceeds from the alliance.

Successful collaboration agreements typically have clear, yet flexible, monitoring and **governance** mechanisms.[51] Not surprisingly, the more resources put at risk by the collaboration (e.g., the greater the upfront investment or the more valuable the intellectual property contributed to the collaboration), the more governance structure partner firms are likely to impose on the relationship.[52] There are three main types of governance mechanisms organizations use to manage their collaborative relationships: alliance contracts, equity ownership, and relational governance.[53] **Alliance contracts** are legally binding contractual arrangements to ensure that partners (a) are fully aware of their rights and obligations in the collaboration and (b) have legal remedies available if a partner should violate the agreement. Such contracts typically include:

- What each partner is obligated to contribute to the collaboration, including money, services, equipment, intellectual property, and so on.
- How much control each partner has in the arrangement. For example, the contract may stipulate whether partners have the right to admit new partners to the relationship or change the terms of the agreement. It may also stipulate the rights partners will have over any proprietary products or processes developed in the course of the collaboration.
- When and how proceeds of the collaboration will be distributed. For example, the collaboration agreement may stipulate whether cash, intellectual property rights, or other assets will be distributed and the schedule of such distribution.

Such contracts also often include mechanisms for monitoring each partner's adherence to the agreement, such as through regular review and reporting requirements.[54] Some collaboration agreements include provisions for periodic auditing either by the partner organizations or by a third party. Many agreements also include provisions for terminating the relationship if the need for the alliance ends (e.g., if the mission of the alliance is completed or the goals of the partner firms have changed) or partners encounter disputes they cannot resolve.[55] Markets and strategies change over time, and effective collaboration agreements should be flexible enough to be adapted in the event of change and provide a graceful exit strategy for members that no longer wish to participate in the collaboration.

Many alliances involve shared **equity ownership**, that is, each partner contributes capital and owns a share of the equity in the alliance. Equity ownership helps to align

relational governance Self-enforcing norms based on goodwill, trust, and reputation of the partners. These typically emerge over time through repeated experiences of working together.

the incentives of the partners (because the returns to their equity stake are a function of the success of the alliance) and provides a sense of ownership and commitment to the project that can facilitate supervision and monitoring of the alliance.

Finally, many alliances also rely on **relational governance**. Relational governance is the self-enforcing governance based on the goodwill, trust, and reputation of the partners that is built over time through shared experiences of repeatedly working together. Research suggests that relational governance can help to reduce contracting and monitoring costs of managing an alliance, and facilitate more extensive cooperation, sharing, and learning by alliance partners.[56]

Summary of Chapter

1. A number of factors will influence whether a firm chooses to collaborate on an innovation. Some of the most important include whether the firm (or a potential partner) has the required capabilities or other resources, the degree to which collaboration would make proprietary technologies vulnerable to expropriation by a potential competitor, the importance the firm places on controlling the development process and any innovation produced, and the role of the development project in building the firm's own capabilities or permitting it to access another firm's capabilities.
2. Firms may choose to avoid collaboration when they already possess the necessary capabilities and other resources in-house, they are worried about protecting proprietary technologies and controlling the development process, or they prefer to build capabilities in-house rather than access a partner firm's capabilities.
3. Some of the advantages of collaboration include sharing costs and risks of development, combining complementary skills and resources, enabling the transfer of knowledge between firms and the joint creation of new knowledge, and facilitating the creation of shared standards.
4. The term *strategic alliances* refers to a broad class of collaboration activities that may range from highly structured (e.g., joint ventures) to informal. Strategic alliances can enable simple pooling of complementary resources for a particular project, or they may enable the transfer of capabilities between partners. The transfer of capabilities often requires extensive coordination and cooperation.
5. A joint venture is a partnership between firms that entails a significant equity investment and often results in the creation of a new separate entity. Joint ventures are usually designed to enable partners to share the costs and risks of a project, and they have great potential for pooling or transferring capabilities between firms.
6. Licensing involves the selling of rights to use a particular technology (or other resource) from a licensor to a licensee. Licensing is a fast way of accessing (for the licensee) or leveraging (for the licensor) a technology, but offers little opportunity for the development of new capabilities.
7. Outsourcing enables a firm to rapidly access another firm's expertise, scale, or other advantages. Firms might outsource particular activities so that they can avoid the fixed asset commitment of performing those activities in-house. Outsourcing can give a firm more flexibility and enable it to focus on its core competencies. Overreliance on outsourcing, however, can make the firm hollow.

8. Groups of organizations may form collective research organizations to jointly work on advanced research projects that are particularly large or risky.
9. Each form of collaboration mode poses a different set of trade-offs in terms of speed, cost, control, potential for leveraging existing competencies, potential for developing new competencies, or potential for accessing another firm's competencies. An organization should evaluate these trade-offs in formulating a collaboration strategy.
10. Successful collaboration requires choosing partners that have both a resource fit and a strategic fit.
11. Successful collaboration also requires developing clear and flexible monitoring and governance mechanisms to ensure that partners understand their rights and obligations, and have methods of evaluating and enforcing each partner's adherence to these rights and obligations.

Discussion Questions

1. What are some advantages and disadvantages of collaborating on a development project?
2. How does the mode of collaborating (e.g., strategic alliance, joint venture, licensing, outsourcing, collective research organization) influence the success of a collaboration?
3. Identify an example of collaboration between two or more organizations. What were the advantages and disadvantages of collaboration versus solo development? What collaboration mode did the partners choose? What were the advantages and disadvantages of the collaboration mode?
4. If a firm decides it is in its best interest to collaborate on a development project, how would you recommend the firm choose a partner, a collaboration mode, and governance structure for the relationship?

Suggested Further Reading

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