Chapter Ten

Organizing for Innovation

Organizing for Innovation at Google

Google was founded in 1998 by two Stanford Ph.D. students, Sergey Brin and Larry Page, who had developed a formula for rank ordering random search results by relevancy. Their formula gave rise to an incredibly powerful Internet search engine that rapidly attracted a loyal following. The search engine enabled users to quickly find information through a simple and intuitive user interface. It also enabled Google to sell highly targeted advertising space.

The company grew rapidly. In 2001, Brin and Page hired Eric Schmidt, former CTO of Sun Microsystems and former CEO of Novell, to be Google's CEO. In 2004, the company went public, raising $1.6 billion in one of the most highly anticipated IPOs ever. Under Schmidt, the company adhered to a broad yet disciplined mission: "To organize the world's information and make it universally accessible and useful." This led the company to leverage its core search and advertising capabilities into blogging, online payments, social networks, and other information-driven businesses.

By 2014, Google had sales of over $66 billion, and employed more than 57,000 people. Despite this size, however, the company eschewed hierarchy and bureaucracy and sought to maintain a small-company feel. As noted by Schmidt during an interview, "Innovation always has been driven by a person or a small team that has the luxury of thinking of a new idea and pursuing it. There are no counter examples. It was true 100 years ago and it'll be true for the next 100 years. Innovation is something that comes when you're not under the gun. So it's important that, even if you don't have balance in your life, you have some time for reflection. So that you could say, 'Well, maybe I'm not working on the right thing.' Or, 'maybe I should have this new idea.' The creative parts of one's mind are not on schedule."[a]

In accordance with this belief, Google's engineers were organized into small technology teams with considerable decision-making authority. Every aspect of the headquarters, from the shared offices with couches, to the recreation facilities and the large communal cafe known as "Charlie's Place," was designed to foster informal communication and collaboration.[b] Managers referred to Google as a flexible and flat "technocracy," where resources and control were allocated based on the quality of people's ideas rather than seniority or hierarchical status. Schmidt remarked, "One of the things that we've tried very hard to avoid at Google is the sort of divisional structure that prevents collaboration across units. It's difficult. So I understand why people want to build business units, and have their presidents. But by doing that you cut down the informal ties that, in an open culture, drive so much collaboration. If people in the organization understand the values of the company, they should be able to self-organize to work on the most interesting problems."[c]

A key ingredient in Google's organization is an incentive system that requires all technical personnel to spend 20 percent of their time on innovative projects of their own choosing. This budget for innovation is not merely a device for creating slack in the organization for creative employees—it is an aggressive mandate that employees develop new product ideas. As noted by one Google engineer, "This isn't a matter of doing something in your spare time, but more of actively making time for it. Heck, I don't have a good 20% project yet and I need one. If I don't come up with something I'm sure it could negatively impact my review."[d] Managers face similar incentives. Each manager is required to spend 70 percent of his or her time on the core business, 20 percent on related-but-different projects, and 10 percent on entirely new products. According to Marissa Mayer, Google's head of search products and user experience, a significant portion of Google's new products and features (including Gmail and AdSense) resulted from the 20 percent time investments of Google engineers.

In 2015, the company was reorganized into Alphabet Inc., a holding company, wherein Google and other divisions such as Access, Calico, CapitalG, Nest, and others were wholly owned subsidiaries. The divisions retained their flat and flexible reporting structures.[e]

In a podcast interview at Stanford University, Andy Grove (former CEO of Intel) remarked that the company's organization appeared chaotic, even noting "From the outside it looks like Google's organizational structure is best described by . . . Brownian motion in an expanding model" and questioned whether Schmidt believed this model would continue to work forever. In his response, Schmidt responded, "There's an important secret to tell, which is there are parts of the company that are not run chaotically. Our legal department, our finances. Our sales force has normal sales quotas. Our normal strategic planning activities, our normal investment activities, our M&A activities are run in a very traditional way. So the part of Google that gets all the attention is the creative side, the part where new products are being built and designed, and that is different. And it looks to us like that model will scale for quite some time . . . it looks like small teams can run ahead and that we can replicate that model for that part of the company."[f]

Discussion Questions

1. What are the advantages and disadvantages of the creative side of Google being run as a flexible and flat "technocracy"?
2. How does Google's culture influence the kind of employees it can attract and retain?

3. What do you believe the challenges are in having very different structure and controls for Google's creative side versus the other parts of the company?
4. Some analysts have argued that Google's free-form structure and the 20 percent time to work on personal projects is possible only because Google's prior success has created financial slack in the company. Do you agree with this? Would Google be able to continue this management style if it had closer competitors?

[a] J. Manyika, "Google's View on the Future of Business: An Interview with CEO Eric Schmidt," *McKinsey Quarterly,* November 2008.

[b] From "The Google Culture," www.google.com.

[c] Manyika, "Google's View on the Future of Business."

[d] B. Iyer and T. H. Davenport, "Reverse Engineering Google's Innovation Machine," *Harvard Business Review,* April 2008.

[e] R. Price and M. Nudelman, "Google's Parent Company, Alphabet, Explained in One Chart," *Business Insider,* 2016. Available at: http://www.businessinsider.com/chart-of-alphabet-google-parent-company-infographic-x-gv-2016-1.

[f] Podcast retrieved on April 13, 2009, at http://iinnovate.blogspot.com/2007/03/eric-schmidt-ceoof-google.html.

OVERVIEW

The structure of an organization and the degree to which it uses formalized and standardized procedures and controls can significantly influence its likelihood of innovating, the effectiveness of its innovation projects, and the speed of its new product development processes.[1] For example, it is often argued that small, flexible organizations with a minimum of rules and procedures will encourage creativity and experimentation, leading to more innovative ideas. At the same time, it is also frequently pointed out that well-developed procedures and standards can ensure that the organization makes better development investment decisions and is able to implement projects quickly and efficiently. How then do managers decide what structure and controls would make the most sense for their firm?

A vast majority of firms use some type of product team structure to organize their new product development process, and we will look closely at how teams are composed and structured in Chapter Twelve, Managing New Product Development Teams. This chapter focuses on the organization-wide structural dimensions that shape the firm's propensity and ability to innovate effectively and efficiently. We will review the research on how firm size and structural dimensions such as formalization, standardization, and centralization affect a firm's innovativeness. By focusing on these underlying structural dimensions, we will elucidate why some structures may be better for encouraging the creativity that leads to idea generation, while other structures may be better suited for efficient production of new products. We will also explore structural forms that attempt to achieve the best of both worlds—the free-flowing organic and entrepreneurial structures and controls that foster innovation, plus the formalized and standardized forms that maximize efficiency while ensuring coherence across all of the corporation's development activities. The chapter then turns to the challenge of managing innovation across borders. Multinational firms face particularly difficult questions about where to locate—and how to manage—their development activities. We will review some of the work emerging on how multinational firms can balance the trade-offs inherent in these choices.

SIZE AND STRUCTURAL DIMENSIONS OF THE FIRM

Size: Is Bigger Better?

In the 1940s, Joseph Schumpeter challenged supporters of antitrust law by proposing that large firms would be more effective innovators.[2] Schumpeter pointed out that (1) capital markets are imperfect, and large firms are better able to obtain financing for R&D projects, and (2) firms with larger sales volume over which to spread the fixed costs of R&D would experience higher returns than firms with lower sales volume. Large firms are also likely to have better-developed complementary activities such as marketing or financial planning that enable them to be more effective innovators, and they are also likely to have greater global reach to obtain information or other resources.

Another advantage of size may arise in scale and learning effects. If large firms spend more on R&D in an absolute sense, they might also reap economies of scale and learning curve advantages in R&D—that is, they may get better and more efficient at it over time.[3] Through investing in R&D, the firm develops competencies in the new product development process and thus may improve its development process. It may accumulate better research equipment and personnel. Furthermore, as a large firm gains experience in choosing and developing innovation projects, it may learn to make better selections of projects that fit the firm's capabilities and have a higher likelihood of success.

Large firms are also in a better position to take on large or risky innovation projects than smaller firms.[4] For example, only a large company such as Boeing could develop and manufacture a 747, and only large pharmaceutical companies can plow millions of dollars into drug development in hopes that one or two drugs are successful.[5] This suggests that in industries that have large development scale (i.e., the average development project is very big and costly), large firms will tend to outperform small firms at innovation. In theory a coalition of small firms ought to achieve the same scale advantages, but in practice, coordinating a coalition of firms tends to be very difficult. While a single large firm can exert hierarchical authority over all of the development activities to ensure cooperation and coordination, coalitions often do not have such a well-defined system of authority and control.

On the other hand, as a firm grows, its R&D efficiency might decrease because of a loss of managerial control.[6] That is, the bigger a firm gets the more difficult it can become to effectively monitor and motivate employees. Furthermore, as a firm grows, it becomes increasingly difficult for individual scientists or entrepreneurs to appropriate the returns of their efforts; therefore their incentives diminish.[7] Thus, as the firm grows, the effectiveness of its governance systems may decrease.

Large firms may also be less innovative because their size can make them less nimble and responsive to change. Large firms typically have more bureaucratic inertia due to many layers of authority and well-developed policies and procedures.[8] For example, in the early 1980s, Xerox discovered that the administrative layers it had added to prevent errors in new product development had the unintended effect of blocking a project's progress, making product development cycles unacceptably long and putting Xerox at a disadvantage to more nimble Japanese competitors.[9]

High numbers of employees, large fixed-asset bases, and a large base of existing customers or supplier contracts can also be sources of inertia, making it difficult for the firm to change course quickly. As the number of employees grows, communication and coordination may become more difficult and prone to decision-making delays. When large firms have large fixed-asset bases and/or significant fixed costs, they often prefer to stick with existing sources of cash flow rather than gambling on big changes. Strategic commitments to customers and suppliers can also tie the firm to its existing businesses and technologies, making it more difficult to respond to technological change. Strategic commitments can thus lead to an *Icarus Paradox*—a firm's prior success in the market can hinder its ability to respond to new technological generations.

Small firms are often considered more flexible and entrepreneurial than large firms. They are unencumbered by multiple layers of administration, large fixed-asset bases, or strategic commitments to large numbers of employees, customers, and suppliers. Small firms may also find it much simpler to monitor employees and reward them for their effort or success at innovation.[10] Because resources are less abundant, small firms may also be more motivated to choose projects more carefully, leading to higher rates of new product success.

A number of empirical studies have attempted to test whether large size improves or hampers innovation productivity. Several studies of patent counts, new drug introductions, and technological innovations that improve product performance have indicated that small firms often outperform large firms in innovation.[11] For example, a few studies of patenting output have concluded that small firms appear to spend their R&D dollars more carefully and are more efficient, receiving a larger number of patents per R&D dollar.[12] One study of 116 firms developing new business-to-business products also found that small firms (those with annual sales less than $100 million) had significantly shorter development cycles than large firms (those with $100 million and more in sales), even when considering the relative magnitude of the innovation.[13] However, a few studies have indicated that large firms may still outperform small firms in innovation in some industries.[14]

disaggregated
When something is separated into its constituent parts.

While the firm's overall size is not an easy-to-manipulate attribute of the firm, many firms have found ways of making even large firms feel small. One primary method is to break the overall firm into several smaller subunits, and then encourage an entrepreneurial culture within these subunits. Multiple studies have observed that in industries characterized by high-speed technological change, many large and hierarchical firms have been **disaggregated** (or "unbundled") into networks of smaller, often more specialized, autonomous divisions or independent firms.[15] In such industries, many firms have undergone large-scale downsizing, with many functions and layers of management eliminated. The giant multidivisional firms of the twentieth century were replaced by leaner firms that were more focused and flexible, loosely coupled in a network of alliances, supplier relationships, and distribution agreements.[16] This phenomenon led to the rise of terms such as *virtual organization,*[17] *network organization,*[18] and *modular organization.*[19]

Since firms also use big company–small company hybrids to vary other structural dimensions of the firm (including formalization, standardization, and centralization), these ambidextrous approaches to organizing will be covered in more depth after the structural dimensions of the firm are reviewed.

STRUCTURAL DIMENSIONS OF THE FIRM

Firms vary on a number of structural dimensions that can influence the amount, type, and effectiveness of their innovation. Key structural dimensions include centralization, formalization, and standardization.

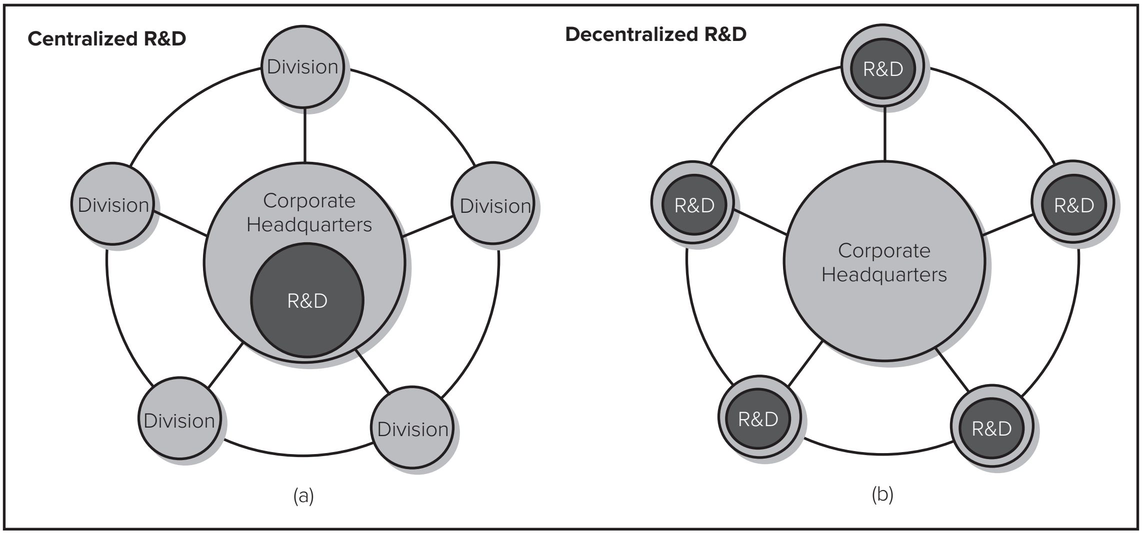
Centralization

centralization/decentralization
Centralization is the degree to which decision-making authority is kept at top levels of management. Decentralization is the degree to which decision-making authority is pushed down to lower levels of the firm.

Centralization is the degree to which decision-making authority is kept at top levels of the firm, while **decentralization** is the degree to which decision-making authority is pushed down to lower levels of the firm. Centralization can refer both to the geographical location of activities (that is, the degree to which activities are performed in a central location for the firm) and to where power and authority over activities are located. That is, activities might occur in locations far from the corporate headquarters, but the authority and decision making over those activities may be retained at headquarters—leading to greater centralization than their physical location would suggest.

For firms that have multiple R&D projects ongoing, whether to centralize or decentralize R&D activities is a complex issue. Decentralizing R&D activities to the divisions of the firm enables those divisions to develop new products or processes that closely meet their particular division's needs (see Figure 10.1). The solutions they develop are more likely to fit well within the operating structure of the division, and be closely matched to the requirements of the customers served by that division. The decentralization of development projects also enables the firm to take advantage of the

FIGURE 10.1
Centralized and Decentralized R&D Activities



diversity of knowledge and market contacts that may exist in different divisions. Consistent with this, studies by Felipe Csaszar show that when decision-making about new projects is pushed down to the lowest levels of the firm, the firm ends up taking on both a greater quantity and variety of projects. Though there will be more failed projects, the firm makes fewer "errors of omission."[20] However, there is much risk of reinventing the wheel when R&D activities are decentralized. Many redundant R&D activities may be performed in multiple divisions, and the full potential of the technology to create value in other parts of the firm may not be realized. Furthermore, having multiple R&D departments may cause each to forgo economies of scale and learning-curve effects.

By contrast, if the firm centralizes R&D in a single department, it may maximize economies of scale in R&D, enabling greater division of labor among the R&D specialists and maximizing the potential for learning-curve effects through the development of multiple projects. It also enables the central R&D department to manage the deployment of new technologies throughout the firm, improving the coherence of the firm's new product development efforts and avoiding the possibility that valuable new technologies are underutilized throughout the organization. For example, in the late 1980s, Intel realized that, as a result of the rising complexity and information processing demands in the semiconductor industry, its decentralized process development (which was scattered across diverse business groups) was resulting in serious delays and cost overruns. In the 1990s Intel thus centralized all process development, giving a single fabrication facility full responsibility for all new process generation. This development group would have maximum development resources (the highest in the industry). Once a new development process was completed and tested, it was replicated (in a process known in Intel as "copy exactly") in all of the company's other fabrication facilities.

The use of a centralized versus decentralized development process varies by type of firm and industry. For example, a study by Laura Cardinal and Tim Opler found that research-intensive firms that were highly diversified were more likely to establish separate research and development centers to facilitate communication and transfer of innovation across divisions.[21] A study by Peter Golder, on the other hand, found that consumer products companies tend to utilize more decentralized R&D, tailoring projects to local markets, while firms in electronics industries tend to centralize R&D in centers of excellence that are devoted to leveraging particular competencies.[22]

There is some disagreement about whether centralization enhances or impedes a firm's flexibility and responsiveness to technological change (or other environmental shifts). A highly centralized firm may be better able to make a bold change in its overall direction because its tight command-and-control structure enables it to impose such change on lower levels of the firm in a decisive manner. Decentralized firms may struggle to get the cooperation from all the divisions necessary to undergo a significant change. But decentralized firms may be better able to respond to some types of technological or environmental change because not all decisions need to be passed up the hierarchy to top management; employees at lower levels are empowered to make decisions and changes independently and thus may be able to act more quickly.

formalization
The degree to which the firm utilizes rules, procedures, and written documentation to structure the behavior of individuals or groups within the organization.

Formalization and Standardization

Formalization and standardization are closely related structural dimensions of organizations. The **formalization** of the firm is the degree to which the firm utilizes rules, procedures, and written documentation to structure the behavior of individuals or groups within the organization. **Standardization** is the degree to which activities in a firm are performed in a uniform manner. The rules and procedures employed in formalization can facilitate the standardization of firm activities and help to regulate employee behavior by providing clear expectations of behavior and decision-making criteria. Formalization can substitute for some degree of managerial oversight, and thereby help large companies run smoothly with fewer managers. This is demonstrated in the accompanying Theory in Action about 3M, where both Lehr and Jacobson responded to the difficulty of managing the growing firm by imposing more discipline and rules. By creating formal processes for choosing and managing development projects, Lehr and Jacobsen hoped to improve the overall efficiency and coherence of the firm's many decentralized development activities. However, high degrees of formalization can also make a firm rigid.[23] If a firm codifies all of its activities with detailed procedures, it may stifle employee creativity. Employees may not feel empowered or motivated to implement new solutions. This is also noted in the 3M example, when employee resentment of the new planning methods led to morale and motivation problems.

standardization
The degree to which activities are performed in a uniform manner.

Similarly, while standardization can ensure that activities within the firm run smoothly and yield predictable outcomes, standardization can also stifle innovation. Standardization may be used to ensure quality levels are met and that customers and suppliers are responded to consistently and equitably. However, by minimizing variation, standardization can limit the creativity and experimentation that leads to innovative ideas.

Mechanistic versus Organic Structures

mechanistic
An organization structure characterized by a high degree of formalization and standardization, causing operations to be almost automatic or mechanical.

The combination of formalization and standardization results in what is often termed a **mechanistic** *structure.* Mechanistic structures are often associated with greater operational efficiency, particularly in large-volume production settings. The careful adherence to policies and procedures combined with standardization of most activities results in a well-oiled machine that operates with great consistency and reliability.[24] For example, Dell Computer achieves its operational excellence, delivering products cost-effectively and with minimal inconvenience, by being highly standardized, disciplined, and streamlined.[25] While mechanistic structures are often associated with high centralization, it is also possible to have a highly decentralized mechanistic structure by using formalization as a substitute for direct oversight. By establishing detailed rules, procedures, and standards, top management can push decision-making authority to lower levels of the firm while still ensuring that decisions are consistent with top management's objectives.

organic
An organization structure characterized by a low degree of formalization and standardization. Employees may not have well-defined job responsibilities and operations may be characterized by a high degree of variation.

Mechanistic structures, however, are often deemed unsuitable for fostering innovation. Mechanistic structures achieve efficiency by ensuring rigid adherence to standards and minimizing variation, potentially stifling creativity within the firm. **Organic** structures that are more free-flowing, and characterized by low levels of formalization and standardization, are often considered better for innovation and dynamic environments.[26] In the organic structure, employees are given far more latitude in their job responsibilities and operating procedures. Because much innovation arises from experimentation and improvisation, organic structures are often thought to be better for innovation despite their possible detriment to efficiency.[27]

Theory in Action Shifting Structures at 3M

In 1916, William McKnight, the then general manager of sales and production for 3M, authorized the creation of the company's first research laboratory to improve 3M's sandpaper. McKnight had a strong belief in the power of individual entrepreneurship and innovation. He encouraged innovation through a combination of setting ambitious goals for new product development and giving individuals considerable freedom in how they pursued those goals. For example, McKnight established a companywide objective that 25 percent of sales should come from products created in the last five years. He also endorsed a "bootlegging" program whereby researchers could spend up to 15 percent of their time on whatever projects they were interested in pursuing.

As the firm grew, McKnight continued to support a centralized R&D lab while also encouraging divisions to pursue their own development initiatives in response to market needs they encountered. However, as 3M's product portfolio grew, it became increasingly difficult for 3M to manage functions such as production and sales. In 1944, McKnight began to experiment with an even more decentralized organizational form wherein divisions would have not only their own R&D labs, but also their own production operations and sales force. McKnight believed that small independent businesses would grow faster than a large company, leading to his "grow and divide" philosophy: Each division would be independent, and as its development projects grew into successful departments, they too would be spun off into new divisions.

By 1980, when Lou Lehr took the helm, 3M had grown to have 85 basic technologies and competed in about 40 major product markets. Lehr feared that 3M's greatest strength had become its weakness—the proliferation of independent businesses had led to a fragmentation of effort. Lehr worried that divisions might be wasting too much time on redundant activities and not taking advantage of the opportunity to leverage technologies across multiple divisions where they might be valuable. He wanted to ensure that divisions with related technologies would cooperate on development projects, and that new technologies would be diffused across the company. So he consolidated the company's 42 divisions and 10 groups into four business sectors based on their relatedness of technology. He also created a three-tiered R&D system: central research laboratories that concentrated on basic research with long-term potential, sector labs that would serve groups of related divisions and develop core technologies to drive medium-term (5 to 10 years) growth, and division labs that would continue to work on projects with immediate applications. Lehr also imposed much more formal planning on the development process—some of 3M's managers began to refer to it as "planning by the pound." He also eliminated many projects that had been struggling for years.

The arrival of "Jake" Jacobson in 1986 as the new CEO led 3M into an era of even greater discipline. Jacobson increased the target of sales from products developed within the past five years to 35 percent. He increased the R&D funding rate to about twice that of other U.S. companies, but also directed the company to become more focused in its project selection and to shorten development cycle times. He also implemented a companywide move toward using teams for development rather than encouraging individual entrepreneurs. Though Jacobson's initiatives improved efficiency, many researchers began to resent some of the changes. They believed that the move to manage all development projects with teams was destroying the individualistic culture of entrepreneurship at 3M and that the focus on discipline came at the expense of creativity and excitement. Motivation and morale problems began to emerge.

Thus, when "Desi" Desimone became the CEO in 1991, he eased the company back toward a slightly looser, more entrepreneurial focus. He believed his predecessors had established a good architecture for ensuring that innovation did not run away in an uncontrolled fashion, but he also believed the company needed more balance between freedom and control, as reflected in the following quote:

> Senior management's role is to create an internal environment in which people understand and value 3M's way of operating. It's a culture in which innovation and respect for the individual are still central. If you have senior management who have internalized the principles, you create a trust relationship in the company.

continued

concluded

The top knows it should trust the process of bottom-up innovation by leaving a crack open when someone is insistent that a blocked project has potential. And the lower levels have to trust the top when we intervene or control their activities.

Source: Adapted from C. Bartlett and A. Mohammed, "3M: Profile of an Innovating Company," Harvard Business School case no. 9-395-016, 1995.

Size versus Structure

Many of the advantages and disadvantages of firm size that were discussed at the beginning of the chapter are related to the structural dimensions of formalization, standardization, and centralization. Large firms often make greater use of formalization and standardization because as the firm grows it becomes more difficult to exercise direct managerial oversight. Formalization and standardization ease coordination costs, at the expense of making the firm more mechanistic. Many large firms attempt to overcome some of this rigidity and inertia by decentralizing authority, enabling divisions of the firm to behave more like small companies. For example, firms such as General Electric, Hewlett-Packard, Johnson and Johnson, and General Motors have attempted to take advantage of both bigness and smallness by organizing their companies into groups of small companies that can access the large corporation's resources and reach while retaining a small company's simplicity and flexibility.[28] The next section examines several methods by which firms can achieve some of the advantages of large size, and the efficiency and speed of implementation afforded by mechanistic structures, while simultaneously harnessing the creativity and entrepreneurial spirit of small firms and organic structures.

The Ambidextrous Organization: The Best of Both Worlds?

ambidextrous organization
The ability of an organization to behave almost as two different kinds of companies at once. Different divisions of the firm may have different structures and control systems, enabling them to have different cultures and patterns of operations.

Most firms must simultaneously manage their existing product lines with efficiency, consistency, and incremental innovation, while still encouraging the development of new product lines and responding to technological change through more radical innovation. Tushman and O'Reilly argue that the solution is to create an ambidextrous organization.[29] An **ambidextrous organization** is a firm with a complex organizational form that is composed of multiple internally inconsistent architectures that can collectively achieve both short-term efficiency and long-term innovation.[30] Such firms might utilize mechanistic structures in some portions of the firm and organic structures in others. This is one of the rationales for setting up an R&D division that is highly distinct (either geographically or structurally) from the rest of the organization; a firm can use high levels of formalization and standardization in its manufacturing and distribution divisions, while using almost no formalization or standardization in its R&D division. Incentives in each of the divisions can be designed around different objectives, encouraging very different sets of behavior from employees. A firm can also centralize and tightly coordinate activities in divisions that reap great economies of scale such as manufacturing, while decentralizing activities such as R&D into many small units so that they behave like small, independent ventures. Whereas traditionally research emphasized the importance of diffusing information across the firm and ensuring cross-fertilization of ideas across new product development efforts, recent research suggests that some amount of isolation of teams, at least in early development stages, can be valuable. When multiple teams interact closely, there is a risk that a solution that appears to have an advantage (at least at the outset) will be too rapidly adopted by other teams. This can cause all of the teams to converge on the same ideas, thwarting the development of other creative approaches that might have advantages in the long run.[31] Consistent with this, a significant body of research on "**skunk works**" has indicated that there can be significant gains from isolating new product development teams from the mainstream organization.[32] Separating the teams from the rest of the organization permits them to explore new alternatives, unfettered by the demands of the rest of the organization.

Skunk Works®
Skunk Works® is a term that originated with a division of Lockheed Martin that was formed in June of 1943 to quickly develop a jet fighter for the United States Army. It has evolved as skunk works to refer more generally to new product development teams that operate nearly autonomously from the parent organization, with considerable decentralization of authority and little bureaucracy.

Similarly, firms that have multiple product divisions might find that one or more divisions need a more organic structure to encourage creativity and fluid responses to environmental change, while other divisions benefit from a more structured and standardized approach. For example, when *USA Today* decided to establish an online version of the popular newspaper, management discovered it would need more flexible procedures to respond to both rapid technological change and the real-time information updating requirements of the online paper. The paper would also require different incentive schemes to attract and retain technologically savvy employees. The company established the online paper as a separate division with a different reporting structure, less formalization, a different pay structure, and even different cultural norms about appropriate work attire and working hours.

Apple provides another example. In 1980, Apple was churning out Apple II personal computers at a fast clip. However, Steve Jobs was not content with the product design; he wanted a product that would revolutionize the world by dramatically changing the way people interact with computers. He wanted to develop a computer so user-friendly and self-contained that it would appeal even to people who had no interest in the technological features of computers—it would become an extension of their everyday lives. Jobs began working with a team of engineers on a new project called Macintosh (originally developed by another Apple engineer, Jef Raskin). Jobs did not believe that the growing corporate environment at Apple was conducive to nurturing a revolution, so he created a separate division for the Macintosh that would have its own unique culture. He tried to instill a free-spirited entrepreneurial atmosphere reminiscent of the company's early beginnings in a garage, where individualistic and often eccentric software developers would flourish. The small group of team members was handpicked and sheltered from normal corporate commitments and distractions. He encouraged the Macintosh team members to consider themselves renegades, and even hung a pirate's skull-and-crossbones flag over their building. Jobs would also take the team on regular retreats to isolated resorts and reaffirm the renegade culture with quotes like "It's more fun to be a pirate than to join the Navy."[33]

If big firms can have internal structures with the incentives and behavior of small firms, then much of the logic of the impact of firm size on technological innovation rates becomes moot. A single organization may have multiple cultures, structures, and processes within it; large firms may have entrepreneurial divisions that can tap the greater resources of the larger corporation, yet have the incentive structures of small firms that foster the more careful choice of projects or enhance the motivation of R&D scientists. Such entrepreneurial units may be capable of developing discontinuous innovations within the large, efficiency-driven organizations that tend to foster incremental innovations.

Firms can also achieve some of the advantages of mechanistic and organic structures by alternating through different structures over time.[34] Schoonhoven and Jelinek studied Intel, Hewlett-Packard, Motorola, Texas Instruments, and National Semiconductor and found that these firms maintained a "dynamic tension" between formal reporting structures, quasiformal structures, and informal structures.[35] While the organizations had very explicit reporting structures and formalized development processes, the organizations were also reorganized frequently to modify reporting relationships and responsibilities in response to a changing environment. Thus, while the organizations used seemingly mechanistic structures to ensure systematic and efficient production, frequent reorganizing enabled the firms to be flexible.

These firms also used what Schoonhoven and Jelinek term *quasiformal structures* in the form of teams, task forces, and dotted-line relationships (that is, reporting relationships that were not formally indicated on the organizational chart). These quasiformal structures were more problem-focused and could change faster than the rest of the company. They also provided a forum for interaction across divisions and thus played an important boundary-spanning role. One advantage of quasiformal structures is that they fostered interactions based on interests rather than on hierarchy. This can foster more employee motivation and cross-fertilization of ideas. As noted by one employee: "Sometimes [innovation] happens in the men's room. One guy's talking to another guy, and another guy's standing, eavesdropping on the conversation, scribbling on a napkin."[36] Some of the downsides to such quasiformal structures were that they required time to manage, and they could be hard to kill. Since the quasi structures were not part of the formal reporting structure, it could sometimes be difficult to establish who had the authority to disband them.

MODULARITY AND "LOOSELY COUPLED" ORGANIZATIONS

Another method firms use to strike a balance between efficiency and flexibility is to adopt standardized manufacturing platforms or components that can then be mixed and matched in a modular production system. This enables them to achieve standardization advantages (such as efficiency and reliability) at the component level, while achieving variety and flexibility at the end product level.

Modular Products

Modularity refers to the degree to which a system's components may be separated and recombined.[37] Making products modular can exponentially increase the number of possible configurations achievable from a given set of inputs.[38] For example, many of IKEA's shelving systems are designed so that users can mix and match a number of components to meet their needs. The shelves and supports come in a range of standardized sizes, and they can all be easily attached with standardized connectors. Similarly, some stoves now offer customers the ability to expand the range of the stove's functionality by removing the burners and plugging in other cooking devices such as barbecue grills and pancake griddles. Publishers have even embraced modularity by offering digital content that enables instructors to assemble their own textbooks from book chapters, articles, cases, or their own materials.

Many other products are produced in a modular way, even though the customer does not perceive the modularity. By standardizing a number of common components and using flexible manufacturing technologies that can quickly shift from one assembly configuration to another, companies can produce a wide variety of product models just by changing which components are combined, while still achieving economies of scale and efficiency in the individual components. For example, Chrysler achieves one of the fastest new product development cycles in the automobile industry while also keeping new product development costs low through its practice of using a few standard platforms upon which all of its new car models are built. Tata Motors, the Indian company that introduced a $2500 car in 2008, used modularity even more dramatically. The Nano is built in components that can be sold and shipped in kits to be assembled and serviced by local entrepreneurs. This both enables the distribution of the Nano to be fast and streamlined and enables better penetration of remote rural markets.[39]

Modularity is achieved in product design through the specification of standard interfaces. For example, by designing all of its shelving components to work with its standardized connectors, IKEA ensures that components can be freely mixed and matched. Individual components can be changed without requiring any design changes in the other components. Because modularity enables a wider range of end configurations to be achieved from a given set of inputs, it provides a relatively cost-effective way for firms to meet heterogeneous customer demands. Furthermore, since modularity can enable one component to be upgraded without changing other components, modularity can enable firms and customers to upgrade their products without replacing their entire system. The personal computer is an excellent example of a modular system that enables upgrading. For example, if users want their personal computer to have more memory or a better monitor, they do not need to replace their entire computer system—they can simply purchase and install additional memory or a new monitor.

Modular products become more valuable when customers have heterogeneous demands and there are diverse options for meeting them. For example, suppose a car may be assembled from a range of components. The wider the range of components that may be recombined into a car, the wider is the range of possible car configurations achievable through modularity, and the greater is the potential opportunity cost of being "locked in" to a single configuration. Furthermore, the more heterogeneous customers are in their demand for car features, the less likely they are to agree on a single configuration. By employing modularity, heterogeneous customers can choose a car configuration that more closely meets their preferences.[40] By contrast, if customers all want the same thing, then there is little to be gained through offering a modular system—it will be a simple matter to determine the best combination of components to meet customer demands and integrate them into a nonmodular system.

When products are made more modular, it enables the entire production system to be made more modular. The standard interfaces reduce the amount of coordination that must take place between the developers of different components, freeing them to pursue more flexible arrangements than the typical organizational hierarchy.[41] Thus more modular products are often associated with more modular organizations with less centralization.[42] Such flexible arrangements are referred to as "loosely coupled organizational structures," as described in the next section.

Loosely Coupled Organizational Structures

Organizations can also be made modular through the adoption of structures that enable "loose coupling."[43] In a loosely coupled structure, development and production activities are not tightly integrated but rather achieve coordination through their adherence to shared objectives and common standards. If, for example, each development group agrees to a development plan and standardized interfaces that enable the components they develop to connect and interact effectively, there may be little need for close coordination between the groups. The standard interface provides "embedded coordination" among all the development and production participants.[44] This can enable components of a product to be produced by highly autonomous divisions of the firm, or even by multiple independent firms.

Advances in information technology have also enabled loosely coupled organizational structures to become more common.[45] Information technology can enable a firm to access and process more information at a lower cost, vastly increasing the firm's options for development configurations.[46] For example, information technology lowers a firm's search costs for locating suitable development partners, as well as the costs of monitoring the partner's performance. This was clearly demonstrated in a study by Nick Argyres of the development of the B-2 "Stealth" bomber, a highly advanced military aircraft, developed jointly by Northrop, Boeing, Vaught, and General Electric.[47] Argyres found that enhanced information technology limited the need for coordination of activities through hierarchical control. By using information technology and developing a standard interface—a shared "technical grammar" that facilitated communication across firms—the firms involved in the development of the bomber could work autonomously, yet cooperatively.

Less need for integration frees firms to pursue more flexible research and development and production configurations. For instance, firms can become more specialized by focusing on a few key aspects of technological innovation that relate closely to the firm's core competencies, while obtaining other activities through outsourcing or alliances. By focusing on those activities in which the firm has a competitive advantage, the firm can improve its chance of developing a product that has a price-to-value ratio that attracts customers while reducing the overhead and administrative complexity of maintaining a wide scope of activities. This can cause whole industries to be transformed as large vertically integrated firms are displaced by nimbler, more specialized producers.[48] For example, when computer workstations displaced their more integrated predecessors, minicomputers (which were traditionally built using a proprietary central processor, combined with a proprietary system bus, and run with a proprietary operating system), the entire computer industry began to become more modular as integrated producers like Prime, Wang, and Data General were displaced by a network of producers (including Sun Microsystems, Silicon Graphics, and Motorola), whose components could be combined in numerous end product configurations. The platform ecosystems described in Chapter Four are another example of loosely coupled organizations, as are distributed innovation systems that use crowdsourcing like Linux and Wikipedia.[49]

There are, however, disadvantages of loose coupling. Many activities reap significant synergies by being integrated.[50] In particular, activities that require the frequent exchange of complex or tacit knowledge are likely to need closer integration than a loosely coupled development configuration can offer. For example, suppose the design of a delivery mechanism for a drug will require intensive coordination with the design of the drug itself. It may be that the strength and dosage of the drug must be carefully

Theory in Action The Loosely Coupled Production of Boeing's 787 Dreamliner[a]

When Boeing launched its sales program for the yet-to-be-built 787 Dreamliner in late 2003, it rapidly became the fastest-selling commercial jet liner in history. By 2011, Boeing had received more than 800 advance orders for the aircraft—more than any other plane in history.[b] The Dreamliner marked an important turning point for the company. Boeing had not built an all-new airliner since 1994, when the 777 took to the sky. Since that time, Airbus had led the way in aerospace innovation, while Boeing had been content to stretch and refine its existing families of airplanes such as the 737 and 747. Many had begun to believe that Boeing no longer had what it took to build an entirely new aircraft.[c] The Dreamliner's success or failure would thus send strong signals to the market about the company's prospects for the future.

The Dreamliner was a super-efficient long-range mid-sized airliner. It would be the first commercial jet manufactured primarily from carbon fiber composites, enabling it to be significantly lighter and thus more fuel efficient than traditional commercial jets. Because the composite material could be more easily sculpted than aluminum, the wings of the jet would have graceful curves like a bird's wings. Furthermore, since the composite material was exceptionally strong and resistant to corrosion, the cabin could be both more pressurized and more humidified, making air travel more comfortable.[d] Composites also allowed Boeing to easily assemble the forward, center, and rear sections of the fuselage, the wings, the horizontal stabilizers, and the vertical fins as large individual modules that could be quickly snapped together to form the airplane, instead of constructing the aircraft piece by piece using aluminum sheets as prior aircraft had been constructed.[e]

The innovations of the Boeing 787 program extended well past the actual composition of the aircraft. For the 787 project, Boeing also revolutionized the structure of the production processes involved in building a commercial aircraft. The production of the 787 would be significantly more loosely coupled than any commercial aircraft to date. Dozens of partners from around the world built and preassembled large pieces of the plane which were then delivered to the Boeing plant for final assembly.[f] For example, Mitsubishi, Kawasaki, and Fuji, all of Japan, were contracted to produce the wings, forward fuselage, and center wing box, respectively. Saab makes the cargo doors, and Alenia Aeronautica of Italy produces a horizontal stabilizer and central fuselage. Dozens of companies from other countries contribute other parts.[g] Roughly 70 percent of the Dreamliner would be built outside of the United States. The dramatic increase in outsourcing was expected to provide a range of benefits that included spreading the risk of developing the aircraft, containing costs, and improving the prospects for foreign sales since purchasers and their governments often like to see work done on the aircraft in their countries.[h]

Though Boeing had outsourced a portion of the work on its planes for decades, the 787 ushered in a new era of outsourcing, Boeing's role would shift from being the traditional designer and manufacturer to becoming "an essential elements company, reserving for itself optimum design and integration tasks and relying on a select group of outsiders for everything else."[i] The revolutionary new production process was not without its challenges, however. The sheer complexity of the project and the large number of suppliers involved made coordination much more complicated. Breakdowns in this coordination had led to several delays. Though the first Dreamliner had been slated to take flight in August of 2007, customers did not actually take delivery of the first Dreamliners until late 2011. The challenges of coordinating suppliers around the globe had led to numerous production delays and design adjustments. Boeing's managers indicated that the company would make little profit on the first several dozen planes because even after they rolled off the assembly line, they would require corrective work, including the repair of parts and design changes.[j] Boeing's management acknowledged that some mistakes had been made in the supply chain, and Engineering Vice President Mike Denton indicated that the company was considering bringing more of the work back in-house.

continued

concluded

He noted, "We will probably do more of the design and even some of the major production for the next new airplanes ourselves as opposed to having it all out with the partners."[k]

[a] Adapted from "The Loosely Coupled Production of Boeing's 787 Dreamliner" by Jaspal Singh and Melissa A. Schilling, New York University teaching case.

[b] C. Drew, "Boeing Posts 20% Profit Gain But Cuts Forecast For 2012 As Jet Completion Slows," *New York Times,* January 25, 2012.

[c] M. V. Copeland, "Boeing's Big Dream," *Fortune* 157, no. 9 (2008), pp. 180–91.

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[f] P. Hise, "How Many Small Businesses Does It Take to Build a Jet?" *Fortune Small Business* 17, no. 6 (2007), pp. 42–45.

[g] J. Weber, "Boeing to Rein in Dreamliner Outsourcing," *BusinessWeek Online,* January 19, 2009, p. 10.

[h] Ibid., and M. Mecham, "The Flat-Earth Airplane," *Aviation Week & Space Technology,* July 3, 2006, p. 43.

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[k] Weber, "Boeing to Rein in Dreamliner Outsourcing."

calibrated and adjusted in accordance to the speed at which the delivery mechanism releases the drug. Alternative materials considered for the delivery mechanism may also have to be evaluated for their risk of potential interaction with chemicals used in the drug solution. If ongoing intensive coordination is required, the development activities might be better carried out through close integration of all parties.

An integrated firm also has mechanisms for resolving conflict that may be more effective or less expensive than those available in the market.[51] For example, if a dispute should arise over the development of a new product among development groups that are within the same firm, top managers can decide what action to take and exercise their authority over the development groups. But if the development groups are in separate companies, developing a new product in a collaboration agreement, neither firm may possess the authority to resolve the dispute and enforce a particular outcome. If the firms are unable to resolve the dispute themselves, they may face going to court or arbitration to resolve the dispute, an expensive and time-consuming option.

MANAGING INNOVATION ACROSS BORDERS

The organization of innovation activities becomes particularly interesting for multinational firms. Many of the same issues that shape the centralization-versus-decentralization decision discussed earlier become highly amplified in the multinational firm. Foreign markets offer highly diverse sources of information and other resources. They may also have highly diverse product needs and different operating norms. This prompts many firms to consider decentralizing R&D to take advantage of local information and tailor innovation activities to the local market. However, innovations developed in this decentralized manner might never be diffused to the other divisions. The customization of products and processes to the local markets makes them particularly difficult to transfer to divisions serving different markets. Divisions that are accustomed to developing their own innovations may be reluctant to share them with others for fear of giving away their proprietary knowledge. They may also be reluctant to adopt other divisions' innovations because of the belief that innovations that are not developed locally will not suit their local market needs (a phenomenon known as *not-invented-here syndrome*). However, much of the value creation potential of a multinational is the opportunity to leverage technological innovation (and other core competencies) into multiple markets. Allowing innovation activities to become completely autonomous and disconnected risks forfeiting this opportunity. How does the multinational resolve this dilemma? A series of studies by Christopher Bartlett and Sumantra Ghoshal highlight some advantages and disadvantages of various approaches to the management of multinational innovation. They identify four primary strategies used by firms: center-for-global, local-for-local, locally leveraged, and globally linked.[52]

center-for-global strategy
When all innovation activities are conducted at a central hub and innovations are then diffused throughout the company.

The **center-for-global strategy** entails conducting all innovation activities at a centralized hub. These innovations are then deployed globally throughout the company. The centralization of innovation activities enables management to:

- Tightly coordinate all R&D activities (across both functions and projects).
- Achieve greater specialization and economies of scale in R&D activities while avoiding duplication of activities in multiple divisions.
- Develop and protect core competencies.
- Ensure that innovations are standardized and implemented throughout the company.

Managers are likely to choose a center-for-global approach to innovation when they have a strong desire to control the evolution of a technology, when they have strong concerns about the protection of proprietary technologies, when development activities require close coordination, or when there is a need to respond quickly to technological change and dispersed efforts are likely to create inefficiencies.[53] However, a center-for-global approach tends to not be very responsive to the diverse demands of different markets. Furthermore, the divisions that serve these markets might resist adopting or promoting centrally developed innovations. As a result, innovations developed centrally may not closely fit the needs of foreign markets and may also not be deployed quickly or effectively.

local-for-local strategy
When each division or subsidiary of the firm conducts its own R&D activities, tailored for the needs of the local market.

A **local-for-local strategy** is the opposite of the center-for-global strategy. Each national subsidiary uses its own resources to create innovations that respond to the needs of its local market. A local-for-local strategy takes advantage of access to diverse information and resources, and it customizes innovation for the needs and tastes of the local market. Managers are likely to choose a local-for-local strategy when divisions are very autonomous and when markets are highly differentiated.

There are several downsides to the local-for-local strategy, however. It can result in significant redundancy in activities as each division reinvents the wheel. Furthermore, each division may suffer from a lack of scale in R&D activities, and there is a risk that valuable innovations will not be diffused across the firm.

locally leveraged strategy
When each division or subsidiary of the firm conducts its own R&D activities, but the firm attempts to leverage resulting innovations throughout the company.

Over time, firms have developed variants of these strategies that attempt to reap advantages of both the center-for-global and local-for-local strategies. Bartlett and Ghoshal identify one such strategy as the **locally leveraged strategy**. A firm implementing a locally leveraged strategy attempts to take the most creative resources and innovative developments from the divisions and deploy them across the company. This strategy enables the firm to take advantage of the diverse ideas and resources created in local markets, while leveraging these innovations across the company. One way this strategy is employed in consumer markets is to assign an individual the role of international brand custodian. This person is responsible for ensuring that a successful brand is deployed into the firm's multiple markets while also maintaining consistency in the product's image and positioning.[54] Such a strategy can be very effective if different markets the company serves have similar needs.

globally linked strategy
Innovation activities are decentralized, but also centrally coordinated for the global needs of the corporation.

Another approach, the **globally linked strategy**, entails creating a system of decentralized R&D divisions that are connected to each other. Each geographically decentralized division might be charged with a different innovation task that serves the global company's needs. For example, a multinational auto manufacturer may empower one of its European divisions with the responsibility for developing new subcompact models that most closely fit the European markets but that may ultimately also be sold in the United States, Canada, and South America. In the meantime, its American division might bear the bulk of the responsibility for collaborating with other manufacturers to develop more efficient manufacturing processes that will ultimately be deployed corporatewide. Thus, while innovation is decentralized to take advantage of resources and talent pools offered in different geographic markets, it is also globally coordinated to meet companywide objectives. This approach also attempts to enable the learning accrued through innovation activities to be diffused throughout the firm. This strategy can be quite powerful in its ability to tap and integrate global resources, but it is also expensive in both time and money as it requires intensive coordination.

In both the locally leveraged and globally linked strategies, R&D divisions are decentralized and linked to each other. The difference lies in the missions of the R&D divisions. In the locally leveraged strategy, the decentralized R&D divisions are largely independent of each other and work on the full scope of development activities relevant to the regional business unit in which they operate. This means, for example, that if their regional business unit produces and sells health care items, beauty care products, and paper products, the R&D division is likely to work on development projects related to all of these products. However, to ensure that the best innovations are leveraged across the company, the company sets up integrating mechanisms (such as holding regular cross-regional meetings, or establishing a liaison such as an international brand custodian) to encourage the divisions to share their best developments with each other. By contrast, in the globally linked strategy, the R&D divisions are decentralized, but they each play a different role in the global R&D strategy. Instead of working on all development activities relevant to the region in which they operate, they specialize in a particular development activity. For example, an R&D division may be in a regional business unit that produces and sells health care, beauty care, and paper products, but its role may be to focus on developing paper innovations, while other R&D divisions in the firm work on health care items or beauty care products. Or it might focus on basic chemistry applications relevant to all of the products, while another division explores packaging innovations, and so on. The role of the division should exploit some local market resource advantage (such as abundant timber or a cluster of chemical technology firms). This strategy attempts to take advantage of the diversity of resources and knowledge in foreign markets, while still linking each division through well-defined roles in the company's overall R&D strategy.

Bartlett and Ghoshal argue that, overall, the multinational firm's objective is to make centralized innovation activities more effective (that is, better able to serve the various local markets) while making decentralized innovation activities more efficient (that is, eliminating redundancies and exploiting synergies across divisions). Bartlett and Ghoshal propose that firms should take a *transnational* approach wherein resources and capabilities that exist anywhere within the firm can be leveraged and deployed to exploit any opportunity that arises in any geographic market. They argue that this can be achieved by:

- Encouraging reciprocal interdependence among the divisions of the firm (that is, each division must recognize its dependency on the other divisions of the firm).
- Utilizing integration mechanisms across the divisions, such as division-spanning teams, rotating personnel across divisions, and so on.
- Balancing the organization's identity between its national brands and its global image.

Ericsson provides an excellent example of this approach. Instead of using a strictly centralized or decentralized structure for its innovation activities, Ericsson's structure ebbs and flows between centralization and decentralization. Sometimes Ericsson increases levels of centralization and global integration for particular projects, while other times it decentralizes much more authority over innovation activities to its geographically dispersed divisions. Similar to the dynamic tension approach described by Jelinek and Schoonhoven, Ericsson regularly modifies its structure to adjust the balance between integration and autonomy. To encourage interunit integration, Ericsson also sends teams of 50 to 100 engineers to a different subsidiary for a year or two. Such member rotation programs facilitate the diffusion of knowledge throughout the firm.[55] Furthermore, encouraging engineers to become integrated into multiple areas of the company helped the engineers identify with both the global company and particular divisions.

Summary of Chapter

1. The impact of firm size on innovation has been debated for more than 50 years. Size is thought to confer advantages such as economies of scale in R&D, greater access to complementary resources (like capital and market access), and learning benefits. However, size may also be associated with disadvantages such as inertia and governance problems.
2. Many firms attempt to make big companies feel small by breaking them into networks of more specialized divisions. These divisions can behave like smaller, more entrepreneurial firms.
3. Structural dimensions of the firm, including formalization, standardization, and centralization, also affect the firm's propensity to innovate and its effectiveness at innovation. Formalization and standardization tend to improve efficiency, but can stifle experimentation and creativity. Centralization has a more ambiguous effect

on innovation; in some cases, centralization can enable significant innovation to occur more rapidly, and in other situations, decentralization fosters more innovation by enabling managers to respond quickly to local needs.

4. Traditionally, scholars have divided organization structures into two major types: mechanistic structures, which are highly formalized and standardized, and are good for efficient production, and organic structures, which are loose and free flowing and are good for creativity and experimentation.
5. Ambidextrous organizations attempt to achieve both the efficiency advantages of large mechanistic firms and the creativity and entrepreneurial spirit of small organic firms. These firms may have divisions with different structures and control schemes, or they may alternate between different structures.
6. Recently, many firms have begun forming loosely coupled networks both within and between firms to conduct development activities. Part of this transition is attributed to the rise in information technology and the resultant decrease in coordination costs.
7. Multinational firms face significant challenges in determining where and how to conduct their R&D activities. One primary challenge is to balance the need to tap the knowledge and resources of local markets while also achieving coherence across the corporation and ensure that technological innovations are diffused and leveraged throughout the organization.

Discussion Questions

1. Are there particular types of innovation activities for which large firms are likely to outperform small firms? Are there types for which small firms are likely to outperform large firms?
2. What are some advantages and disadvantages of having formalized procedures for improving the effectiveness or efficiency of innovation?
3. What factors should a firm consider when deciding how centralized its R&D activities should be? Should firms employ both centralized and decentralized R&D activities?
4. Why is the tension between centralization and decentralization of R&D activities likely to be even greater for multinational firms than for firms that compete in one national market?
5. What are some of the advantages and disadvantages of the transnational approach advocated by Bartlett and Ghoshal?

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