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Chapter 4

Entrepreneurship and Sustainability Innovation Analysis

4.1 Entrepreneurial Process

LEARNING OBJECTIVES

1. Understand the constituent elements of the entrepreneurial process.
2. Gain appreciation for how the elements fit together to form a whole.

In this chapter, we examine the ways in which entrepreneurial ventures combine the classic entrepreneurial process with sustainability concepts. This combination encompasses design approaches and corporate competencies that generate new offerings that achieve revenue growth and profitability while enhancing human health, supporting ecological system stability, and contributing to the vitality of local communities. This chapter shows the interconnections across sustainability, innovation, and entrepreneurship to give the reader greater understanding of a current global phenomenon: the search for new products, technologies, and ways of conducting business that will replace the old with designs intended to help solve some of society's most challenging issues.

When products are designed and business strategies are structured around systems thinking that is associated with sustainability, the outcome, as in any system composed of interacting and interdependent parts, emerges as larger than the sum of its constituent elements. So we should keep in mind, as we dissect the entrepreneurial process into its core elements, that we do so for analytic purposes—first to understand the individual parts and then to see how they come together. Once that picture is clear, the reader will have gained new insights into what entrepreneurs active in the sustainability innovation space actually do. The Walden Paddlers case discussed in [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis"](#), [Section 4.5 "Adaptive Collaboration through Value-Added Networks"](#), is a representative example of this approach.

Bear in mind that sustainability, innovation, and entrepreneurship are terms used to represent a wide range of ideas, depending on the context. However, just because they have come into common use and have been interpreted broadly does not mean they cannot be defined in focused and practical ways to help guide entrepreneurial individuals in business. Individuals and companies are, in fact, implementing sustainability designs and strategies through the use of innovative initiatives. At the present time, these three terms—sustainability, innovation, and entrepreneurship—are our best and most accurate descriptors of what is happening in the marketplace. No one term covers all the ground required. In the following

sections, we examine entrepreneurial process and then discuss sustainability concepts to explain how the necessary parts merge to create a holistic picture.

Entrepreneurial activity can seem mysterious for those not familiar with the phenomenon. US culture has created heroic myths around its most famous entrepreneurs, reinforcing the idea that entrepreneurship is about individuals. As a consequence, many people believe those individuals are born entrepreneurs. In fact, it is more accurate to talk about entrepreneurship as a process. More frequently than not, a person becomes an entrepreneur because she or he is compelled to pursue a market opportunity. Through that activity—that process—entrepreneurship unfolds. A typical story of entrepreneurship is one in which the entrepreneur is influenced by his or her engagement with favorable conditions, circumstances in which an idea comes together successfully with a market opportunity. An individual has an idea or sees a problem needing a solution and generates a way to meet that need. A new venture is initiated and, if successful, an ongoing business created. Thus entrepreneurship—the creation of new ventures as either new companies or initiatives within larger organizations—is about the process of individuals coming together with opportunities, resulting in specific customers being provided with new goods and services.

For purposes of this discussion, entrepreneurship is not constrained to starting a company. While that definition is commonly assumed, entrepreneurship and entrepreneurial innovation can occur in a variety of settings including small or large companies, nonprofit organizations, and governmental agencies. Entrepreneurship emerges under widely diverse circumstances, typically in response to new conditions and in pursuit of newly perceived opportunities. We focus here not on the average new venture set up to compete under existing rules against existing companies and delivering products or services comparable to those already in the market. Rather, our focus is on entrepreneurial innovators who forge new paths and break with accepted ways of doing business, creating new combinations that result in novel technologies, products, services, and operating practices—that is, substantial innovation.

In that regard, our approach is aligned with entrepreneurship as defined by twentieth-century economist and entrepreneurship scholar Joseph Schumpeter, who pointed out that change in societies comes as a result of innovation created by entrepreneurs. His emphasis was on innovation and the entrepreneur's ability through innovation to generate new demand that results in significant wealth creation. Peter Drucker, a twentieth- and twenty-first-century scholar of entrepreneurship, echoed similar ideas many decades later. Entrepreneurship is innovative change through new venture creation; it is the creation of *new* goods and services, processes, technologies, markets, and ways of organizing that offer alternatives with the intention of better meeting people's needs and improving

their lives. Innovation encompasses the creative combination of old and novel ideas that enables individuals and organizations to offer desired alternatives and replacements for existing products and services. These innovative products and ways of doing business, typically led by independent-thinking entrepreneurial individuals, constitute the substitutions that eventually replace older products and ways of doing things. Sustainability entrepreneurship and innovation build on the basics of this accepted view of innovation and entrepreneurship and extend it to encompass life-cycle thinking, ecological rules, human health, and social equity considerations.

Understanding entrepreneurial processes and the larger industrial ecosystem at work requires that we break down the subject matter into separate pieces and then recombine them. The pieces need to be examined on their own merit and then understood in relation to one another. We start with understanding the entrepreneurial process and move to examining the elements of sustainability innovation. Each piece is a necessary, but not sufficient, part of the puzzle. By examining the pieces carefully, we can see in [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis", Section 4.1 "Entrepreneurial Process"](#), how the entrepreneurial process unfolds and in [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis", Section 4.2 "Systems Thinking"](#), what entrepreneurial leaders do to integrate sustainability principles.

Bear in mind that the mental exercise required in the following discussion is useful not only as an analytic approach for entrepreneurs or investors but also to set out core business plan elements. Business plans require elaboration on the market opportunity, a thorough understanding of what the entrepreneur brings to the business and the qualifications of the management team, and a clear articulation of the product or service offered and why a customer would purchase it. The business plan also must discuss the resources needed to launch the business and the market entry strategy proposed to establish early sales, lock in reliable suppliers, and provide a platform for growth. Thus learning and applying the analytical steps discussed in this section has direct synergies with writing a business plan.

Analysis of Entrepreneurial Process

Successful entrepreneurship occurs when creative individuals bring together a new way of meeting needs and a market opportunity. This is accomplished through a patterned process, one that mobilizes and directs resources to deliver a specific product or service to customers using a market entry strategy that shows investors financial promise of building enduring revenue and profitability streams. Sustainability adds to the design of a product and operations by applying the criteria of reaching toward benign (or at least considerably safer) energy and

material use, a reduced resource footprint, and elimination of inequitable social impacts due to the venture's operations, including its supply-chain impacts.

Entrepreneurial innovation combined with sustainability principles can be broken down into the following five key pieces for analysis. Each one needs to be analyzed separately, and then the constellation of factors must fit together into a coherent whole. These five pieces are as follows:

- Opportunity
- Entrepreneur/team
- Product concept
- Resources
- Entry strategy

Successful ventures are characterized by coherence or “fit” across these pieces. The interests and skills of the entrepreneur must fit with the product design and offering; the team's qualifications should match the required knowledge needed to launch the venture. The market opportunity must fit with the product concept in that there must be demand in the market for the product or service, and of course, early customers (those willing to purchase) have to be identified. Finally, sufficient resources, including financial resources (e.g., operating capital), office space, equipment, production facilities, components, materials, and expertise, must be identified and brought to bear. Each piece is discussed in more detail in the sections that follow.

The Opportunity

The opportunity is a chance to engage in trades with customers that satisfy their desires while generating returns that enable you to continue to operate and to build your business over time. Many different conditions in society can create opportunities for new goods and services. As a prospective entrepreneur, the key questions are as follows:

- What are the conditions that have created a marketplace opportunity for my idea?
- Why do people want and need something new at this point in time?
- What are the factors that have opened up the opportunity?
- Will the opportunity be enduring, or is it a window that is open today but likely to close tomorrow?
- If you perceive an unmet need, can you deliver what the customer wants while generating durable margins and profits?

Sustainability considerations push this analysis further, asking how you can meet the market need with the smallest ecological footprint possible. Ideally, this need is met through material and energy choices that enhance natural systems; such systems include healthy human bodies and communities as well as environmental systems. Sustainability considerations include reducing negative impact as well as working to improve the larger system outcomes whenever and wherever financially possible. Let us examine the different pieces separately before we try to put them all together. The Walden Paddlers case in [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis"](#), [Section 4.5 "Adaptive Collaboration through Value-Added Networks"](#), provides a company example to apply these concepts in their entirety.

Opportunity conditions arise from a variety of sources. At a broad societal level, they are present as the result of forces such as shifting demographics, changes in knowledge and understanding due to scientific advances, a rebalancing or imbalance of political winds, or changing attitudes and norms that give rise to new needs. These macroforces constantly open up new opportunities for entrepreneurs. Demographic changes will dictate the expansion or contraction of market segments. For example, aging populations in industrialized countries need different products and services to meet their daily requirements, particularly if the trend to stay in their homes continues. Younger populations in emerging economies want products to meet a very different set of material needs and interests. Features for cell phones, advanced laptop computer designs, gaming software, and other entertainment delivery technologies are higher priorities to this demographic group.

Related to sustainability concerns, certain demographic shifts and pollution challenges create opportunities. With 50 percent of the world's population for the first time in history living in urban areas, city air quality improvement methods present opportunities. Furthermore, toxicological science tells us that industrial chemicals ingested by breathing polluted air, drinking unclean water, and eating microscopically contaminated food pass through the placenta into growing fetuses. We did not have this information ten years ago, but monitoring and detection technologies have improved significantly over a short time frame and such new information creates opportunities. When you combine enhanced public focus on health and wellness, advanced water treatment methods, clean combustion technologies, renewable "clean" energy sources, conversion of used packaging into new asset streams, benign chemical compounds for industrial processes, and local and sustainability grown organic food, you begin to see the wide range of opportunities that exist due to macrotrends.

When we speak of an opportunity, we mean the chance to satisfy a specific need for a customer. The customer has a problem that needs an answer or a solution. The

opportunity first presents itself when the entrepreneur sees a way to innovatively solve that problem better than existing choices do and at a comparable price. Assuming there are many buyers who have the same problem and would purchase the solution offered, the opportunity becomes a true business and market opportunity. When opportunities are of a sufficient scale (in other words, enough customers can be attracted quickly), and revenues will cover your costs and promise in the near term to offer excess revenue after initial start-up investment expenditures are repaid, then you have a legitimate economic opportunity in the marketplace.

It is important to understand that ideas for businesses are not always actual opportunities; unless suppliers are available and customers can be identified and tapped, the ideas may not develop into opportunities. Furthermore, an opportunity has multiple dimensions that must be considered including its duration, the size of the targeted market segment, pricing options that enable you to cover expenses, and so forth. These dimensions must be explored and analyzed as rigorously as possible. While business plans can serve multiple purposes, the first and most important reason for writing a business plan is to test whether an idea is truly an economically promising market opportunity.

The Entrepreneur

The opportunity and the entrepreneur must be intertwined in a way that optimizes the probability for success. People often become entrepreneurs when they see an opportunity. They are compelled to start a venture to find out whether they can convert that opportunity into an ongoing business. That means that, ideally, the entrepreneur's life experience, education, skills, work exposure, and network of contacts align well with the opportunity.

However, before we talk about alignment, which is our ultimate destination, we look at the entrepreneur. Consider the individual entrepreneur as a distinct analytic category by considering the following questions:

- Who is this person?
- What does this person bring to the table?
- What education, skills, and expertise does this person possess?

Like the opportunity, the entrepreneur can be broken down into components. This analysis is essential to understanding the entrepreneur's commitment and motivations. Analysis of the entrepreneur also indicates the appropriateness of the individual's capacities to execute on a given business plan. The components are as follows:

- **Values.** What motivates the individual? What does he or she care enough about to devote the time required to create a new venture?
- **Education.** What training has the individual received, what level of formal education, and how relevant is it to the tasks the venture requires to successfully launch?
- **Work experience.** Formal education may be less relevant than work experience. What prior jobs has the individual held, and what responsibilities did he have? How did he perform in those positions? What has he learned?
- **Life experience.** What exposure to life's diversity has the individual had that might strengthen (or weaken) her competencies for building a viable business?
- **Networks.** What relationships does the individual bring to the venture? Have her prior experiences enabled her to be familiar and comfortable with a diverse mix of people and institutions so that she is able to call upon relevant outside resources that might assist with the venture's execution?

If any one category could claim dominance in shaping the outcome of an innovative venture, it is that of the entrepreneur. This is because investors invest in people first and foremost. A good business plan, an interesting product idea, and a promising opportunity are all positive, but in the end it is the ability of the entrepreneur to attract a team, get a product out, and sell it to customers that counts. While management teams must be recruited relatively quickly, typically there is an individual who initially drives the process through his or her ability to mobilize resources and sometimes through sheer force of will, hard work, and determination to succeed. In challenging times it is the entrepreneur's vision and leadership abilities that can carry the day.

Ultimately, led by the entrepreneur, a team forms. As the business grows, the team becomes the key factor. The entrepreneur's skills, education, capabilities, and weaknesses must be augmented and complemented by the competencies of the team members he or she brings to the project. The following are important questions to ask:

- Does the team as a unit have the background, skills, and understanding of the opportunity to overcome obstacles?
- Can the team act as a collaborative unit with strong decision-making ability under fluid conditions?
- Can the team deal with conflict and disagreement as a normal and healthy aspect of working through complex decisions under ambiguity?

If a business has been established and the team has not yet been formed, these questions will be useful to help you understand what configuration of people might compose an effective team to carry the business through its early evolutionary stages.

Resources

Successful entrepreneurial processes require entrepreneurs and teams to mobilize a wide array of resources quickly and efficiently. All innovative and entrepreneurial ventures combine specific resources such as capital, talent and know-how (e.g., accountants, lawyers), equipment, and production facilities. Breaking down a venture's required resources into components can clarify what is needed and when it is needed. Although resource needs change during the early growth stages of a venture, at each stage the entrepreneur should be clear about the priority resources that enable or inhibit moving to the next stage of growth. What kinds of resources are needed? The following list provides guidance:

- **Capital.** What financial resources, in what form (e.g., equity, debt, family loans, angel capital, venture capital), are needed at the first stage? This requires an understanding of cash flow needs, break-even time frames, and other details. Back-of-the-envelope estimates must be converted to pro forma income statements to understand financial needs.
- **Know-how.** Record keeping and accounting and legal process and advice are essential resources that must be considered at the start of every venture. New ventures require legal incorporation, financial record keeping, and rudimentary systems. Resources to provide for these expenses must be built into the budget.
- **Facilities, equipment, and transport.** Does the venture need office space, production facilities, special equipment, or transportation? At the early stage of analysis, ownership of these resources does not need to be determined. The resource requirement, however, must be identified. Arrangements for leasing or owning, vendor negotiations, truck or rail transport, or temporary rental solutions are all decision options depending on the product or service provided. However, to start and launch the venture, the resources must be articulated and preliminary costs attached to them.

The Product/Service Concept

What are you selling? New ventures offer solutions to people's problems. This concept requires you to not only examine the item or service description but understand what your initial customers see themselves buying. A customer has a

need to be met. He or she is hungry and needs food. Food solves the problem. Another customer faces the problem of transferring money electronically and needs an efficient solution, a service that satisfies the need. Automatic teller machines are developed and services are offered. Other buyers want electricity from a renewable energy source; their problem is that they want their monthly payments to encourage clean energy development, not fossil fuel-based electricity. In any of these situations, in any entrepreneurial innovation circumstance in fact, as the entrepreneur you must ask the following questions:

- What is the solution for which you want someone to pay?
- Is it a service or product, or some combination?
- To whom are you selling it? Is the buyer the actual user? Who makes the purchase decision?
- What is the customer's problem and how does your service or product address it?

Understanding what you are selling is not as obvious as it might sound. When you sell an electric vehicle you are not just selling transportation. The buyer is buying a package of attributes that might include cutting-edge technology, lower operating costs, and perhaps the satisfaction of being part of a solution to health, environmental, and energy security problems.

Entry Strategy

Another category to examine carefully at the outset of a venture is market entry strategy. Your goal is to create something where nothing previously existed. Mobilizing resources, analyzing your opportunity, producing your first products for sale—none of these proves the viability of your business. Only by selling to customers and collecting the payments, expanding from those earliest buyers to a broader customer base, and scaling up to sufficient revenue streams to break even and then profit do you prove the enduring viability of the enterprise. Even then, a one-product operation is not a successful business; it is too vulnerable. A successful entrepreneur should consider additional products or services. Living through the early stages of a venture educates you about the customer and market and can point you to new opportunities you were unable to see previously. Your product concept at the end of year two may be, and often is, different from your original vision and intent.

The process of entrepreneurship melds these pieces together in processes that unfold over weeks and months, and eventually years, if the business successful. Breaking down the process into categories and components helps you understand the pieces and how they fit together. What we find in retrospect with successful

launches is a cohesive fit among the parts. The entrepreneur's skills and education match what the start-up needs. The opportunity can be optimally explored with the team and resources that are identified and mobilized. The resources must be brought to bear to launch the venture with an entry strategy that delivers the product or service that solves customers' problem. Disparities among these core elements are signs of trouble. If your product launch requires engineering and information technology expertise and your team has no one with that knowledge, your team does not "fit" with the product. If you launch the product and have insufficient funds to sustain operations, perhaps you did not adequately calculate the capital resources required to reach the break-even point. Each category must be analyzed and thoroughly understood and all puzzle pieces joined to create the integrated picture required for financial success. In [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis"](#), [Section 4.2 "Systems Thinking"](#), we will look at the core elements of sustainability innovation.

KEY TAKEAWAYS

- Entrepreneurship is the creation of new ways of meeting needs through novel products, processes, services, technologies, markets, and forms of organizing.
- Entrepreneurial ventures can be start-ups or occur within large companies.
- Entrepreneurship is an innovation *process* that mobilizes people and resources.
- Key to entrepreneurial success is the fit among the entrepreneur/team, the product concept, the opportunity, the resources, and the entry strategy.

EXERCISE

1. In small teams, identify a successful entrepreneurial venture in your community and interview the entrepreneur or members of the management team. Define and describe the key elements of the entrepreneurial process for this enterprise. Analyze the fit between the entrepreneurial founder and the product or service, the fit between the product and the opportunity, and the fit between the resources and the entry strategy.

4.2 Systems Thinking

LEARNING OBJECTIVES

1. Understand the elements of sustainability innovation.
2. Explain how they can apply to existing companies and new ventures.

In this section, we discuss the ways in which entrepreneurial organizations integrate sustainability ideas into their ventures. Five core elements are necessary—systems thinking, molecular thinking, leveraging weak ties, collaborative adaptation, and radical incrementalism. Each contributes to innovation by opening up new vistas for creativity. For example, systems thinking allows participants to see previously hidden linkages and opportunities within a broader context. Molecular thinking initiates possibilities for innovation through substitution of more benign materials. The use of outside ties contributes novel perspectives and information to the decision process. Collaboration across functional and organizational boundaries helps generate new solutions. Radical incrementalism leads to system-wide innovation. Each of the core elements will be discussed and illustrated with examples.

Systems Thinking

Perhaps the most fundamentally distinctive feature of those engaged with sustainability innovation is the notion of **systems thinking**¹. Systems thinking does not mean “systems analysis,” which implies a more formal, mathematical tool. Nor is systems thinking one-dimensional, as we shall see. Systems thinking is best illustrated by contrasting it to *linear thinking*, the approach historically associated with business decision making. Linear thinking assumes businesses create and sell, each business focusing on its own operations. Supplier or customer activities are relevant only to the extent that understanding them can generate greater sales and profitability. This linear approach frames business activity as making and selling products that customers use and throw away. Therefore, conventional linear thinking in business ignores consideration of the product’s origins; the raw materials and labor input to make it; and the chemical, engineering, and energy-consuming processes required to convert raw materials into constituent components and the ultimate finished product. In addition, it does not consider the effects of the product’s use and the impacts when it is discarded at the end of its useful life.

1. An approach to entrepreneurial innovation that views business ventures as interdependent with complex living and nonliving systems including the natural world as well as conventional business ties to markets, customers, and vendors.

In contrast, systems thinking applied to new ventures reminds us that companies operate in complex sets of interlocking living and nonliving systems, including markets and supply chains as well as natural systems. These natural systems can range from the atmosphere, to a wetlands area, to a child's immune system. Bear in mind that systems thinking can be applied to new ventures whether the firm sells products or provides services. If the venture is a service business, conventional business thinking can obscure the fact that service delivery involves information technology including hardware, software, servers, and energy use (heating and cooling). Service businesses may use office buildings and have employees who travel daily to the office and deliver services using truck fleets. Thus service businesses and their related supply chains also can benefit from the application of sustainability thinking and systems thinking. In sum, every venture rests within and is increasingly buffeted by shifts in natural and commercial systems that may be influenced through the direct or indirect reach of its activities.

Taking a systems perspective reminds us that we are accustomed to thinking of businesses in terms of discrete units with clear boundaries between them. We forget that these boundaries exist primarily in our minds or as legal constructs. For example, we may view a venture or company as a discrete entity. By extension we perceive a boundary between the firm and its suppliers and customers. Yet research suggests that the most successful business innovations arise from activities that cross category boundaries. Thus if one's mental map imposes boundaries, options may be unnecessarily constrained. In fact, given the dominance of linear thinking in business, systems thinking can give you an advantage over your more narrowly focused competitor. Your linear-oriented competitor may target incremental improvements to existing processes and shortchange research and development investments in longer-term goals—and then be surprised by unanticipated innovations in the industry. However, because you perceive the larger systems in which the venture is embedded, you can anticipate opportunities and be poised to act. Not only does the broader systems view lead to more opportunities, enabling you to adapt your competencies, it also holds the potential of producing outcomes that better serve the needs of customers and employees, your community, and your shareholders.

In other words, systems thinking asks you to see the larger picture, which, in turn, opens up new opportunity space. Let's look more closely at the systems view through an analogy. When you imagine a river, what do you see? A winding line on a map? A favorite fishing spot? Or the tumbling, rushing water itself? Do you include the wetlands and its wildlife, visible and microscopic? Do you see the human communities along the water? Do you see the ultimate end points of the water flows—the estuaries, deltas, and the sea? Do you include the water cycle from the ocean, through evaporation raining in the mountains regenerating the

headwaters of the river? In other words, do you see the river as its component parts or as an integrated living system?

Sustainability applied to new ventures incorporates systems thinking. If you think only about the fish or the single stream, you miss what makes the river alive; you miss what it feeds and what feeds it. Similarly, your venture is part of a set of interlocking and interdependent systems characterized by suppliers and buyers as well as by energy and material flows. The more you are aware of these systems and their relationships to your company, the more rigor you bring to product design and strategy development and the more sophisticated your analysis of how to move forward.

Another advantage of systems thinking is its invitation to jettison outdated ideas about the environment. The environment has, in the past, been considered “out there” somewhere, separate and apart from people and businesses. In reality, the environment is not external to business. Indeed, it is coming to comprise an integral new set of competitive factors that shape options and opportunities for entrepreneurs and firms. For ventures to successfully launch and grow in the twenty-first century, it is essential to understand this more expansive systems definition of the new competitive conditions.

When systems thinking guides strategy and action, the collision between business and natural systems becomes a frontier of opportunity. Systems thinking can encourage and institutionalize the natural ability of companies to evolve—not through small adaptations but through creative leaps. The companies discussed in this section demonstrate these tactics in action. For example, AT&T shows how a company can work from a systems view to optimize benefits across multiple systems. Shaw Industries underwent a profound strategic reorientation when it redesigned its products—carpets—not in the traditional linear make-use-waste model but in a new circular strategy. Shaw now takes back carpets at the end of their use life, disassembles them, and remanufactures them as new carpets. This is a radical rethinking of the value of a product. Coastwide Lab offers an example of a systems view that helped a smaller company generate systems solutions for customers, not just products. All three sustainability-inspired strategies indicate a stepped-up understanding of the broader systems in which the business operates. Systems thinking allowed each company to recognize new opportunities in its competitive terrain and to act on them in innovative ways that greatly improved its competitive position.

AT&T

In hindsight, it seems obvious that AT&T, a telecommunications company, should be an early advocate of its employees telecommuting to work. At the outset, however, there was more doubt than confidence in the telecommuting arrangement. Yet it was soon shown that AT&T's innovative policy—grounded in systems and sustainability thinking—resulted in productivity growth, lower overhead costs, greater employee retention, reduced air pollution, lower gasoline and thus oil consumption, and more satisfied employees.

Was telecommuting an environmental policy because it reduced pollution, a cost-cutting measure because overhead and real estate costs dropped, or a national security measure because it lowered oil consumption? Perhaps it was a human resources initiative since it resulted in more satisfied employees. All of these descriptions are accurate, yet no single measure fully captures the *systemic* nature and benefits of this sustainability approach to rethinking work. AT&T's telecommuting policy is an example of *systems thinking*. Between 1998 and 2004, then AT&T vice president Braden Allenby led the telecommuting initiative. Braden R. Allenby is currently professor of civil and environmental engineering and professor of law at Arizona State University and moved from his position as the environment, health, and safety vice president for AT&T in 2004. His systems thinking comes naturally as author of multiple publications on industrial ecology, design for the environment, and earth systems engineering and management. His coediting of *The Greening of Industrial Ecosystems*, published by the National Academy Press in 1994, and his authorship of *Environmental Threats and National Security: An International Challenge to Science and Technology*, published by Lawrence Livermore National Laboratory in 1994, and *Information Systems and the Environment*, published by the National Academy Press in 2001, also enhanced his ability to see natural systems as integral to corporate strategy. With his systems focus on linkages and interdependencies rather than emphasis on discrete units, Allenby looked to inputs and outputs, processes, and feedback, taking into consideration multiple viewpoints within and outside AT&T. Over time, analysis pinpointed a cross-cutting convergence of factors that, when targeted for optimization, produced positive benefits across the system of AT&T's financial performance, employees, communities, and air pollution emissions.

New questions were asked. What is the relationship among working at home, spending hours in a car, spending time at a remote AT&T site, and productivity? What gasoline volumes, carbon dioxide (CO₂) levels, greenhouse gas emissions, and dollar savings for AT&T are involved when telecommuting is an option for managers? If there are benefits for certain employees and the company, what about extending the policy to other employees? What is AT&T's contribution to urban vehicle congestion, and can a telecommuting program help reduce gasoline use in a

way that reduces oil dependency while benefiting towns, employees, and the firm? We know intuitively that these factors are interrelated, but it is unusual for a senior corporate executive to examine them from a strategic perspective. In this case, the telecommuting policy saved the company millions of dollars while raising productivity and enhancing AT&T's reputation. Sustainability strategies will always be tailored to a venture's unique competencies and circumstances; it will grow organically from the business you are in, the products you make, and the employees you hire.

Braden Allenby is a trained systems thinker and has contributed extensive writings on industrial ecology. Allenby saw the opportunity for telecommuting to reduce costs for AT&T and reduce pollution while raising employee productivity and satisfaction. As the environment, health, and safety vice president at AT&T, Allenby took the strategic view as opposed to the compliance perspective proscribed for many environment, health, and safety office heads. By the late 1990s AT&T had moved out of manufacturing. The key to the company's success became service, and the key to high-quality service was application of in-house technology know-how by productive, satisfied employees.

Allenby quietly and successfully promoted telecommuting within the firm for over ten years, despite opposition. It helped that the program was not seen as a conventional "environmental" one that some might have assumed imposed irretrievable overhead costs. Inevitable resistance included the usual institutional inertia against change but also managers' and employees' discomfort with unfamiliar telecommuting job structures and loss of easy metrics for productivity. "Time at desk" was still equated with individual productivity as though the assembly line mentality of "if I don't see you working, you probably aren't working" held firm in the twenty-first-century information-age economy. In addition, many questioned how telecommuting relates to environment, health, and safety. Furthermore, weak technology, such as limited home computer bandwidth and an insufficient number of individuals willing to lead, slowed the process.

Despite obstacles, over time significant benefits were returned to AT&T as well as to its employees, their families, and their communities. Real estate overhead costs decreased (offices could be closed down) while productivity and job satisfaction increased according to the company's Telework Center of Excellence studies. Joseph Roitz, Binny Nanavati, and George Levy, *Lessons Learned from the Network-Centric Organization: 2004 AT&T Employee Telework Results* (Bedminster, NJ: AT&T Telework Center of Excellence, 2005). Brad Allenby provided me with this source. Survey results showed that not having to commute and gaining uninterrupted time to concentrate increased each telecommuter's workday by one additional productive hour, translating to an approximate 12.5 percent productivity increase. Upgrades to communication technology enabled easier phone messaging through personal

computers and saved about one hour per week, an approximate 2.5 percent increase in telecommuters' productivity.

The program expanded rapidly as financial and other advantages proved the efficacy of telecommuting. About 35,000 AT&T management employees were full-time telecommuters in 2002 representing 10 percent of the workforce. By 2004 that number had expanded to 30 percent. Another 41 percent worked from home one to two days a week. Detailed records were kept on the telecommuting program's benefits and costs. Records included the number of employees who telecommuted and how many days they telecommuted per month, whether on the road, at home, or in a telecenter or satellite office. An annual survey provided the quantitative data and subjective elements of participation, such as employee perceptions of the personal and professional benefits.

Important results relevant for other companies were described in the AT&T report: "Work/family balance and improved productivity remain the top-tier benefits. Typically, these two things are seen as mutually exclusive—spending more time with one's family while simultaneously getting more work done would seem to be impossible—but teleworkers are able to have their cake and eat it, too." Joseph Roitz, Binny Nanavati, and George Levy, *Lessons Learned from the Network-Centric Organization: 2004 AT&T Employee Telework Results* (Bedminster, NJ: AT&T Telework Center of Excellence, 2005). Brad Allenby provided me with this source. Feedback on disadvantages of telework was recorded and used to adjust the program optimally.

The positive externalities reported were reduced use of fossil fuel resources, reduced vehicular air pollution, reduced contribution to greenhouse gases and global climate change, reduced runoff of automobile fluids, and decreased air deposition of nitrogen oxides (NO_x) that lead to water pollution. AT&T estimated that "since one gallon of gasoline produces 19 lbs. of carbon dioxide (CO₂), the 5.1 million gallons of gas our employee teleworkers didn't use in 2000 (by avoiding 110 million miles of driving by telecommuting) equate to almost 50,000 tons of CO₂. Similar benefits result from reductions in NO_x and hydrocarbons." Braden Allenby, "Telework: The AT&T Experience" (testimony before the House Subcommittee on Technology and Procurement Policy, Washington, DC, March 22, 2001), accessed December 2, 2010, <http://www.fluxx.net/toronto/soc4.html>. Reduced emissions may provide AT&T with assets in the form of emission credits to be used as internal offsets or sold at market price.

Results of the telecommuting policy included the following:

- Reduced costs for real estate and overhead. AT&T estimated savings of \$75 million a year when it first changed its policies to make salespeople and consultants mobile. Jennifer Bresnahan, “Why Telework?,” *CIO Enterprise* 11, no. 7 (January 15, 1998): 28–34.
- Employee productivity gains: AT&T estimated that increased productivity due to telework was worth \$100 million a year. Eighty percent of employees surveyed said the change had improved their productivity.
- Improved employee quality of life and morale: Eliminating the stress and wasted time of commuting contributed to productivity.
- Employee retention and related cost savings: AT&T employees turned down other job offers in part because of the telecommuting options they enjoyed.
- Appropriate management metrics: AT&T accelerated a transition from time-at-desk management to management by results and, more broadly, learned how to effectively manage knowledge workers in a rapidly changing, increasingly knowledge-based economy (seen as a competitive advantage).
- Security: After the 9/11 attacks on the World Trade Center and the Pentagon, a more dispersed workforce was viewed as a way to increase institutional resiliency and limit the impact of an attack (or for that matter any disaster, natural or otherwise).

As the AT&T example shows, when systems thinking guides strategy and action, the collision between business and natural systems can become a frontier of opportunity. Systems thinking can encourage and institutionalize the natural ability of companies to evolve, not through small adaptations but through creative leaps.

Shaw Industries

Shaw Industries underwent a profound strategic reorientation and redesigned its products—carpets—not in the traditional linear make-use-waste model but in a sustainability-inspired circular strategy. Shaw now takes back products at the end of their useful life, disassembles them, and remanufactures them as new carpets. This is a radical rethinking of the value of a product using systems terms.

In 2003, Shaw’s EcoWorx product won the US Green Chemistry Institute’s Green Chemistry Award for Designing Safer Products. The company combined application of green chemistry principles with a cradle-to-cradle design approach to create new environmentally benign carpet tile. Shaw Industries worked with William McDonough and Michael Braungart, an architect and chemist who conceived the cradle-to-cradle design approach that considers the ultimate end of products from

the very beginning of their design in order to reduce waste and toxicity. The product met the rising demand for sustainable products, helping define a new market space that emerged in the late 1990s and 2000s as buyers became more cognizant of health hazards associated with building materials and furnishings. EcoWorx also educated the marketplace on the desirability of sustainable products as qualitatively, economically, and environmentally superior substitutes, in this case for a product that had been in place for thirty years. See Jeffrey W. Segard, Steven Bradfield, Jeffrey J. White, and Mathew J. Realff, "EcoWorx, Green Engineering Principles in Practice," *Environmental Science and Technology* 37, no. 23 (2003): 5269–77.

Carpeting is big business. In 2004, the global market for carpeting was about \$26 billion, and it was expected to grow to \$73 billion in 2007. Carpeting and rugs sectors expect a combined growth rate of 17 percent that year. Shaw Industries of Dalton, Georgia, was the world's largest carpet manufacturer in 2004. Its carpet brand names include Cabin Crafts, Queen, Designweave, Philadelphia, and ShawMark. The company sells residential products to distributors and retailers and offers commercial products directly to customers through Shaw Contract Flooring. The company also sells laminate, ceramic tile, and hardwood flooring. In 2003, Shaw recorded \$4.7 billion in sales.

Now acknowledged as an innovator in sustainable product design and business strategy, by early 2005, Shaw had completed a successful transformation to an environmentally benign carpet tile system design. Customers self-selected EcoWorx over tiles containing polyvinyl chloride (PVC), driving the new technology to over 80 percent of Shaw's total carpet tile production. In retrospect, selecting carpet tiles as a key part of its sustainability strategy looks like a smart decision. In 2005, carpet tile was the fastest growing product category in the commercial carpet market.

In hindsight, Shaw's decision seems the only way forward in the highly competitive floor covering business. However, in 1999, Shaw Industries Vice President Steve Bradfield described the carpet industry as "a marketing landscape that looked increasingly like a quagmire of greenwash." Waste issues were putting pressure on the industry to clean up its act. Carpet took up considerable space in municipal landfills, took a long time to decompose, and was notoriously difficult to recycle. Moreover, carpet was coming under increasing scrutiny for its association with health problems.

In the late 1990s, companies vied to project the best image of environmental responsibility. However, Shaw Industries moved beyond marketing hype to a strategy that eliminated hazardous materials and recovered and reused carpet in a closed materials cycle. Shaw had to differentiate itself and create new capabilities

and even new markets. EcoWorx, designed with cradle-to-cradle logic, required more innovation than simply the product. To implement its strategy, the company had to think in systems and design products not in the linear make-use-waste model but in cycles. For Shaw, this meant it must collect, disassemble, and reuse the old carpet tile material in new products. Moreover, the materials used in its products needed to be environmentally superior to anything used before.

Shaw was not the first company to think of this approach. In 1994, Ray Anderson of Interface Flooring Systems set the bar high for the industry by declaring sustainability as a corporate (and industry) goal. Ray Anderson, *Mid Course Correction: Toward a Sustainable Enterprise: The Interface Model* (Atlanta, GA: Peregrinzilla, 1998). While smaller in scale than Shaw Industries, Interface succeeded in changing the terms of the debate. For Shaw, the biggest player in the field, to not only rise to the challenge but to champion the way forward was not something one could necessarily predict.

Shaw's EcoWorx, the replacement system for the PVC-nylon incumbent system, drove double-digit growth for carpet tile after its introduction in 1999. The system made it possible to recycle both the nylon face and the backing components into next-generation face and backing materials for future EcoWorx carpet tile. Shaw used its own EcoSolution Q nylon 6 branded fiber that would be recycled as a technical nutrient through a recovery agreement with Honeywell's Arnprior depolymerization facility in Canada. The nylon experienced no loss of performance or quality reduction and cost the same or less.

Seeking every way possible to reduce materials use, remove hazardous inputs, and maintain or improve product performance, Shaw made the following changes:

- Replacement of PVC and phthalate plasticizer with an inert and nonhazardous mix of polymers ensuring material safety throughout the system. (PVC-contaminated nylon facing cannot be used for noncarpet applications of recycled materials.)
- Elimination of antimony trioxide flame retardant associated with harm to aquatic organisms.
- Dramatic reduction of waste during the processing phases by immediate recovery and use of the technical nutrients. (The production waste goal is zero.)
- A life-cycle inventory and mass flow analysis that captures systems impacts and material efficiencies compared with PVC backing.
- Efficiencies (energy and material reductions) in production, packaging, and distribution—40 percent lighter weight of EcoWorx tiles over PVC-

backed tiles yields transport and handling (installation and removal/demolition) cost savings.

- Use of a minimum number of raw materials, none of which lose value, as all can be continuously disassembled and remanufactured.
- Use of a closed-loop, integrated plant-wide cooling water system providing chilled water for the extrusion process as well as the heating and cooling system.
- Provision of a toll-free phone number on every EcoWorx tile for the buyer to contact Shaw for removal of the material for recycling.

Models assessing comparative costs of the conventional versus the new system indicated the recycled components would be less costly to process than virgin materials. Essentially, EcoWorx tile remains a raw material indefinitely.

Moreover, as is typical of companies actively applying a systems-oriented innovation to product lines, Shaw has found other opportunities for cost reduction and new revenue. For example, Shaw projects \$2.5 million in overall savings per year from a Dalton, Georgia, steam energy plant designed collaboratively with Siemens Building Technologies. Manufacturing waste by-products are converted into gas that fuels a boiler to produce fifty thousand pounds of steam per hour that will be used on-site for manufacturing. The facility lowers corporate plant emissions, eliminates postmanufacturing carpet waste, and provides the Dalton manufacturing site with a fixed-cost reliable energy source, which is no small benefit in a time of high and fluctuating energy prices.

Once the power of systems thinking becomes clear, returning to a compartmentalized or linear view becomes an irrational abandonment of essential knowledge. Systems thinking illuminates how the world actually works and how actions far beyond what we can see influence our decisions and choices. It frees us to imagine alternative future products and services and create positive outcomes for more stakeholders. For Shaw, the benefits of thinking in systems were clear. The takeaway is that breaking out of the traditional linear approach to products and designing from a systems perspective can lead to differentiation, new competitive advantage, and tangible results.

Coastwide Labs

Systems thinking encourages *systems solutions* for your customers. Once you see the broader systems context and tightly coupled interdependencies, you have the opportunity to simultaneously solve multiple customer problems and provide a comprehensive “answer” for which they could not even form the right question.

Coastwide Laboratories, when it was a stand-alone company before being acquired by Express and then Staples, sold systems solutions to its customers. Coastwide's approach was developed over several years and culminated in a complete strategic transformation in 2006. The change separated the firm from its competitors and enabled it to shape a regional market to its advantage. Rewards included customer retention, increased sales to existing customers, new customers, dominant market share in a seven-state region, and brand visibility. By selling systems solutions, Coastwide Labs reduced regulatory burdens for itself and its customers, reduced costs for both, and removed human health and environmental threats across the supply chain. The company tracked an array of trends and systems that influenced its market and customers. The resulting perspective put senior management in the driver's seat to benefit from and shape those trends in ways that also meet customers' latent needs.

Context is important. For decades, Coastwide's product formulations, typical for the industry, were consistent with expectations for old-style janitorial products. The company made or bought cleaners, disinfectants, floor finishes and sealers, and degreasers and provided a full line of sanitary maintenance equipment and supplies. Performing the cleaning function was the primary requirement; other health and ecosystem impact considerations did not emerge until years later.

Serving the US Pacific Northwest region, Coastwide competed in a growing market in the 1990s, driven by expanding high-tech firms that emerged or grew rapidly in the 1980s and 1990s (e.g., Microsoft, Intel, Amgen, and Boeing). By the 1990s, the growth of overall demand for cleaning products had tapered off and the products were essentially commodities. This meant that growth, improved sales, and profitability depended on either increasing market share or offering value-added services. The commercial and industrial cleaning products industry remained fragmented in 2000 with many small companies with less than \$5 million in revenue competing as producers, distributors, or both.

However, this sleepy, traditional industry was about to wake up. In August 2002, Coastwide—by then a commercial and industrial cleaning product formulator and distributor—introduced the Sustainable Earth line of products. This experimental line was designed for performance efficacy, easy use, and low to zero toxicity. By 2006, the line had grown to dominate the company's strategy, positioning Coastwide as the largest provider of safe and "clean" cleaning products, janitorial supplies, and related services in the region. The market extended from southern Canada to central California and west to Idaho.

The Sustainable Earth line enabled Coastwide to lower its customers' costs for maintenance by offering system solutions. Higher dilution rates for chemicals,

dispensing units that eliminate overuse, improved safety for the end user, and less employee lost-work time because of health problems associated with chemical exposure were reported. Higher dilutions also reduced the packaging waste stream, thereby reducing customer waste disposal fees. TriMet, the Portland, Oregon, metropolitan area's municipal bus and light rail system, reduced its number of cleaning products from twenty-two to four by switching to Sustainable Earth products. Initial cleaning chemical cost savings to the municipality amounted to 70 percent, not including training cost savings associated with the inventory simplification. In 2006, the Sustainable Earth line performed as well or better than the category leaders while realizing a gross margin over 40 percent higher than on its conventional cleaners.

Perhaps most telling, Coastwide's overall corporate strategy changed in 2006 to implement a corporate transformation to what the company terms "sustainability" products. All cleaning product lines were replaced with sustainably designed formulations and designs. It is important to keep in mind that health benefits and improved water quality in the region's cities were not the reasons to design this strategy; they characterized opportunities for innovation that drove lower costs for buyers and higher revenues for Coastwide. Through carefully crafted positioning, this company has become a major player creating and shaping the market to its advantage.

Coastwide's strategic roots were in its early systems approach to meet customers' full-service needs, long before environmental and sustainability vocabulary entered the business mainstream. The corporate vision evolved from simply selling cleaning products to offering unique, nonhazardous cleaning formulations at the lowest "total cost" to the buyer. Eventually, Coastwide addressed its customers' *comprehensive* maintenance and cleaning needs—in other words, their system's needs—which only later included sustainability features.

The cleaning product markets are more complicated than one might suspect. Several factors shaped industry selling strategies. Customers needed multiple cleaning products and equipment for different applications. However, buyers had more than cleaning needs. Fast-growing and large electronics manufacturers with clean rooms had to protect their production processes from contaminants or suffer major financial losses from downtime, as much as a million dollars a day. In addition, a barrage of intensifying local, state, and federal regulatory requirements demanded safe handling, storage, and disposal of all toxic and hazardous materials. These legal mandates imposed additional costs such as protective clothing, training, and hazardous waste disposal fees. Adding complexity, historic buying patterns fragmented purchase decisions. One facility maintenance manager ordered a set of products from one supplier; a second ordered different products from another supplier. As a result, companies with geographically dispersed sites made

nonoptimal choices from both a price and a systems sense. As in many compartmentalized companies, jobs were divided with people working against each other, sometimes under the same roof. Maintenance bought the products; the environment, health, and safety group was responsible for knowing what was in the products as well as for workers' safety and health; and manufacturing had to ensure pristine production.

Furthermore, all buyers contended with wastewater disposal regulations that forbade contaminated water from leaving the premises and entering the water supply system, but the requirements were different depending on the local or state regulations. Typically, minimal or no training was given maintenance staff members who actually used the hazardous cleaning chemicals. High janitorial employee turnover and low literacy rates made it expensive to hire and train employees. A 150 to 200 percent annual turnover rate was typical with this employee group, imposing its own unique costs and health risks to the employer. The low status of the maintenance and janitorial function didn't help. The job was delegated in the organization to the staff that did the cleaning work, or one supervisory level above. In other words, despite many small areas needing the customer's attention as a complex set of interrelated factors (a system), responsibility was either nonexistent or fragmented across different departments that traditionally had no incentive to communicate.

More history magnifies the systems thinking in action. In the late 1990s, buyers wanted stockless systems with just-in-time delivery and single source purchasing to avoid dealing with seven or eight companies for ninety cleaning items. Coastwide had designed its first system-solution contract in the late 1980s when it contracted with Tektronix, a test, measurement, and monitoring computer equipment producer, then the largest Oregon employer and a high-tech company with a dozen operating locations. Coastwide offered to supply all Tektronix maintenance needs, including training personnel to use cleaning products safely. Getting Tektronix's business required knowing the company's different facilities, various manufacturing operations requirements, and maintenance standards. It also meant that Coastwide presented an analysis showing Tektronix the economics of why it made sense to outsource the company's system needs. Coastwide had to understand the buyer's internal use and purchasing systems, including its costs and chemical vulnerabilities.

Roger McFadden, Coastwide's chemist and senior product development person—the internal entrepreneur, or intrapreneur—took on the additional job of keeping a list of chemicals the buyer wanted kept out of its facilities due to clean room contamination risks. McFadden saw this change as an opportunity to look at a variety of suspect chemicals on various health, safety, and environmental lists. The lists were growing for the customer and regulatory agencies. Eventually Coastwide

was asked to handle the complete health and safety functions for this customer and eventually for others because it could do so at a lower cost with customized analyses presented to each buyer, and with a systems perspective that optimized efficiencies across linked system parts with tagged areas for continuous improvement. Important interrelated issues for Roger McFadden included product contamination, regulations, customers' workers' compensation and injury liability, and chemical compound toxicity thresholds and cancer rates.

To compete with foresight Coastwide also had to stay current on and continuously adapt its solutions services to larger and increasingly more relevant trends. McFadden served on the Governor's Community Sustainability Taskforce for Oregon and in the process gained more information about the science of toxicity, state regulatory intentions, and changing governmental agency purchasing practices. This led to expanded sales to the state and city governments and to Nike, Hewlett-Packard, and Intel. Coastwide's involvement with broader community issues translated into flows of information to senior management that helped the firm position itself and learn despite constantly moving terrain.

McFadden's first step was to rethink the cleaning product formulations. The products had to work as well as not pose a risk or threat. The second step was to expand the product line so that customers would source a range of products solely from Coastwide, a step that provided customers with insurance that all cleaning products met uniform "clean" and low- or zero-toxicity specifications. Coastwide extended its "cleaner cleaners" criteria to auxiliary products. For example, PVC-containing buckets were rejected in favor of those made from safely reusable polyethylene. Used buckets were picked up by Coastwide's distribution arm, with the containers color coded to ensure no other containers (for which the company would not know the materials inside) would inadvertently be brought back.

Understanding the interconnections across systems continued to bring Coastwide financial and competitive benefits. By 2005 the major trade organization for the industrial cleaning industry, the International Sanitary Supply Association (ISSA), began highlighting members' green cleaning products and programs. Grant Watkinson, president of Coastwide, was featured on the organization's website. The American Association of Architects' US Green Building Council developed its Leadership in Energy and Environmental Design (LEED) program that set voluntary national standards for high-performance sustainable buildings. LEED assigned points that could be earned by organizations requesting certification if they integrated system-designed cleaning practices. Since many major corporations and organizations gain productivity and reputation advantages for having their buildings certified by LEED, Coastwide was positioned with more knowledge and media visibility as this market driver accelerated a transition to lower toxicity and more benign materials.

In addition, Coastwide was in a far better position than its competition when Executive Order 13148, Greening the Government Through Leadership in Environmental Management, appeared. This order set strict requirements for all federal agencies to “reduce [their] use of selected toxic chemicals, hazardous substances, and pollutants...at [their] facilities by 50 percent by December 31, 2006.” National Environmental Policy Act, “Executive Order 13148,” accessed March 7, 2011, <http://ceq.hss.doe.gov/nepa/regs/eos/eo13148.html>.

By 2006 most of the major institutional cleaning-products companies across the country had “green” product offerings of some sort, but Coastwide already was well ahead of them. Building service contractor and property manager customers told Coastwide they were awarded new business because of the “green” package Coastwide offers. Some buyers use the Sustainable Earth line as part of their marketing program to differentiate and enhance the value of their services. The city of San Francisco specified Coastwide’s line even though the company did not have sales representatives in that market (sales are through distributors). Inquiries from the US Midwest, South, and East Coast increased in 2006, and Roger McFadden and the firm’s corporate director of sustainability were frequently invited to speak in various US and Canadian cities outside Coastwide’s market area. In sum, by making sure it understood the dynamics of the relevant systems for its success and its customers’ benefit, Coastwide created a successful strategy because, in the current competitive environment, it was just good business.

Results for Coastwide included the following:

- The industry average net operating income was 2 percent; Coastwide averaged double or triple that level.
- Sales in 2005 increased by 8 percent, driven by market share increases in segments where the most Sustainable Earth products were sold; operating profits rose by an even larger percentage.
- The number of new customers rose over 35 percent in 2005, largely attributable to Sustainable Earth product lines.

Coastwide’s solution for buyers went further than any other firm’s to blend problem solving around a company’s unique needs with changing regulatory system requirements and emerging human health and ecosystem trends. Coastwide, through McFadden’s entrepreneurial innovation, saw an opportunity in the complex corporate, regulatory, and ecological systems and in its customers’ need for a sustainable response. By understanding the systems in which you operate, higher level solutions can emerge that will give you competitive advantage. By 2010 McFadden had become Staples’ senior scientist, advising the \$27 billion office products company on its sustainability strategy.

In each instance of these instances, entrepreneurial (or intrapreneurial) leaders made decisions from a systems perspective. The individuals came to this understanding in different ways, but this way of seeing their companies' interdependencies with both living and nonliving systems allowed them to introduce innovative ways of doing business, create new product designs and operating structures, and generate new revenues. Systems analysis is an effective problem-solving tool in dynamic, complex circumstances where economic opportunities are not easily apparent. A systems perspective accommodates the constant changes that characterize the competitive terrain.

To recap, we provide the following tactics to help you think in systems terms:

- Design products in “circles,” not lines.
- Optimize across multiple systems.
- Sell systems solutions.

This kind of broader systems-oriented strategy will be increasingly important for claiming market share in the new sustainability market space. Increasingly, senior management, and eventually everyone within firms and their supply chains, will understand that the future lies on a path toward benign products (no harm to existing natural systems) or products that—at the end of use—are returned so that their component parts can be used to make equal or better quality new products. The point is not the goal but the continuous effort. Systems thinking applied to entrepreneurial innovation is not merely a tool or theory—it is increasingly a mind-set, a survival skill, and key to strategic advantage.

KEY TAKEAWAYS

- A systems approach to business is a reminder that companies operate in complex sets of interlocking living and nonliving systems, including markets and supply chains as well as natural systems.
- Systems thinking can open up new opportunities for product and process redesign and lead to innovative business models.
- Individuals with a creative bent can lead sustainability innovation changes inside small or large firms.

EXERCISE

1. In teams, identify a commonly used product. Try to name all the component parts and material inputs involved in bringing the product to market. List the ways in which producing that item likely depended on, drew from, and impacted natural systems over the product's life.

4.3 Molecular Thinking

LEARNING OBJECTIVES

1. Explore systems thinking at the molecular level.
2. Focus on materials innovation.
3. Provide examples of green chemistry applications.

In this discussion, we encourage you to think on the micro level, as though you were a molecule. We tend to focus on what is visible to the human eye, forgetting that important human product design work takes place at scales invisible to human beings. Molecular thinking, as a metaphorical subset of systems thinking, provides a useful perspective by focusing attention on invisible material components and contaminants. In the first decade of the twenty-first century there has been heavy emphasis on clean energy in the media. Yet our world is composed of energy *and* materials. When we *do* examine materials we tend to focus on visible waste streams, such as the problems of municipal waste, forgetting that some of the most urgent environmental health problems are caused by microscopic, and perhaps nanoscale, compounds. These compounds contain persistent contaminants that remain invisible in the air, soil, and water and subsequently accumulate inside our bodies through ingestion of food and water. Thinking like a molecule can reveal efficiency and innovation opportunities that address hazardous materials exposure problems; the principles of **green chemistry**² give you the tools to act on such opportunities. The companies discussed in this section provide examples of successful sustainability innovation efforts at the molecular level.

Green chemistry, an emerging area in science, is based on a set of twelve design principles. Paul T. Anastas and John C. Warner, *Green Chemistry: Theory and Practice* (Oxford: Oxford University Press, 1998). Application of the principles can significantly reduce or even eliminate generation of hazardous substances in the design, manufacture, and application of chemical products. Green chemistry offers many business benefits. Its guiding principles drive design of new products and processes around health and environmental criteria and can help firms capture top (revenue) and bottom line (profitability) gains within the company and throughout value chains. As public demand and regulatory drivers for “clean” products and processes grow, molecular thinking enables entrepreneurs inside large and small companies to differentiate their businesses and gain competitive advantage over others who are less attuned to the changing market demands.

2. Chemical design, manufacture, and use guided by principles that reduce or eliminate the use or generation of hazardous substances and waste.

In the ideal environment, green chemistry products are derived from renewable feedstocks, and toxicity is deliberately prevented at the molecular level. Green chemistry also provides the means of shifting from a petrochemical-based economy based on oil feedstocks (from which virtually all plastics are derived) to a bio-based economy. This has profound consequences for a wide range of issues, including environmental health, worker safety, national security, and the agriculture sector. While no one scientific approach can supply all the answers, green chemistry plays a foundational role in enabling companies to realize concrete benefits from greener design.

What does it mean to pursue sustainability innovation at the molecular level? When chemicals and chemical processes are selected and designed to eliminate waste, minimize energy use, and degrade safely upon disposal, the result is a set of processes streamlined for maximum efficiency. In addition, hazards to those who handle the chemicals, along with the chemicals' inherent costs, are designed out of both products and processes. With the growing pressure on firms to take responsibility for the adverse impacts of business operations throughout their supply chain and the demand for greater transparency by corporations, forward-thinking organizations—whether start-ups or established firms—increasingly must assess products and process steps for inherent hazard and toxicity.

12 Principles of Green Chemistry

1. Prevent waste, rather than treat it after it is formed.
2. Maximize the incorporation of all process materials into the final product.
3. Use and generate substances of little or no toxicity.
4. Preserve efficacy of function while reducing toxicity.
5. Eliminate or minimize use of or toxicity of auxiliary substances (e.g., solvents).
6. Recognize and minimize energy requirements; shoot for room temperature.
7. Use renewable raw material feedstock, if economically and technically possible.
8. Avoid unnecessary derivatization (e.g., blocking group, protection/deprotection).
9. Consider catalytic reagents superior to stoichiometric reagents.
10. Design end product to innocuously degrade, not persist.
11. Develop analytical methodologies that facilitate real-time monitoring and control.
12. Choose substances/forms that minimize potential for accidents, releases, and fires. Paul T. Anastas and John C. Warner, *Green Chemistry: Theory and Practice* (Oxford: Oxford University Press, 1998), 30.

Molecular thinking, applied through the use of the green chemistry principles, guides you to examine the nature of material inputs to your products. Once again, a life-cycle approach is required to consider, from the outset, the ultimate fate of your waste outputs and products. This analysis can occur concurrently with delivering a high-quality product to the buyer. Thus thinking like a molecule asks business managers and executives to examine not only a product's immediate functionality but its entire molecular cycle from raw material, through manufacture and processing, to end of life and disposal. Smart decision makers will ask, Where do we get our feedstocks? Are they renewable or limited? Are they vulnerable to price and supply fluctuations? Are they vulnerable to emerging environmental health regulations? Are they inherently benign or does the management of risk incur costs in handling, processing, and disposal? Managers and sustainability entrepreneurs also must ask whether chemicals in their products accumulate in human tissue or biodegrade harmlessly. Where do the molecular materials go when thrown away? Do they remain stable in landfills, or do they break down to pollute local water supplies? Does their combination create new and

more potent toxins when incinerated? If so, can air emissions be carried by wind currents and influence the healthy functioning of people and natural systems far from the source?

Until very recently these questions were not business concerns. Increasingly, however, circumstances demand that we think small (at the molecular and even nano levels) to think big (providing safe products for two to four billion aspiring middle-class citizens around the world). As we devise more effective monitoring devices that are better able to detect and analyze the negative health impacts of certain persistent chemical compounds, corporate tracking of product ingredients at the molecular level becomes imperative. Monitoring chemical materials to date has been driven primarily by increased regulation, product boycotts, and market campaigns by health-oriented nonprofit organizations. But instead of a reactive defense against these growing forces, forward-thinking entrepreneurial companies and individuals see new areas of business opportunity and growth represented by the updated science and shifting market conditions.

Green chemistry design principles are being applied by a range of leading companies across sectors including chemical giants Dow, DuPont, and Rohm and Haas and consumer product producers such as SC Johnson, Shaw Industries, and Merck & Co. Small and midsized businesses such as Ecover, Seventh Generation, Method, AgraQuest, and Metabolix also play a leading innovative role. (See the Presidential Green Chemistry Challenge Award winners for a detailed list of these businesses.)US Environmental Protection Agency, “Presidential Green Chemistry Challenge: Award Winners,” last updated July 28, 2010, accessed December 3, 2010, <http://www.epa.gov/greenchemistry/pubs/pgcc/past.html>. Currently green chemistry-inspired design and innovation has made inroads into a range of applications, including the following:

- 3. A practice that emphasizes the most efficient use of every input molecule in the final product.
- 4. An efficiency measurement for chemicals production expressed as a ratio of inputs to outputs in any given product. E-factor measurement tells you how many units of weight of output one gets per unit of weight of input and provides a process efficiency metric that reports inherent costs associated with waste, energy, and other resources' inputs rates of use.

Adhesives	Pesticides
Cleaning products	Pharmaceuticals
Fine chemicals	Plastics
Fuels and renewable energy technologies	Pulp and paper
Nanotechnologies	Textile manufacturing
Paints and coatings	Water purification

Included in green chemistry is the idea of the **atom economy**³, which would have manufacturers use as fully as possible every input molecule in the final output product. The pharmaceutical industry, an early adopter of green chemistry efficiency principles in manufacturing processes, uses a metric called **E-factor**⁴ to

measure the ratio of inputs to outputs in any given product. The definition of E-factor is evolving at this writing. Currently pharmaceutical companies engaged in green chemistry are debating whether to include input factors such as energy, water, and other nontraditional inputs. In essence, an E-factor measurement tells you how many units of weight of output one gets per unit of weight of input. This figure gives managers a sense of process efficiency and the inherent costs associated with waste, energy, and other resources' rates of use. By applying green chemistry principles to pharmaceutical production processes, companies have been able to dramatically lower their E-factor—and significantly raise profits.

Merck & Co., for example, uncovered a highly innovative and efficient catalytic synthesis for sitagliptin, the active ingredient in Januvia, the company's new treatment for type 2 diabetes. This revolutionary synthesis generated 220 pounds less waste for each pound of sitagliptin manufactured and increased the overall yield by nearly 50 percent. Over the lifetime of Januvia, Merck expects to eliminate the formation of at least 330 million pounds of waste, including nearly 110 million pounds of aqueous waste. US Environmental Protection Agency, "Presidential GC Challenge: Past Awards: 2006 Greener Synthetic Pathways Award," last updated June 21, 2010, accessed December 2, 2010, <http://www.epa.gov/greenchemistry/pubs/pgcc/winners/gspa06.html>.

Pfizer

In 2002, pharmaceutical firm Pfizer won the US Presidential Green Chemistry Challenge Award for Alternative Synthetic Pathways for its innovation of the manufacturing process for sertraline hydrochloride (HCl). Sertraline HCl is the active ingredient in Zoloft, which is the most prescribed agent of its kind used to treat depression. In 2004, global sales of Zoloft were \$3.4 billion. Pharmaceutical wisdom holds that companies compete on the nature of the drug primarily and on process secondarily, with "maximum yield" as the main objective. Green chemistry adds a new dimension to this calculus: Pfizer and other pharmaceutical companies are discovering that by thinking like a molecule and applying green chemistry process innovations, they see their atom economy exponentially improve.

In the case of Pfizer, the company saw that it could significantly cut input costs. The new commercial process offered dramatic pollution prevention benefits, reduced energy and water use, and improved safety and materials handling. As a consequence, Pfizer significantly improved worker and environmental safety while doubling product yield. This was achieved by analyzing each chemical step. The key improvement in the sertraline synthesis was reducing a three-step sequence in the original process to a single step. Stephen K. Ritter, "Green Challenge," *Chemical & Engineering News*, 80, no. 26 (2009): 30. Overall, the process changes reduced the solvent requirement from 60,000 gallons to 6,000 gallons per ton of sertraline. On an

annual basis, the changes eliminated 440 metric tons of titanium dioxide-methylamine hydrochloride salt waste, 150 metric tons of 35 percent hydrochloric acid waste, and 100 metric tons of 50 percent sodium hydroxide waste. With hazardous waste disposal growing more costly, this represented real savings now and avoided possible future costs.

By redesigning the chemical process to be more efficient and produce fewer harmful and expensive waste products, the process of producing sertraline generated both economic and environmental/health benefits for Pfizer. Typically, 20 percent of the wholesale price is manufacturing costs, of which approximately 20 percent is the cost of the tablet or capsule with the remaining percentage representing all other materials, energy, water, and processing costs. Using green chemistry can reduce both of these input costs significantly. As patents expire and pharmaceutical products are challenged by cheaper generics, maintaining the most efficient, cost-effective manufacturing process will be the key to maintaining competitiveness.

As mentioned earlier, E-factor analysis offers the means for streamlining materials processing and capturing cost savings. An efficiency assessment tool for the pharmaceutical industry, E-factor is defined as the ratio of total kilograms of all input materials (raw materials, solvents, and processing chemicals) used per kilogram of active product ingredient (API) produced. A pivotal 1994 study indicated that as standard practice in the pharmaceutical industry, for every kilogram of API produced, between twenty-five and one hundred kilograms or more of waste was generated—a ratio still found in the industry. By the end of the decade, E-factors were being used more frequently to evaluate products. Firms were identifying drivers of high E-factor values and taking action to improve efficiency. Multiplying the E-factor by the estimated kilograms of API produced by the industry overall suggested that, for the year 2003, as much as 500 million to 2.5 billion kilograms of waste could be the by-product of pharmaceutical industry API manufacture. This waste represented a double penalty: the costs associated with purchasing chemicals that are ultimately diverted from API yield and the costs associated with disposing of this waste (ranging from one to five dollars per kilogram depending on the hazard). Very little information is released by competitors in this industry, but a published 2004 GlaxoSmithKline life-cycle assessment of its API manufacturing processes revealed approximately 75 to 80 percent of the waste produced was solvent (liquid) and 20 to 25 percent solids, of which a considerable proportion of both was likely hazardous under state and federal laws.

For years, the pharmaceutical industry stated it did not produce the significant product volumes needed to be concerned about toxicity and waste, particularly relative to commodity chemical producers. However, government and citizen

concern about product safety and high levels of medications in wastewater combined with the growing cost of hazardous waste disposal is changing that picture relatively quickly. With favorable competitive conditions eroding, companies have been eager to find ways to cut costs, eliminate risk, innovate, and improve their image.

After implementing the green chemistry award-winning process as standard in sertraline HCl manufacture, Pfizer's experience indicated that green chemistry-guided process changes reduced E-factor ratios to ten to twenty kilograms. The potential to dramatically reduce E-factors through green chemistry could be significant. Other pharmaceutical companies that won Presidential Green Chemistry Challenge Awards between 1999 and 2010—Lilly, Roche, Bristol-Meyers Squibb, and Merck—reported improvements of this magnitude after the application of green chemistry principles. Additionally, Pfizer was awarded the prestigious UK environmental Crystal Faraday Award for innovation in the redesign of the manufacturing process of sildenafil citrate (the active ingredient in the product Viagra).

Not surprisingly, thinking like a molecule applied through use of green chemistry's twelve principles fits easily with existing corporate Six Sigma quality programs whose principles consider waste a process defect. "Right the first time" was an industry quality initiative backed strongly by the US Food and Drug Administration. Pfizer's Dr. Berkeley ("Buzz") Cue (retired but still actively advancing green chemistry in the industry), credited with introducing green chemistry ideas to the pharmaceutical industry, views these initiatives as a lens that allows the companies to look at processes and yield objectives in a more comprehensive way (a systems view), with quality programs dovetailing easily with the approach and even enhancing it.

Dr. Cue, looking back on his history with green chemistry and Pfizer, said, "The question is what has Pfizer learned through understanding Green Chemistry principles that not only advantages them in the short term, but positions them for future innovation and trends?" Phone interview with Berkeley Cue, retired Pfizer executive, July 16, 2003. This is an important question for entrepreneurs in small firms and large firms alike. If you think like a molecule, overlooked opportunities and differentiation possibilities present themselves. Are you calculating the ratio of inputs to outputs? Has your company captured obvious efficiency cost savings, increased product yield, and redesigned more customer and life-cycle effective molecules? Are you missing opportunities to reduce or eliminate regulatory oversight by replacing inherently hazardous and toxic inputs with benign materials? Regulatory compliance for hazardous chemical waste represents a significant budget item and cost burden. Those dollars would be more usefully spent elsewhere.

Green chemistry has generated breakthrough innovations in the agriculture sector as well. Growers face a suite of rising challenges connected with using traditional chemical pesticides. A primary concern is that pests are becoming increasingly resistant to conventional chemical pesticides. In some cases, pesticides must be applied two to five times to accomplish what a single application did in the 1970s. Moreover, pests can reproduce and mutate quickly enough to develop resistance to a pesticide within one growing season. Increased rates of pesticide usage deplete soil and contaminate water supplies, and these negative side effects and costs (so-called externalities) are shifted onto individuals while society bears the cost.

AgraQuest

AgraQuest is an innovative small company based in Davis, California. The company was founded by entrepreneur Pam Marrone, a PhD biochemist with a vision of commercially harnessing the power of naturally occurring plant defense systems. Marrone had left Monsanto, where she had originally been engaged to do this work, when that company shifted its strategic focus to genetically modified plants. Marrone looked for venture capital and ultimately launched AgraQuest, a privately held company, which in 2005 employed seventy-two people and expected sales of approximately \$10 million.

AgraQuest strategically differentiated itself by offering products that provided the service of effective pest management while solving user problems of pest resistance, environmental impact, and worker health and safety. AgraQuest provides an exemplary case study of green chemistry technology developed and brought to market at a competitive cost. The company is also a prime example of how a business markets a disruptive technology and grapples with the issues that face a challenge to the status quo.

About AgraQuest

Powering today's agricultural revolution for cleaner, safer food through effective biopesticides and innovative technologies for sustainable, highly productive farming and a better environment.

As a leader in innovative biological and low-chemical pest management solutions, AgraQuest is at the forefront of the new agriculture revolution and a shift in how food is grown. AgraQuest focuses on discovering, developing, manufacturing and marketing highly effective biopesticides and low-chem pest and disease control and yield enhancing products for sustainable agriculture, the home and garden, and food safety markets. Through its Agrochemical and BioInnovations Divisions, AgraQuest provides its customers and partners with tools to create value-enhancing solutions. Andrea Larson and Karen O'Brien, from field interviews; untitled/unpublished manuscript, 2006.

Winner of the Presidential Green Chemistry Challenge Small Business Award in 2003 for its innovative enzymatic biotechnology process used to generate its products, AgraQuest employed a proprietary technology to screen naturally occurring microorganisms to identify those that may have novel and effective pest management characteristics. US Environmental Protection Agency, "Green Chemistry: Award Winners," accessed July 28, 2010, <http://www.epa.gov/gcc/pubs/pgcc/past.html>. AgraQuest scientists traveled around the world searching out promising-looking microbes for analysis. AgraQuest scientists gathered microbe samples from around the world, identifying those that fight the diseases and pests that destroy crops. Once located, these microorganisms were screened, cultivated, and optimized in AgraQuest's facilities and then sent in powder or liquid form to growers. In field trials and in commercial use, AgraQuest's microbial pesticides have been shown to attack crop diseases and pests and then completely biodegrade, leaving no residue behind. Ironically, AgraQuest's first product was developed from a microbe found in the company's backyard—a nearby peach orchard. Once the microbe was identified, company biochemists analyzed and characterized the compound structures produced by selected microorganisms to ensure there were no toxins, confirm that the product biodegraded innocuously, and identify product candidates for development and commercialization.

The company, led by entrepreneur Marrone, has screened over twenty-three thousand microorganisms and identified more than twenty product candidates that display high levels of activity against insects, nematodes, and plant pathogens.

These products include Serenade, Sonata, and Rhapsody biological fungicides; Virtuoso biological insecticide; and Arabesque biofumigant. The market opportunities for microbial-based pesticides are extensive. Furthermore, the booming \$4 billion organic food industry generates rising demand for organic-certified pest management tools. As growers strive to increase yields to meet this expanding market, they require more effective, organic means of fighting crop threats. AgraQuest's fungicide Serenade is organic certified to serve this expanding market, and other products are in the pipeline.

The US Environmental Protection Agency (EPA) has streamlined the registration process for "reduced-risk" bio-based pesticides such as AgraQuest's to help move them to market faster. The Biopesticides and Pollution Prevention Division oversees regulation of all biopesticides and has accelerated its testing and registration processes. The average time from submission to registration is now twelve to fourteen months rather than five to seven years.

Moreover, since the products biodegrade and are inherently nontoxic to humans, they are exempt from testing for "tolerances"—that is, the threshold exposure to a toxic substance to which workers can legally be exposed. This means that workers are required to wait a minimum of four hours after use before entering the fields, whereas other conventional pesticides require a seventy-two-hour wait. The reduction of restricted entry intervals registers as time and money saved to growers. Therefore, AgraQuest products can act as "crop savers"—used immediately prior to harvest in the event of bad weather. To growers of certain products, such as wine grapes, this can mean the difference between success and failure for a season.

AgraQuest deployed exemplary green chemistry and sustainability innovation strategies. The opportunity presented by the problems associated with conventional chemical pesticides was relatively easy to perceive, but designing a viable alternative took real ingenuity and a dramatic diversion from well-worn industry norms. Thinking like a molecule in this context enabled the firm to challenge the existing industry pattern of applying toxins and instead examine how natural systems create safe pesticides. Marrone and her team have been able to invent entirely new biodegradable and benign products—and capitalize on rising market demand for the unique array of applications inherent in this type of product.

As the science linking cause and effect grows more sophisticated, public concern about the human health and environmental effects of pesticides is increasing. Rick A. Relyea, "The Impact of Insecticides and Herbicides on the Biodiversity and Productivity of Aquatic Communities," *Ecological Applications* 15, no. 2 (2005): 618–27; Xiaomei Ma, Patricia A. Buffler, Robert B. Gunier, Gary Dahl, Martyn T. Smith,

Kyndaron Reinier, and Peggy Reynolds, “Critical Windows of Exposure to Household Pesticides and Risk of Childhood Leukemia,” *Environmental Health Perspectives* 110, no. 9 (2002): 955–60; Anne R. Greenlee, Tammy M. Ellis, and Richard L. Berg, “Low-Dose Agrochemicals and Lawn-Care Pesticides Induce Developmental Toxicity in Murine Preimplantation Embryos,” *Environmental Health Perspectives* 112, no. 6 (2004): 703–9. Related to this is an international movement to phase out specific widely used pesticides such as DDT and methyl bromide. Moreover, a growing number of countries impose trade barriers on food imports due to residual pesticides on the products.

In this suite of challenges facing the food production industry, AgraQuest found opportunity. The logic behind AgraQuest’s product line is simple: rather than rely solely on petrochemical-derived approaches to eradicating pests, AgraQuest products use microbes to fight microbes. Over millennia, microbes have evolved complex defense systems that we are only now beginning to understand. AgraQuest designs products that replicate and focus these natural defense systems on target pests. When used in combination with conventional pesticides, AgraQuest products are part of a highly effective pest management system that has the added benefit of lowering the overall chemical load released into natural systems. Because they are inherently benign, AgraQuest products biodegrade innocuously, avoiding the threats to human health and ecosystems—not to mention associated costs—that growers using traditional pesticides incur.

NatureWorks

In a final example, NatureWorks, Cargill’s entrepreneurial biotechnology venture, designed plastics made from biomass, a renewable input. The genius of NatureWorks’ biotechnology is that it uses a wide range of plant-based feedstocks and is not limited to corn, thus avoiding competition with food production. NatureWorks’ innovative breakthroughs addressed the central environmental problem of conventional plastic. Derived from oil, conventional plastic, a nonrenewable resource associated with a long list of environmental, price, and national security concerns, has become a major health and waste disposal problem. By building a product around bio-based inputs, NatureWorks designed an alternative product that is competitive in both performance and price—one that circumvents the pollution and other concerns of oil-based plastics. As a result of its successful strategy, NatureWorks has shifted the market in its favor.

NatureWorks LLC received the 2002 Presidential Green Chemistry Challenge Award for its development of the first synthetic polymer class to be produced from renewable resources, specifically from corn grown in the American Midwest. At the Green Chemistry and Engineering conference and awards ceremony in Washington, DC, attended by the president of the US National Academy of Sciences, the White

House science advisor, and other dignitaries from the National Academies and the American Chemical Society, the award recognized the company's major biochemistry innovation, achieved in large part under the guidance and inspiration of former NatureWorks technology vice president Patrick Gruber.

Gruber was an early champion of sustainability innovation. As an entrepreneur inside a large firm, he led the effort that resulted in NatureWorks' bio-based plastic. Together with a team of chemical engineers, biotechnology experts, and marketing strategists, Gruber spearheaded the effort to marry agricultural products giant Cargill with chemical company Dow to create the spin-off company originally known as Cargill Dow and renamed NatureWorks in January 2005. Gruber was the visionary who saw the potential for a bio-based plastic and the possibilities for a new enzymatic green chemistry process to manufacture it. He helped drive that process until it was cost-effective enough to produce products competitive with conventional products on the market.

NatureWorks' plastic, whose scientific name is polylactic acid (PLA), has the potential to revolutionize the plastics and agricultural industries by offering biomass-based biopolymers as a substitute for conventional petroleum-based plastics. NatureWorks resins were named and trademarked NatureWorks PLA for the polylactic acid that comprises the base plant sugars. In addition to replacing petroleum as the material feedstock, PLA resins have the added benefit of being compostable (safely biodegraded) or even infinitely recyclable, which means they can be reprocessed again and again. This provides a distinct environmental advantage, since recycling—or “down-cycling”—postconsumer or postindustrial conventional plastics into lower quality products only slows material flow to landfills; it does not prevent waste. Moreover, manufacturing plastic from corn field residues results in 30 to 50 percent fewer greenhouse gases when measured from “field to pellet.” Additional life-cycle environmental and health benefits have been identified by a thorough life-cycle analysis. In addition, PLA resins, virgin and postconsumer, can be processed into a variety of end uses.

In 2005, NatureWorks CEO Kathleen Bader and Patrick Gruber were wrestling with a number of questions. NatureWorks' challenges were operational and strategic: how to take the successful product to high-volume production and how to market the unique resin in a mature plastics market. NatureWorks employed 230 people distributed almost equally among headquarters (labs and management offices), the plant, and international locations. As a joint venture, the enterprise had consumed close to \$750 million dollars in capital and was not yet profitable, but it held the promise of tremendous growth that could transform a wide range of markets worldwide. In 2005, NatureWorks was still the only company in the world capable of producing large-scale corn-based resins that exhibited standard performance traits,

such as durability, flexibility, resistance to chemicals, and strength—all at a competitive market price.

The plastics industry is the fourth largest manufacturing segment in the United States behind motor vehicles, electronics, and petroleum refining. Both the oil and chemical industries are mature and rely on commodities sold on thin margins. The combined efforts of a large-scale chemical company in Dow and an agricultural processor giant in Cargill suggested Cargill Dow—now NatureWorks—might be well suited for the mammoth task of challenging oil feedstocks. However, a question inside the business in 2005 was whether the company could grow beyond the market share that usually limited “environmental” products, considered somewhere between 2 and 5 percent of the market. Was PLA an “environmental product,” or was it the result of strategy that anticipated profound market shifts?

NatureWorks brought its new product to market in the late 1990s and early 2000s at a time of shifting market dynamics and converging health, environmental, national security, and energy independence concerns. These market drivers gave NatureWorks a profound edge. Oil supplies and instability concerns loomed large in 2005 and have not subsided. Volatile oil prices and political instability in oil-producing countries argued for decreasing dependence on foreign oil to the extent possible. The volatility of petroleum prices between 1995 and 2005 wreaked havoc on the plastics industry. From 1998 to 2001, natural gas prices (which typically tracked oil prices) doubled, then quintupled, then returned to 1998 levels. The year 2003 was again a roller coaster of unpredictable fluctuations, causing a Huntsman Chemical Corp. official to lament, “The problem facing the polymers and petrochemicals industry in the U.S. is unprecedented. Rome is burning.” Reference for Business, “SIC 2821: Plastic Materials and Resins,” accessed January 10, 2011, <http://www.referenceforbusiness.com/industries/Chemicals-Allied/Plastic-Materials-Resins.html>. In contrast PLA, made from a renewable resource, offered performance, price, environmental compatibility, high visibility, and therefore significant value to certain buyers for whom this configuration of product characteristics is important.

Consumers are growing increasingly concerned about chemicals in products. This provides market space for companies who supply “clean materials.” NatureWorks’ strategists knew, for example, that certain plastics were under increasing public scrutiny. Health concerns, especially those of women and children, have put plastics under suspicion in the United States and abroad. The European Union and Japan have instituted bans and regulatory frameworks on some commonly used plastics and related chemicals. Plastic softeners such as phthalates, among the most commonly used additives, have been labeled in studies as potential carcinogens and endocrine disruptors. Several common flame retardants in plastic can cause developmental disorders in laboratory mice. Studies have found plastics and related

chemicals in mothers' breast milk and babies' umbilical cord blood samples. Sara Goodman, "Tests Find More Than 200 Chemicals in Newborn Umbilical Cord Blood," *Scientific American*, December 2, 2009, accessed January 10, 2011, <http://www.scientificamerican.com/article.cfm?id=newborn-babies-chemicals-exposure-bpa>; Éric Dewailly Dallaire, Gina Muckle, and Pierre Ayotte, "Time Trends of Persistent Organic Pollutants and Heavy Metals in Umbilical Cord Blood of Inuit Infants Born in Nunavik (Québec, Canada) between 1994 and 2001," *Environmental Health Perspectives* 36, no. 13 (2003):1660–64.

Consumer concern about chemicals and health opens new markets for "clean" materials designed from a sustainability innovation perspective. In addition, international regulations are accelerating growth in the market. In 1999, the European Union banned the use of phthalates in children's toys and teething rings and in 2003 banned some phthalates for use in cosmetics. States such as California have taken steps to warn consumers of the suspected risk of some phthalates. The European Union, California, and Maine banned the production or sale of products using certain polybrominated diphenyl ethers (PDBEs) as flame retardants. In 2006, the European Union was in the final phases of legislative directives to require registration and testing of nearly ten thousand chemicals of concern. The act, called Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH), became law in 2007 and regulates the manufacture, import, marketing, and use of chemicals. All imports into Europe need to meet REACH information requirements for toxicity and health impacts. Companies are required to demonstrate that a substance does not adversely affect human health, and chemical property and safe use information must be communicated up and down supply chains to protect workers, consumers, and the environment.

All of these drivers contributed to the molecular thinking that generated NatureWorks' corn-based plastics. The volatility of oil prices, growing consumer concerns about plastics and health, waste disposal issues, and changing international regulations are among the systemic issues creating a new competitive arena in which bio-based products based on green chemistry design principles can be successfully introduced.

Given higher levels of consumer awareness in Europe and Japan, NatureWorks' plastic initially received more attention in the international market than in the United States. In 2004, IPER, an Italian food market, sold "natural food in natural packaging" (made with PLA) and attributed a 4 percent increase in deli sales to the green packaging. Carol Radice, "Packaging Prowess," *Grocery Headquarters*, August 2, 2010, accessed January 10, 2011, <http://www.groceryheadquarters.com/articles/2010-08-02/Packaging-prowess>. NatureWorks established a strategic partnership with Amprica SpA in Castelbelforte, Italy, a major European manufacturer of thermoformed packaging for the bakery and convenience food markets. Amprica

was moving ahead with plans to replace the plastics it used, including polyethelene terephthalate (PET), polyvinyl chloride (PVC), and polystyrene with the PLA polymer.

In response to the national phaseout and ultimate ban of petroleum-based shopping bags and disposable tableware in Taiwan, Wei-Mon Industry (WMI) signed an exclusive agreement with NatureWorks to promote and distribute packaging articles made with PLA. NatureWorks LLC, “First Launch by Local Companies of Environmentally Friendly Paper & Pulp Products with NatureWorks PLA,” June 9, 2006, accessed January 7, 2011, <http://www.natureworkslc.com/news-and-events/press-releases/2006/6-9-06-wei-mon-extrusion-coated-paper-launch.aspx>. In other markets, Giorgio Armani released men’s dress suits made completely of PLA fiber and Sony sold PLA Discman and Walkman products in Japan. Due to growing concerns about the health impacts of some flame-retardant additives, NEC Corp. of Tokyo combined PLA with a natural fiber called kenaf to make an ecologically and biologically neutral flame-resistant bioplastic. “NEC Develops Flame-Resistant Bio-Plastic,” *GreenBiz*, January 26, 2004, accessed December 2, 2010, [http://www/greenbiz.com/news/news_third.cfm?NewsID=26360](http://www.greenbiz.com/news/news_third.cfm?NewsID=26360).

The US market has been slower to embrace PLA, but Walmart’s purchasing decisions may change that. In fact, NatureWorks’ product solves several of Walmart’s problems. Walmart has battled corporate image problems on several fronts—in its treatment of employees, as a contributor to “big box” sprawl, and in its practice of outsourcing, among others. Sourcing NatureWorks’ bio-based, American-grown, corn-based plastic not only fits into Walmart’s larger corporate “sustainability” effort but addresses US dependence on foreign oil and supports the American farmer.

The spectrum of entrepreneurial activities in the sustainable materials arena is wide. While some entrepreneurs are early entrants who are fundamentally reconfiguring product systems, others take more incremental steps toward adopting cleaner, innovative materials and processes. However, incremental changes can be radical when taken cumulatively, as long as one constantly looks ahead toward the larger goal.

Many companies, within the chemical industry and outside, now understand that cost reductions and product/process improvements are available through green chemistry and other environmental efficiency policies. Documented cost savings in materials input, waste streams, and energy use are readily available. In recognition of the efficiency gains to be realized, as well as risk reduction and regulatory advantages, most firms acknowledge the benefits that result from developing a strategy with these goals in mind. In addition, companies know they can help avoid

the adverse effects of ignoring these issues, such as boycotts and stockholders' resolutions that generate negative publicity.

However, the efficiency improvement and risk reduction sides of environmental concerns and sustainability are only the leading edge of the opportunities possible. Sustainability strategies and innovative practices go beyond incremental improvement to existing products. This future-oriented business strategy—geared toward new processes, products, technologies, and markets—offers profound prospects for competitive advantage over rival firms.

As the molecular links among the things we make and macrolevel issues such as health, energy independence, and climate change become more widely understood, companies that think strategically about the chemical nature of their products and processes will emerge as leaders. A “think like a molecule” approach to designing materials, products, and processes gives entrepreneurs and product designers an advantage. By combining this mode of operating with systems thinking and the other sustainability approaches discussed in [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis"](#), [Section 4.4 "Weak Ties"](#), you will have a strategy that will enable you not to merely survive but to lead in the twenty-first century.

KEY TAKEAWAYS

- Invisible design considerations—for example, the design of molecular materials—must be factored into consideration of sustainability design.
- Green chemistry offers principles to guide chemical design and production.
- Thinking like a molecule opens new avenues for progress toward safer product innovation.

EXERCISE

1. Contact your local government and ask about chemical compounds from industrial and commercial activity that end up in the water and air. What are the government's major concerns? What are the sources of problematic chemicals? What is being done to reduce their release? Go to <http://blog.epa.gov/blog/2010/12/17/tri> or <http://www.epa.gov/tri> to read about the Toxic Release Inventory. Search the inventory for evidence of hazardous chemicals used in your area.

4.4 Weak Ties

LEARNING OBJECTIVES

1. Understand the notion of weak ties.
2. Know how and why weak ties contribute to innovation.

Firms that carve out positions on the cutting edge of sustainable business share a common feature. They reach out to attract new information from nontraditional sources. Developing the capacity to seek, absorb, and shape changing competitive conditions with respect to human activity and natural systems through weak tieMark Granovetter, “The Strength of Weak Ties,” *American Journal of Sociology* 78, no. 6 (1973): 1360–80. cultivation holds a key to successful innovation. This is not surprising. Business success depends on continuous revitalization of strategic capabilities. Good strategy creates the future in which a company will succeed.

Not all individuals or companies can embrace change, however. In the past, revitalization of existing firms meant analysis of standard factors: competitors, market size and growth, product attributes, past consumer behavior, pricing strategies, and marketing programs. We suggest that limiting yourself to conventional analysis constrains strategic options.

To compete in the sustainability arena, companies must go beyond what has worked in the past and seek perspectives outside the historically assumed subset. We argue that incorporating rigorous sustainability analysis into your market positioning is likely to yield opportunities that can be keys to future success. What does this mean when it comes to environmental topics, opportunities in green chemistry applications, implementing sustainability principles in operations, and the myriad other environmental and health imperatives that fall under the term *sustainability*? It means developing what are called, in the academic literature on networks, **weak ties**⁵ with unconventional partners who provide you with increasingly essential strategic information. This does not mean that “the answer” will be easily found. It does mean that the net must be thrown wider to access information relevant to strategic success.

5. Relationships outside your traditional network of ties that bring in novel information and perspectives that contribute to new ways of thinking.

Sustainability innovation and entrepreneurship involves traveling across new ground. Imagine you will be accompanying the early nineteenth-century explorers Lewis and Clarke to explore the unfamiliar territory of the American West. You will be the first European Americans to chart a course from the eastern seaboard to the

Pacific Ocean. The year is 1803, and there are very few maps of the American interior. The ones that exist are sketchy at best. How would you prepare for such a journey? You might talk to your friends and acquaintances to learn what they know about the terrain you'll be covering. To get the information necessary to survive this foray into the unknown, however, you would probably go outside your immediate circle to talk with trappers, Native Americans, French traders, natural scientists, and other voyagers—people from diverse walks of life. You would need to build new relationships, or *weak ties*, to access a wide range of people who will provide you with the necessary information to move forward.

These ties are called “weak” not because they lack substance or will disappoint you but because they lie outside the traditional network of relationships on which you or the company depends. Contrasting weak ties with “strong ties” highlights their unique characteristics. Strong ties, as a category of network relations, have immediate currency and often long-standing rich histories with extensive mutual exchange. An example in an established company would be an existing relationship with a funder or supplier; for a start-up, it may be someone with whom the company has a history of successful collaboration. Typically, strong ties are to people and organizations you see often and to which you frequently turn for input. In the case of large firms, important strong ties may be those formed between heads of independent business units within the same organization. Alternatively, they might be ties to reliable suppliers or even to the board of directors and the people with whom that group associates.

Research indicates, however, that the longer the duration of strong ties between two entities, the more similar the entities' perspectives are. People from the same circles tend to share the same pools of information. Under normal circumstances this is fine; we augment and reinforce each other's understanding of how the known world works. However, it is likely that information from strong ties will add only minimal value to the information you already possess. When we want to take action in an arena outside the familiar terrain, information from strong ties often proves insufficient. We would argue, moreover, that relying solely on strong ties can actually deprive you of information, thereby insulating you from potentially important emergent data and trends.

In contrast, weak ties bring new or previously marginal information to the forefront. They enable you to reach outside the normal boundaries of “relevant” strategic information. Weak ties trigger innovative thinking because they bring in fresh ideas—viewpoints likely to diverge from yours or from senior management's—and data otherwise overlooked or dismissed because they have not been a priority historically. Sometimes the most fruitful weak ties are to individuals or organizations previously considered to be your adversaries. Not surprisingly, the

most innovative ideas for success may well come from those quarters most critical of how business has traditionally been done.

To successfully traverse the relatively unfamiliar territory of entrepreneurship and sustainability, you need to seek information from weak ties to access emergent perspectives and new scientific data that make what used to be peripheral issues—as many ecological and environmental health issues have been—now salient to strategic success. Perspectives gained from weak ties enable discerning companies to differentiate themselves and gain relative to their competitors. They can be formed with a range of individuals and organizations—including academics, consultants, nonprofit research institutes, government research organizations, and nongovernmental organizations (NGOs). The latter community is often business’s harshest critic on environmental issues. It is for this reason that business is increasingly forming weak ties to NGOs to engage them in thinking strategically about solutions.

Toward this end, it is important to understand that the NGO community is not homogeneous. There is a spectrum of groups active on environmental and sustainability issues. They range from those that view business as antithetical to social and ecological concerns to those that seek partnership and joint solutions. Certainly any weak tie relationship requires due diligence and partnerships must be considered carefully, but there is a wealth of untapped expertise and stakeholder value that is potentially available to you.

The accounts that follow illustrate effective use of weak ties to help craft sustainability strategies. Home Depot’s president Arthur Blank found new perspectives through weak ties by seeking input from NGOs critical of the company’s old-growth forest purchasing practices prior to 1999. That year Home Depot, the largest home improvement retailer in the United States, was also the largest lumber retailer in the world, selling between 5 and 10 percent of the global market. The company recorded \$38 billion in sales and over 200,000 employees in 930 stores. It also had been repeatedly voted “Most Admired Specialty Retailer.”

Faced with negative publicity and store boycotts by activist groups, however, the company’s openness to learning about alternative sourcing opportunities led to invitations to NGO representatives to meet with Home Depot’s senior management. Those new contacts—and the information flows they facilitated—helped put Home Depot on a track and timetable for dramatically reducing and ultimately ending old-growth forest wood purchasing and store sales. Stated Arthur Blank at the time, “Our pledge to our customers, associates and stockholders is that Home Depot will stop selling wood products from environmentally sensitive areas. Home Depot embraces its responsibility as a global leader to help protect endangered forests. By

the end of 2002, we will eliminate from our stores wood from endangered areas—including certain lauan, redwood and cedar products—and give preference to ‘certified’ wood.”CBC News, “Home Depot Going Green,” November 10, 2000, accessed January 7, 2011, <http://www.cbc.ca/money/story/1999/08/27/homedepot990827.html>.

Certified wood is defined as lumber tracked from the forest, through manufacturing and distribution, to the customer to assure that harvesting the wood takes into account a balance of social, economic, and environmental factors. Home Depot’s ultimate goal was to sell only products made from certified lumber, but initially only about 1 percent of timber available was certified. How was Home Depot’s demand—let alone the industry’s—going to be met? The answer was that Home Depot’s decision moved markets. Vendors were asked to dramatically increase their supplies of certified lumber, driving demand back through the supply chain to lumber companies that expanded their activity in sustainably managed forestry.

Evidence that companies are seeking new perspectives grows each year as firms expand their range of conversations about improved practices to citizens groups, environmental scientists, and even international experts from other countries and industries. These groups are outsiders—examples of weak ties—because historically they have not been sought for strategically relevant information. However, this pattern has increasingly been shared by companies for which market scanning processes were previously limited to competitor and narrowly conceived industry trend data.

As the larger picture of economic activity’s impact on nature’s life support systems and the quality of life becomes more important to business, these ties now serve as conduits for knowledge on how and where the company might improve its overall strategy and performance. The known link of deforestation to climate change and species extinction combine with the implication of raw material processing methods in ecological and human health threats and known mutations to require—for fiduciary reasons—that companies buying and selling lumber pay attention to these issues. Firms that actively seek new perspectives that may have a bearing on their business success going forward will have a distinct advantage over those whose efforts are minimal, poorly designed, or viewed as marketing “greenwash.” Gaining true strategic leverage requires leadership. Home Depot was fortunate to have a leader with the broad intellect capable of seeing and implementing a wise path for the firm.

Statement from Home Depot on Wood Purchasing

We pledged to give preference to wood that has come from forests managed in a responsible way and to eliminate wood purchases from endangered regions of the world. Today there is limited scientific consensus on “endangered regions” of forestry. We have broadened our focus to understand the impact of our wood purchases in all regions and embrace the many social and economic issues that must be considered in recognizing “endangered regions” of forests. To fulfill the pledge, it was necessary to trace the origin of each and every wood product on our shelves. After years of research, we now know item by item—from lumber to broom handles, doors to molding and paneling to plywood—where our wood products are harvested. Home Depot, “Wood Purchasing,” accessed March 16, 2011, http://corporate.homedepot.com/wps/portal/Wood_Purchasing.

General Electric, Dell, and IKEA each pursued different types of weak ties. General Electric (GE) publicly announced the integration of environmental issues into product research and development (R&D) strategy and pursued weak ties to help develop strategy both by systematically contacting outside experts and by convening a series of gatherings of national experts and senior GE executives. In the process, GE unearthed previously unappreciated areas of technical innovation of great current and potential value to the company and launched a new corporate R&D strategy called “Ecomagination.” Dell worked with some of its harshest NGO critics to understand the emerging perspectives on managing electronic waste. The NGO links were Dell’s weak ties. This process of engagement not only helped Dell manage a public relations problem but—much to the company’s surprise—created a profitable new secondary service business that differentiated Dell as an industry leader in managing electronic waste. In another example, IKEA searched for assistance in its effort to reorient strategy after being embarrassed by a product that failed to meet European environmental regulatory requirements. IKEA’s weak tie to NGO consultant The Natural Step not only helped IKEA solve immediate product issues but helped fundamentally reorient company strategy on materials. IKEA’s openness to new information played a role in differentiating the company and augmented its existing reputation for design and low cost. The following sections include accounts of these company’s activities with lessons to be learned about profitably pursuing weak ties.

GE

In June 2005, GE CEO Jeff Immelt announced GE's new sustainability strategy, "Ecomagination," at a press event with Jonathan Lash, executive director of the environmental nonprofit organization World Resources Institute. Ecomagination, said Immelt, aims to "focus our unique energy, technology, manufacturing, and infrastructure capabilities to develop tomorrow's solutions such as solar energy, hybrid locomotives, fuel cells, lower-emission aircraft engines, lighter and stronger materials, efficient lighting, and water purification technology." Joel Makower, "Ecomagination': Inside GE's Power Play," *GreenBiz*, May 10, 2005, accessed December 3, 2010, http://www.greenbiz.com/news/columns_third.cfm?NewsID=28061.

Specifically, GE announced it would more than double its research investment in cleaner technologies, from \$700 million in 2004 to \$1.5 billion by 2010. GE also pledged to improve its own environmental performance by "reducing its greenhouse gas emissions 1% by 2012 and the intensity of its greenhouse gas emissions 30% by 2008, both compared to 2004 (based on the company's projected growth, GE says its emissions would have otherwise risen 40% by 2012 without further action)." Joel Makower, "Ecomagination': Inside GE's Power Play," *GreenBiz*, May 10, 2005, accessed December 3, 2010, http://www.greenbiz.com/news/columns_third.cfm?NewsID=28061.

GE's 2005 strategy was driven to a large degree by the cultivation of weak ties. Characteristic of many large firms active in eco-efficiency, GE had long viewed itself as a leader in environmental productivity improvements because it built energy-efficient airplane engines and other smaller systems and appliances that dramatically reduced resource and electricity use. However, these were design improvements that lacked the broader sweep of a systems view. To bring in new thinking and develop a new competitive stance, GE's senior management aggressively sought perspectives from atypical sources. Thanks to Jon Freedman at GE Water, formerly with GE corporate marketing and a leader in the Ecomagination policy development process, for information about GE's activity.

The Ecomagination story begins in 2003 and 2004 when three-year strategic plans drawn up by GE's business unit CEOs were presented to corporate CEO Jeff Immelt. These indicated market opportunities in green-friendly products across all the units. Core customers were asking for products designed to address escalating resource scarcity and pollution pressures. Clean water and clean energy featured prominently. At the same time, Immelt had received periodic inquiries publicly (in the form of shareholder petitions) and privately as to how GE would respond in an increasingly resource-constrained world. What was GE's position on environmental issues? Did it have a position?

A project to research the questions and trends was assigned and scoped out. GE assembled a team to interview thought leaders and experts outside the company in a variety of sectors. Academic experts in many fields, futurists, other business leaders, and leading NGOs were systematically interviewed as part of the information gathering that ultimately informed top management.

Through this process, topics were identified as relevant to GE's markets and offerings. In 2004, GE hosted by-invitation-only meetings of top GE decision makers and a subset of outside experts to look at trends in water and energy concerns five to ten years out. Major customers, the dozen top executives at GE including the CEO, and a select group of outside expert advisors were present at the meetings from beginning to end, an attendance record unusual in the corporate world. In total, over one hundred experts inside and outside GE were consulted, forty leading companies studied, and multiple internal GE seminars and brainstorming sessions convened to discuss megatrends influencing GE's future businesses.

As a result of this process, GE found that it was already seeing \$10 billion annual revenues from existing green technologies and services. The relative value of this activity was unexpected. Rather than being something foreign or new, GE was already seeing high returns from existing green technology innovations. This perspective, when combined with the outside expert feedback on likely trends, confirmed for GE management that their efforts should be redoubled to generate revenues of at least \$20 billion by 2010, with application of more aggressive targets thereafter.

Clean Edge, a research and advisory firm, estimated in 2006 that global markets for three of GE's identified technologies—wind power, solar photovoltaics, and fuel cells—would grow to more than \$100 billion within 10 years, from some \$16 billion in 2006. This figure did not include clean-water technologies, in which GE has also invested heavily. A previous study predicted that the market for world water treatment technologies will reach \$35 billion by 2007. Joel Makower, "Ecomagination': Inside GE's Power Play," *GreenBiz*, May 10, 2005, accessed December 3, 2010, http://www.greenbiz.com/news/columns_third.cfm?NewsID=28061.

Weak ties influenced GE's strategy formation in a number of ways. First, the ties helped GE design metrics to measure the current and potential values of some of its "green" technologies. One of GE's weak ties was to GreenOrder, a New York-based consultancy specializing in sustainable business. According to GreenOrder, GE identified 17 products representing about \$10 billion in annual sales as part of the Ecomagination platform on which it planned to build. In doing so, the company undertook intensive processes to identify and qualify current Ecomagination

products, analyzing the environmental attributes of GE products relative to benchmarks such as competitors' best products, the installed base of products, regulatory standards, and historical performance. For each Ecomagination product, GE created an extensive "scorecard" quantifying the product's environmental attributes, impacts, and benefits relative to comparable products. Joel Makower, "Ecomagination': Inside GE's Power Play," *GreenBiz*, May 10, 2005, accessed December 3, 2010, http://www.greenbiz.com/news/columns_third.cfm?NewsID=28061. Doing this analysis was one of the key roles played by GreenOrder.

As a result of these metrics, GE's corporate Global Research Center doubled its R&D spending on Ecomagination products and associated services. Business units are required to focus on enhanced internal environmental performance *and* new product offerings. By October 2005, a senior vice president and officer of the corporation was appointed who reported directly to the CEO and took responsibility for the quantitative tracking of business units' progress to both "walk the talk" internally and drive new product ideas.

The firm's strategy change was driven by a historically unprecedented search for new information that used many weak ties to gain emerging perspectives and new science data. This process gave senior management a broader view of global resource trends and allowed the company to gauge how it could best leverage its assets and capabilities to both profit from and contribute to solutions.

In contrast to many firms that are low-key about their environmental activities (to avoid criticism of falling short of the ideal), Jeff Immelt put GE out on a limb. The company, already criticized for environmental transgressions such as that in the Hudson River, In 2002 the EPA decided to dredge 2.65 million cubic yards of sediment—enough dirt to fill an area the size of ten football fields to a height of 145 feet—which is expected to cost GE about \$460 million. The dredging is aimed at removing polychlorinated biphenyls (PCBs) dumped into the river from GE plants in Hudson Falls, New York, and Fort Edward, New York, from 1947 to 1977, before PCB use was banned. Deborah Brunswick, "EPA: Hudson River Dredging Delayed," *CNNMoney*, July 26, 2008, accessed December 3, 2010, http://money.cnn.com/2006/07/28/news/companies/hudson_river. will be held to a higher, self-defined standard. There is reasoned debate, moreover, on the "greenness" of some of the technologies that GE is putting forward (nuclear power, "clean" coal, etc.). No company with a brand as well known as GE's can afford to not deliver. Time will tell how successful GE's strategy will be, but suffice it to say that a company such as GE does not make such a significant and public move without a thoroughly reasoned strategy. The GE example shows the formative role that weak ties can play in a company's strategic transformation.

Dell

Next, we look at Dell. The article read, “Las Vegas, Nevada, January 9, 2002, environmentalists dressed in prison uniforms circled a collection of dusty computers outside the Consumer Electronics Show...to protest Dell Computer’s use of inmates to recycle computers. ‘I lost my job. I robbed a store. Went to jail. I got my job back,’ chanted five mock prisoners wearing ‘Dell Recycling Team’ signs and linked by chains. While Dell’s executives gathered at the huge electronics convention, the ‘high-tech chain gang,’ members of the Silicon Valley Toxics Coalition, attracted a small crowd outside.” Janelle Carter, “Senate Rejects Felon Vote Bid,” *Associated Press*, February 15, 2002, accessed December 10, 2011, <http://www.sjcite.info/prison.html>. Dell executives were understandably embarrassed by this incident. The assumption inside the company was that the company was doing what it reasonably could do about product recycling—a thorn in the paw of the industry lion. However, this public relations fiasco drew attention to an issue that no one in the industry was adequately addressing: electronic waste is a burgeoning problem that, if not dealt with, would come back to all players in the industry.

Disposal of electronic products represents one of the fastest growing industrial waste streams. Roughly one thousand hazardous materials used in manufacturing personal computers alone pose problems of human exposure to heavy metals, drinking water contamination, and air quality problems. With the rapid retirement of old models, a staggering volume of computers and other electronic equipment now migrates around the world. Only a small fraction goes to reuse programs. The majority are shipped to landfills and incinerators, or sent as waste to foreign countries. In response to the public health threats from hazardous materials in electronics waste streams, the European Union, Japan, China, and states within the United States are regulating electronic waste. One such regulation in the European Union is the Restrictions on Hazardous Substances in Electrical and Electronic Equipment. NetRegs, “Restriction Of Hazardous Substances in Electrical and Electronic Equipment (RoHS),” last updated October 15, 2010, accessed December 3, 2010, <http://www.netregs.gov.uk/netregs/63025.aspx>. “Product take-back” laws—and the threat of more such regulations in the future—are stimulating companies to experiment with a variety of means to take back and reuse products. (See the sidebar in this section.) Whether you agree or disagree with these actions, they are one of many drivers of sustainability strategies today:

Producers will be responsible for taking back and recycling electrical and electronic equipment. This will provide incentives to design electrical and electronic equipment in an environmentally more efficient way, which takes waste management aspects fully into account. Consumers will be able to return their equipment free of charge. In order to prevent the generation of hazardous waste, the proposal for a Directive on the restriction of the use of certain hazardous substances requires the substitution of various heavy metals and brominated flame retardants in new electrical and electronic equipment from 1 January 2008 onwards. Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment and on the restriction of the use of certain hazardous substances in electrical and electronic equipment. European Commission, “Recast of the WEEE and RoHS Directives proposed,” COM (2000), accessed March 16, 2011, http://ec.europa.eu/environment/waste/weee_index.htm.

Dell is one of the largest personal computer manufacturers in the world. It is an information technology supplier and partner and sells a comprehensive portfolio of products and services directly to customers worldwide. Dell dealt with a US government contractor, UNICOR, which employed prison inmates to recycle outdated computers. The justification was cost; since recycling products was assumed to be a net cost to the company, efforts were made to cut associated expenses.

In February 2002, the Basel Action Network released an alarming report about end-of-life electronics exported and dumped in Asia. The report, “Exporting Harm: The High-Tech Trashing of Asia,” focused a significant amount of media and NGO attention on what computer manufacturers were doing to offer customers options for responsible electronics disposal. Later that year, the Computer Take-Back Coalition launched its “Toxic Dude” website, targeting Dell for not doing enough on computer recycling and reuse. Socially responsible investors (SRIs) and a variety of NGOs, including the aforementioned Silicon Valley Toxics Coalition and the Texas Campaign for the Environment, increased pressure on Dell to do more about electronic waste issues.

Following the prison-garbed protest, Dell began engaging in frequent conversations with these and other NGOs. These were Dell’s weak ties—new sources of information outside the company. Dell found that having conversations with these groups helped the company create a more strategically astute direction for its product end-of-life programs. Dell, a relatively young company that had grown rapidly, had not previously formed relationships with health and environmental NGOs. Through

these conversations, Dell fundamentally reconfigured its recycling and reuse services for customers. As a leader in supply-chain management, productivity, and efficiency, the company designed an “asset recovery” program for end-of-life products—a program that would maximize quality and minimize costs for its recycling programs. Much to Dell’s surprise, the program not only minimized cost but generated value while also enhancing Dell’s brand and reputation as a responsible corporate citizen.

Early in 2003, Dell restructured its recycling program to make it easier for users and more proactive for the company. The “Dell Recycling” program was simplified and made more visible to customers. The company launched a national recycling tour consisting of one-day no-cost computer recycling events in cities across the country, with the objective of raising consumer awareness of computer recycling issues and solutions. When Dell first offered printers among its array of products, the company included free recycling of old printers. Ongoing discussions with NGOs informed the approaches chosen.

In late 2003 Dell broadened its national network of approved recyclers by partnering with two private companies to support its environmental programs for retiring, disassembling, reusing, and recycling obsolete computer equipment. Dell discontinued its partnership with UNICOR. These changes helped Dell grow its environmental programs more quickly and efficiently, improve the economics and convenience for customers, and properly dispose of customers’ old systems with minimal environmental or health impact. Moreover, the company began to see value in reclaiming assets rather than just costs in disposing of waste, a fundamental reorientation that would not have been possible without the weak ties that helped the company rethink its relationship with waste.

Tod Arbogast, who led Dell’s sustainable business efforts, stated,

The early discussions we had with NGOs and SRIs led to brainstorming sessions both within the company and with these stakeholders. Stakeholder input helped shape what we are doing now and it continues to be a valuable dialogue to this day. We came to realize that we could meet both our business objectives as well as the environmental goals we were being asked to adopt with new product recovery services offered to our customers. For example, our product recovery programs for our business customers have both helped grow the amount of used computers we are recovering and have become profitable. We’ve taken this same focus of meeting both sustainability and business goals into many areas since then including workplace conditions in our supply chain, chemical use policies and regular transparent reporting on all of these efforts to a broad set of external stakeholders. Connecting our sustainability objectives to our business objectives helps us get a

broader set of internal colleagues supporting our efforts and helps us continue to expand our sustainability programs. Tod Arbobast, interview by author in preparation of book manuscript, summer 2006.

By engaging with vocal critics and environmental advocates and having open and honest dialogue with NGOs, the company effectively improved its end-of-life disposal offers by making them easier, more affordable, and more visible to customers. Dell was able to reach outside the company to get the additional information it needed to make this possible. By learning from the feedback it received and adjusting several of its tactics for raising awareness among consumers about responsible computer recycling, Dell created what is today one of the industry's most aggressive and comprehensive recycling offers. In addition to the positive brand enhancement that came with having an environmentally responsible business offer, Dell also gained from showing customers that it could manage the entire life cycle of its technology equipment.

The story of electronics waste is not over. Dell and other leading companies are under intense scrutiny by NGOs to fulfill their commitments on waste management and toxics issues. Moreover, as a society, we still have a long way to go. To inspire more corporate action, in 2005, Calvert Investments and other SRIs filed shareholder resolutions with six computer companies, asking them to begin planning for recycling and take-back. As a result, Dell was the first US computer company to commit to setting recycling and take-back goals for personal computers.

IKEA

Global home furnishings retailer IKEA was stunned by claims in the 1990s that one of its most popular products—the Billy bookcase—was off-gassing formaldehyde at levels above German government safety standards. The resulting crisis for this company led to IKEA's search for ways to prevent such an issue from happening in the future. After talking with different environmental groups and receiving much criticism but little concrete direction, IKEA turned to The Natural Step (TNS), an environmental educational organization headquartered in Stockholm, Sweden. Karl Henrik Robèrt, founder of TNS and an oncologist who became an environmental health activist due to children's inexplicably rising cancer rates, was repeatedly invited to talk with IKEA's senior management team and train them in TNS process. By teaching the group about overlooked market conditions that would increasingly impinge on IKEA's worldwide practices, Robèrt catalyzed the group to commit to the first step of designing a green furniture line offering—and this weak tie ultimately helped IKEA develop its overarching sustainability strategy.

The task of “fixing” the company after its regulatory embarrassment seemed enormous to senior executives at the time. But the basic environmental education and criteria for designing both products and strategy offered by TNS educational framework allowed the senior executives to see a path forward. The major learning point is that without seeking outside perspectives from the very groups that had been most critical of the corporation, IKEA would not have found Dr. Robèrt and TNS ideas that were eventually integrated into the company’s strategy.

Working with Robèrt helped IKEA leaders see their industry from the outside; thereafter, they viewed steps transitioning toward “sustainable business” as noncontroversial. IKEA leaders were simply adapting to new scientific and health research data and integrating that data with their strategic choices. In their earliest experience with TNS, that meant certain chemicals known to be toxic to cells (causing cell mutation) would not be used in any production steps required to make residential household furniture. The solution of removing unsafe materials fit with IKEA’s corporate purpose of improving the lives of its customers.

The first concrete product that resulted from this solution was IKEA’s “eco-furniture” line, but the perspectives on materials and IKEA’s strategic positioning went far beyond one product line. IKEA continued to set some of the highest environmental strategy standards in the industry. As one of the first adopters of sustainability standards, IKEA has set the bar that others seek to match. The company’s initial corporate environmental action plan was called Green Steps, which was based on four intended actions/conditions posed in the form of questions:

1. Is the company systematically reducing its dependency on mining and nonrenewable sources?
2. Is the company reducing the use of long-lasting, unnatural substances?
3. Is the company reducing its encroachment on nature and its functions?
4. Is the company reducing unnecessary use of resources?

To ensure this policy is followed, IKEA trains all employees and regularly provides them with clear and up-to-date environmental information. The company also established an internal Environment Council, and all business plans and reports describe environmental measures and costs pertaining to the Green Steps.

IKEA does not manufacture its own products but instead commands a large international supply chain. The IKEA Group has nearly 220 stores in 33 countries. Nearly 1,600 suppliers manufacture products for IKEA. IKEA’s purchasing is carried out through 43 trading service offices around the world. IKEA mainly sources from European countries, but purchases from developing countries and countries in

transition are rapidly increasing. A limited part of the supply comes from the industrial group of IKEA, Swedwood, which has 35 factories in 9 countries.

IKEA has taken steps to work with and educate current and potential suppliers on its environmental specifications and expectations. In this way, the company is shifting the industry standards, as captured in “The IKEA Way on Purchasing Home Furnishing Products” (IWAY). This guiding document supports the IKEA vision and business idea, outlining in great detail its expectations and procedures for suppliers. IWAY is administered and monitored by IKEA of Sweden Trading Services Office and by a global compliance group. “IKEA & the Environment—An Interview with Anders Berglund,” *EarthShare Washington*, accessed December 3, 2010, <http://www.esw.org/giving/ikea.html>.

IKEA has won many environmental business awards and is a leader in setting high standards for its products, particularly environmental standards. As one of the early adopters of a green strategic approach to how it conducts business, IKEA now enjoys brand recognition as the company that not only sells low cost, well-designed home furnishings but clean and safe products as well.

These examples illustrate senior managers responding to a changing business environment by establishing weak ties to outsiders who provide content on a new strategic direction for the company. These managers took advice from sources considered unconventional—even threatening—and used it for their companies’ financial and strategic gain. In these cases, we see three types of weak ties: to professional experts, to NGOs, and to an environmental educational organization.

There is no way to predict what outside source will offer weak tie benefits to your venture. However, a good way to find such sources is to identify the pool of weak ties from among your insider strong-tie group to relevant outsider voices. As noted, environmental groups and other NGOs are not homogeneous; some are more willing and able to work with entrepreneurs and companies than others. Certain leaders and their organizations are well established and widely respected. You need to research the topics that represent opportunities for your venture and then identify individuals and organizations with whom conversation may be fruitful. Ideally, you want to initiate weak tie conversations with individuals and groups aligned with sustainability solutions who do not take issue with your proposed or existing practices. You need a set of weak ties willing to join with you over time to help inform strategy.

In summary, if entrepreneurs do not seek outsider perspectives on the shifting state of the competitive game, they will be blinded to forces that hold, in some cases, the overnight potential to undermine the venture’s efforts. On the positive side, access

to emergent perspectives and new scientific data on sustainability issues holds promise of strategic advantage. Access to this information enables discerning entrepreneurs to gain relative to competitors because information flows from weak ties bring tighter cohesion between a firm's strategic thinking and the shifting conditions that shape market opportunities. Weak ties are a bridge to innovation, competitive differentiation, and new market opportunities. This discussion draws on the work of Mark Granovetter, "The Strength of Weak Ties: A Network Theory Revisited," *Sociological Theory* 1 (1983): 201–33, accessed March 7, 2011, http://www.si.umich.edu/~rfrost/courses/SI110/readings/In_Out_and_Beyond/Granovetter.pdf. Using weak ties for sustainability innovation can be understood as a parallel to adaptation in biology. As the complexity of business decisions and market dynamics grows, the effective use of weak ties can mean the difference between learning and not learning, at the individual, corporate, and supply-chain levels. We would argue that in the twenty-first century, it is essential to seek better information drawn from wider sources logically linked to a firm's social and environmental footprint to adapt intelligently.

KEY TAKEAWAYS

- Incorporating sustainability considerations into business requires reaching out beyond conventional sources of business information.
- Entrepreneurs and businesses that tap into weak tie relationships around sustainability concerns can use them to find new ideas for products and services.
- Adaptation to the new business conditions in which environmental, health, and community concerns have become more important requires cultivation of weak ties.

EXERCISE

1. Identify a business you would like to create. What health, community, and environmental concerns might emerge as you imagine building your firm? Where would you turn for advice and information to anticipate how you should respond? Why?

4.5 Adaptive Collaboration through Value-Added Networks

LEARNING OBJECTIVES

1. Understand how implementation is carried out.
2. Learn about collaborative processes for adaptation and innovation.

Value-added networks (VANs)⁶ are necessary to implement sustainability innovation strategies; VANs provide the horsepower to implement projects and are the means to translate your strategic vision into competitive products or services. VANs are action oriented and results driven.

VANs are distinct from weak ties. The primary contribution of weak ties is new and diverse information that links strategy more coherently with broader systemic forces. Weak ties bridge the corporation to the “outside” world’s events and stakeholders. In contrast, VANs are composed of closer and stronger ties within your firm and its inner circle of collaborators. They are ties that can be intentionally and strategically joined to add value throughout the implementation process. Weak ties also differ from VANs in that they might be critics or even opponents of your company. The purpose of weak ties is information access beyond the known and the predictable, while the purpose of VANs is to take action. Weak ties serve an essential role for bringing creative alternative perspectives to the business at the options generation stage. VANs enable adaptive collaboration.

VANs can offer a wealth of creativity in the implementation process. VANs can be familiar faces in your backyard, or they might include suppliers or customers. They are an untapped, underappreciated resource for implementation ideas, feedback, and adaption as a plan is implemented. Rarely do company executives directly create and monitor VANs. More often they create the circumstances and culture that allow VANs to form and the protection and incentives for them to be effective. Our research indicates that where sustainability innovation strategies are successfully implemented, a group had come together with sufficient senior backing and the skills, resources, and authority to drive the project forward. It should perhaps go without saying that VANs tend to be more successful in implementing sustainability innovations in companies already open to change and known to be culturally innovative.

6. The action-oriented teams that work collaboratively to execute a sustainability strategy.

Membership in VANs can be formal or informal. If sustainability goals have been embraced by a company, the process might be more formal. If sustainability is being

explored by only a subset of the firm, but resources and legitimacy are present, the process may be more organic. Sometimes all that is lacking to catalyze a VAN is the context for the right question, for example, asking a long-standing supplier, “Can we do this better if we integrate environmental/sustainability attributes?” When asked to provide greener, more benign materials, a supplier replied to one of the managers interviewed for this book, “Yes, sure, we can do that. You just never asked before.” In this situation, the collaborative VAN simply emerged, its leaders and other participants identifying themselves by stepping forward once the space is created for them to act and flourish.

VANs are often informal structures; they are interwoven in and under the firm’s formal administrative and functional hierarchies. However VANs are structured for a firm’s circumstances, there are certain things entrepreneurs and managers can do to provide conditions conducive to innovation. First, incentives for innovation and experimentation must be part of the picture. Making it safe to experiment is another essential element, as is fostering a culture where “there are no dumb questions” or “issues off the table.” Creating special, finite committees or advisory panels may be an effective approach for your context; if it is, be sure you reward members for their participation.

The VANs discussed here are the sets of relationships mobilized around sustainability innovation that contribute specific resources to converting ideas into action. In short, VANs are your nearest and best resource for inspiration, input, and feedback on how you can improve what you do and for practical ideas on how to implement and modify sustainability practices.

The examples that follow illustrate companies and individuals able to implement sustainability strategies by drawing knowledge and resources from VANs. Walden Paddlers’ VAN, under the direction of the entrepreneur-founder, illustrates that organizational boundaries—and as we will discuss, even the existence of an organization in some instances—are irrelevant to successful implementation. This example may seem odd to those unfamiliar with the rise of virtual organizations and virtual companies since the 1990s. The Walden Paddlers example is a powerful way of showing the effectiveness of determined efforts to employ VANs to implement sustainability strategy visions regardless of organizational structure.

Moreover, VANs can serve to implement strategy in diverse settings: Walden Paddlers was a fledgling enterprise and United Technologies Corporation (UTC) an established, multibillion-dollar global company. Walden had no existing procedures; UTC has decades of established operations procedures. Walden makes recreational kayaks; UTC makes massive industrial products. The companies have very different circumstances yet use similar strategies and tactics.

Walden illustrates how a sustainability innovation vision can create and mobilize a network and resources around cutting-edge product innovations. Perhaps because sustainability goals can resonate strongly with the values of contributors, VANs can build a distinct energy and momentum. The vision defined by sustainability objectives acts like an extra lift under a VAN's wings. The UTC example shows how VANs form between innovators across functionalities. To borrow from UTC's experience: *work with innovators in other fields*. Differentiation is a moving target; your VAN can help you stay on top of it and continually redefine it.

Tactics for Catalyzing Value-Added Networks

- Start with a compelling vision.
- Don't take "no" for an answer—find people whose values align with yours.
- Work with innovators in other fields.

There will always be pessimists, the lazy, the comfortable, and people whose income depends on continuing the existing way of doing business. These are not the people you want in your VANs. Their attitude is "no," and they bring imaginations to match. Entrepreneur Paul Farrow's launch, successful growth, and ultimate sale of Walden Paddlers provide an unusual illustration of building a VAN to successfully implement strategy. All new initiatives and fledgling enterprises are start-ups and need to recruit resource- and information-rich participants by building lateral networks. In most companies, implementing sustainability strategy will, to a certain extent, constitute a deviation from the norm because it represents a new activity with all the characteristics of entrepreneurial initiatives. This means creating networks of like-minded others who understand and rally behind a powerful vision.

This account provides the core steps that enabled this VAN to succeed. Grit and determination to proceed despite hearing repeated discouraging feedback is part of the process. VANs share this with any innovation process, but remember that strategy that incorporates sustainability values into the core represents a larger and more far-reaching innovation of knowledge and meaning than a new product alone.

Walden Paddlers

Walden Paddlers represented a sustainability-oriented company from its inception. Paul Farrow built his company and core VAN from scratch. One day, on vacation in

Maine, he made a back-of-the-envelope calculation that the economics of recycled plastics made into recreational kayaks was a market opportunity—thirty-five pounds of forty cents per pound of plastic sold for more than four hundred dollars at retail. Farrow saw the possibility for a higher quality product at a lower price to the user, and a profitable company. The question he pondered was whether he could create a new market space for kayaks made from used milk bottles. All he knew at that point was that he had a business idea worth exploring. He knew nothing about kayaks (except enjoying them for recreation) or recycled plastic, but he did know a little about plastics manufacturing.

The project began as many sustainability initiatives do. He talked with people he expected to understand his vision, experts in plastics and material science. He was summarily informed by materials specialists from preeminent Boston-area academic establishments that no one could make high-performance plastic for recreational kayaks from recycled materials. It was common knowledge; the composition of recycled plastics made it impossible. The recycled resins, appropriate for downscaling into speed bumps or perhaps waste cans, would not yield high-performance, aesthetically attractive kayak hulls. Furthermore, the industry lacked equipment to handle the new material and specifications. In conclusion, it could not be done.

Challenging the received wisdom of experts requires reaching beyond them to more open-minded fellow travelers, those with less invested in existing knowledge, objectives, and methods. With only his aspiration of earning a living doing something he believed in and that would help protect the natural environment, and a vague picture of using recycled resins to create a kayak of some sort (for a market that might or might not exist), Paul Farrow kept talking to people about his idea and gathering data. He sought the advice of materials science experts who *would* take his ideas seriously. He conducted research on the prospective customer segment and communicated through his extended family and network of friends that he had this crazy idea. In the process, he found a few receptive individuals who were willing to talk with him and consider the possibilities.

Your VAN can take form from unexpected locations. Reminded by his wife that he had a brother-in-law attending Rensselaer Polytechnic Institute in New York state, Farrow made some phone calls. His brother-in-law had taken a course on materials with a nationally known professor. Through persistence, several phone calls later Farrow connected with the professor, who had recently started a company with one of his former engineering students, Jeff Allott. Allott, now a product designer for the company General Composites, was coincidentally a paddle sports enthusiast and was intrigued by Farrow's plan. Allott was also anticipating that the company's government contracts would taper off in the near future, and General Composites needed to diversify. Moreover, Allott liked the notion of designing an

unprecedented material that the experts had deemed impossible to create. Why not create a high-performance, aesthetically attractive, inexpensive recreational kayak from recycled milk bottles? Why can't positive expectations for health, ecology, community, and financial gains be optimized simultaneously?

This was a typical entrepreneurial endeavor during which Farrow repeatedly heard “no” in response to his questions. Eventually he received a “maybe” from a more imaginative individual who could see the new market space. The pattern of “no” and a few “maybes” repeated itself with manufacturers, national retailers, distributors, and component suppliers. From his innumerable rejections, Farrow had collected valuable information about how to implement his vision that he used to refine and recalibrate his plan. In this learning process Farrow's VAN identified itself in a self-selection, self-organizing fashion typical of new enterprises.

Each node in the network was a person with close knowledge about how to implement the proposal. Each suggested ways forward and was willing to collaborate with untested strategy, design protocols, product ideas, and market segment definitions that had unknown but possibly significant returns. Farrow also tapped into each individual's sense of competitive challenge, fun, and creativity posed by accomplishing something the so-called experts said was impossible. The results of the process were a set of innovations, an award-winning kayak, and a profitable company.

This story teaches the necessity of carefully selecting VAN participants whose goals are aligned with yours. The first manufacturer to sign on was Hardigg Industries. Its manufacturing manager was curious about working with the new recycled plastic resins and driven by the economic pressure of unused plant capacity. This seasoned manager was also interested in the prospect of growing a new customer base in recycled plastic molding. In fact, Hardigg's management was so motivated to try new approaches in recycled plastics that it contributed capital to the start-up by agreeing to generous terms that acknowledged the start-up's cash-strapped condition. Hardigg invested \$200,000 in new equipment and drew up a flexible, informal contract based on shared returns and aligned future interests should the venture take off.

The start-up's next phase illustrates how sustainability innovations are created. Extensive experimentation with different plastic compounds and resin colors followed. There were adjustments to the equipment to modulate temperatures and vary cooling times and methods. Farrow, along with the manufacturer and the designer, spent many hours testing, analyzing, discussing, and retesting. It was a microcosm of any implementation situation characterized by innovation and entrepreneurial process: learn as you go, draw from the creativity and imagination

of your partners, collaborate, adapt and incorporate new knowledge along the way, and allow the feedback and events to shape the path and even the destination.

Entrepreneurs need to keep searching for allies to fill in the VAN gaps. The right mix of recycled plastic had to be developed to match the materials specifications of the product and the high heat demands of the molding equipment. Turned down by multiple plastic recyclers, Farrow finally found a Connecticut recycler who was trying to build his business and had a reputation for being open to new ideas. That recycler joined the emerging VAN and experimented with different collected plastics, testing a variety of pellets for melt consistency, texture, and color. More weeks of prototype experimentation unfolded, involving Paul Farrow, Jeff Allott, the recycler, and the head of manufacturing at Hardigg designing and redesigning incrementally but ultimately successfully to produce the first kayak.

Now Farrow had to address how to sell the kayak. What was the least expensive and most leveraged way to test the market? Attracted to the idea of selling more environmentally responsible kayaks, leading national sports equipment retailers were open to Farrow's product ideas. Through extensive discussions with retailers like REI, Eastern Mountain Sports, L. L. Bean, and others emerged optimal pricing strategies at wholesale and retail, creative in-store marketing, and colorful packaging for the customer to protect the kayak when it is placed on a vehicle roof rack. In other words, the collaborative retailers literally told Farrow what decisions to make on pricing, marketing, and packaging to optimize sales.

A successful VAN process will elicit energy and initiative from those self-selected to be involved because they know that business, the environment, and communities are not separate. Explicit sustainability strategies attract committed people and release their creativity. Dale Vetter, an operations expert and Farrow's friend and former business colleague, was drawn into the business bringing operating skills that complemented Farrow's finance know-how and general management experience. Vetter's creative redesign of the transport system that moved the kayaks from the manufacturer to Walden's tiny warehouse and office headquarters outside Boston resulted in dramatically improved logistics efficiencies and reduced labor costs. The kayak seat supplier was persuaded by Farrow and Vetter to take back its packaging, ultimately saving itself money when it discovered a method to recycle its packaging materials. This allowed Walden to avoid expensive Boston-area waste disposal fees.

Farrow has downplayed the challenges of creating his company, yet in its time Walden Paddlers implemented an early model of sustainability innovation that functioned under an innovative corporate structure. The company was one of the earliest documented virtual corporations. See also extensive literature on "network

organizations.” See Mark Granovetter, “Economic Action and Social Structure: A Theory of Embeddedness,” *American Journal of Sociology* 91 (1985): 481–510; Walter W. Powell, “Neither Market Nor Hierarchy: Network Forms of Organization,” in *Research in Organizational Behavior*, ed. Barry M. Staw and L. L. Cummings (Greenwich, CT: JAI, 1990), 12:295–336; Andrea Larson, “Social Control and Economic Exchange: Conceptualizing Network Organizational Forms” (paper presented at the Annual Meeting of the American Sociological Association, Washington, DC, August 1990); Walter W. Powell, “Hybrid Organizational Arrangements: New Form or Transitional Development?,” *California Management Review* 30, no. 1 (1983): 67–87; H. B. Thorelli, “Networks: Between Markets and Hierarchies,” *Strategic Management Journal* 7 (1986): 37–51; Andrea Larson with Jennifer Starr, “A Network Model of Organization Formation,” *Entrepreneurship Theory and Practice* 17, no. 2 (Winter 1993): 5–15. Andrea Larson, “Network Dyads in Entrepreneurial Settings: A Study of the Governance of Exchange Relationships,” *Administrative Science Quarterly* 37, no. 1 (March 1992): 76–104; Andrea Larson, “Partner Networks: Leveraging External Ties to Improve Entrepreneurial Performance,” *Journal of Business Venturing* 6, no. 3 (May 1991): 173–88; Andrea Larson, “Strategic Alliances: A Study of Entrepreneurial Strategies for the 1990s” (paper presented at the Eleventh Annual Babson College Entrepreneurship Research Conference, Babson College, Babson Park, MA, 1991). and continued to innovate in materials, product design, transportation system, vendor relations, and wholesale buyer collaborations. Farrow was a sincere, informed, and modest yet passionate catalyst. Each VAN participant got hooked on his vision, and Farrow worked to ensure their economic interests were aligned. Both vision and potential returns were critical.

VAN participants, along with Farrow, heard discouraging comments throughout the start-up’s early stages. Farrow laughed as he said, “You have to get used to hearing ‘no.’ Your attitude has to be, ‘so what’? So you hear ‘no’ repeatedly.” Paul Farrow, interview with author, July 1996. Farrow’s casual way of talking about the implementation process masked his determination, persistence, and willingness to learn and adapt and to compromise when economic necessity required. The perfect would not shut out the good. His attitude was contagious and created the required commitment to make this idea fly. He commented on the people who said “no” to him: “Those people just have less imagination. But those aren’t the ones you want to work with. Do people think I’m a little odd in my passion for the vision? Sure, but you keep talking to people until you find the right partners who believe and will work hard to make the impossible happen.”

The Walden Paddlers case shows how you may need to create and inspire your VAN while you are on the journey. If there are no precedents, the VAN literally creates what it is doing as it goes forward. Farrow had only one of the requirements needed to build a company: a vague idea backed by some rough financial calculations. He

needed a materials specialist to design the first kayak from recycled plastic because he knew nothing about designing kayaks and even less about materials science. He needed manufacturers with knowledge of molding equipment. He needed operations capability, administrative processes for health benefits and hiring, transportation services, and retail and wholesale outlets. Yet within eight years he had built a virtual corporation before “virtual” or “network” organizations were recognized as legitimate forms for business. He defied conventional wisdom on materials design and sold high-performance, aesthetically attractive, 100 percent recycled and recyclable recreational kayaks through nationally known retailer chains. In addition, he sold his company at an undisclosed price, gave himself time off to build a vacation home with his wife and three sons, then took on a new corporate sustainability challenge with a small, growing company. How did he do it? It was important that he didn’t accept the notion that his vision could not be realized. He formed his VAN of like-minded others and together they made it real.

What else can we learn from this case? Farrow questioned the conventional business wisdom—a common practice among entrepreneurial individuals. Their commitment to the unproven premise can be intense, and they may seem as though they *will* vision into action and results. However, implementation needs and invites collaborators.

Another lesson from the Walden Paddlers’ example is that it took patience to allow solutions to emerge and evolve from the network participants’ contributions. All participants had to be open to learning and finding the right “partners” willing to go outside their comfort and expertise zones to invest time and resources in a new idea. Don’t be surprised if it takes time to find willing partners. There are too many strong influences at work that cause people and firms to be insular.

Finally, you don’t need extensive resources, just enough to get to the next step. At every stage, the VAN became more closely aligned, tapping into its growing collective wisdom, imagination, and resources. The most underrated resource for breakthrough ideas might be the network of people you already know inside your firm or the network you can build outside through your company’s supplier and customer relationships.

Creativity and imagination drawn from people who initially may be considered outsiders can be pivotal to a company’s success. These individuals and their institutions can come to have a strong stake in the outcome, and they have the knowledge to generate paths forward that otherwise would remain latent. In Paul Farrow’s case, there were no vertically integrated functions; he was building from the ground up. Within an established firm, some functional activities in the VAN are typically incorporated into the formal boundaries of the organization (e.g., design,

product development, manufacturing, marketing, sales). Others lie outside with suppliers and buyers or other key allies. Implementation requires you to ignore conventional corporate boundaries and view the VAN as a lateral web of information and material flows through which ideas and resources can be mobilized. There is no reason not to tap into this potential power.

United Technologies Corporation

United Technologies Corporation (UTC), despite its large size and dominance in mature markets with mature products, remains remarkably innovative, including its leadership in sustainability strategy. In the 1990s, UTC CEO George David announced the company's goal of reducing its environmental footprint by a factor of ten. Explicitly committed to sustainability from the top, UTC was ahead of its time for an aerospace and building products and services firm. Management has since driven resource use efficiency programs through the business units and transitioned into new product designs that provide the power and performance people want for vehicles and operations while delivering on sustainability's positive health, ecological, and overall natural system robustness agenda.

Its disciplined process of bringing innovative ideas to market explains UTC's success over the years. The keys to UTC's success were highly motivated VANs formed across business units and with outside customers and supply-chain participants that drove the new ideas to successful commercialization. These VANs are at the leading edge of solving problems with technology and market receptivity and are characterized by creative and innovative participants who bring extra dedication to sustainability ideas.

The company's alternative power products business unit, UTC Power, faced a challenge, however. UTC's goal for that unit was to shift the market paradigm for power generation in stationary applications and transportation. The issues for large power consumers are straightforward. Customers want energy efficiency and reliability, lower bills, and protection from grid outages. They need system *resiliency* to assure ongoing operations and customer satisfaction in case of weather or other disruptions. For example, supermarket chains, hotels, and hospitals experienced the impact of Hurricane Katrina and the human and financial losses when their doors had to be closed.

UTC Power has a portfolio of solutions that offers power generation solutions in a variety of new technology combinations. However, when you are working with new products and new markets, a paradigm shift requires extraordinary effort. In UTC Power's case, you see examples that build on the company's competencies in technology innovation and management of massive supply chains to form VANs

with more creativity than the norm. Jan van Dokkum, president of the UTC Power business, described the unique VAN situation as follows: “We carefully analyze the market for opportunities to improve emissions and efficiency. We then work closely with UTRC [UTC Research Center], buy standard, volume-produced equipment, optimize the system, and, finally, work with the customer to deliver high levels of service.” Jan van Dokkum, phone interview with author, June 21, 2001.

UTC’s PureComfort heating and cooling energy system is a good example. The PureComfort system offers the customer three features in one: electrical power, heating, and cooling. The system operates either off the electrical grid or connected to it and thus can serve as a cheaper and more reliable ongoing operating power source, even when the grid goes out. Highly motivated existing VANs at UTC drive conventional products and markets effectively, but for a new product and new markets plus a sustainability focused change, there are extra drivers, particularly once the product goes to market. The PureComfort system project began under the leadership of the corporate UTRC, working with autonomous business units Carrier and UTC Power. The group brainstormed combining their expertise to produce new products for new markets. They looked for ways to improve building system efficiencies by using the “waste” from power generating equipment (e.g., microturbines or reciprocating engines) as a “fuel” for heating and cooling equipment. They collected the hot exhaust from the supplier-produced microturbines and ran it to a Carrier double-effect absorption chiller, which produces hot and cool water. They found the flow rate temperature ideal to generate cold or hot water, thus creating three-in-one equipment producing on-site electricity, hot water, and cold water for refrigeration.

The A&P supermarket chain installed a PureComfort system in its store in Mount Kisco, New York. A&P chose the highly efficient heating, cooling, and power system because it leads to energy savings and ultimately reduces the store’s dependence on the grid. The new rooftop unit uses underground-supplied natural gas to generate electricity for the store. Then it generates cold water, runs it to refrigerator “chillers,” and provides heat when needed. The UTC PureComfort unit produces combined power, heating, and cooling at greater than 80 percent efficiency rates compared to approximately 33 percent from the electric grid. Distance monitoring by UTC Power means the company’s service people will be at the A&P store to fix a problem before the people at A&P even realize one exists.

Meeting customers’ multiple cooling, heating, and power needs with an innovative integrated, reliable on-site system solution at a cost reduction from existing options addressed UTC Power’s strategic goals to deliver new products and new revenues. At the same time these offerings provided very low emissions, reduced customers’ energy costs, lowered grid dependence, and assured standby power supply. While it would not have necessarily called its strategy “green,” and its sales force is not

necessarily hearing the term “sustainability” from its customers, UTC Power nonetheless has incorporated the core ideas into its strategy. These products provide safer, cleaner, and more reliable power sources than the alternatives available, at commensurate prices that are less expensive when full costs are considered.

However, the issue was not whether the PureComfort system met buyer needs or satisfied sustainability requirements; it did. The challenge was whether customers’ standard way of meeting power needs—paying for electricity from the grid—could change to a solution that required new purchase practices and economic calculations as well as different impacts on the company’s profit and loss statement and balance sheets.

Breakthroughs happen when VAN teams can tap into an intangible creativity source in sustainability agendas: the energy, the extra little bit of horsepower, or a passion for the technology and market changes. UTC Power experienced this type of breakthrough in its work with the city of London and the Ritz Carlton hotel chain in San Francisco. In each situation the VAN participants were well known for being creative, innovative, and willing to spend extra time to find solutions. New competitive space and successful positioning in that space were realized by firms working with other firms also positioned in the same market frontier.

The catalyst for this creativity is the process dynamics of UTC Power’s technology design to achieve clean, safe, reasonably priced products combined with supply-chain partners that want to save money and assure performance but also have an absolute commitment to creating sustainability solutions through redesign of products and procedures. This means there is more continuity and commitment in teams because participants are passionate about seeing their ideas come to fruition. VAN participants will go the extra distance. When innovators talk with other innovators about how to implement sustainability innovations, results are achieved.

UTC Power uses its internal, highly disciplined product development process and committed working relationships with buyers and original equipment manufacturers to accelerate learning and feedback and to improve its power products. UTC also employs an innovation effort, working with the business units that have identified UTC technologies for new, market-ready products and markets. The PureComfort system process started with a small, multidivisional group looking at opportunities at the intersection of power, heating, and cooling.

Brainstorming engineers, who did not usually work together, found the intersection of power, heating, and cooling rife with possibilities and developed a second

product, known as the PureCycle 200 system. Together they altered standard Carrier industrial cooling equipment by converting it to run “backward”; instead of using electricity to produce cooling, the system uses waste heat to produce electricity. The system uses field-tested Carrier technology to provide turnkey, zero-emission, reliable, low-cost electricity from various industrial heat sources. The electricity can be used on-site where it is produced or sold to the electric utility grid. Customers can potentially make money by offsetting traditional fossil fuel electricity generation. The payback and savings depend on the geographic location in the United States and the price of the displaced energy.

It is not necessarily easy building new types of supply-chain relationships to implement sustainability innovations. In UTC Power’s case, cross-business unit sales and service provisions had to be tightly coordinated, and getting electric utilities to buy excess power from buyers has been an uphill battle. Even with these challenges, a major obstacle is in developing trust with the end users, specifically the facility leader who makes the purchase decision and who is paid to be conservative. It is a tough sell because the system (though not the components) is new. It is mechanical and therefore may need servicing. Facility managers fear the unit will fail, and they have to be educated about the system, which takes time. Finally, having the system installed may seem “inconvenient,” as it can disrupt current operations during the switch.

Thus the value proposition has to be communicated effectively. UTC Power has developed economic models that show payback time frames for equipment installed in different geographic locations according to size of facility, electricity rates based on different fuel sources, and seasonal demand. In addition, a turnkey service contract is offered that monitors units from UTC centers in Charlotte or Hartford where operators have the technological ability to locate errors. As UTC Power continued to refine its extensive supply-chain coordination, more new opportunities for innovation emerged.

Fuel price volatility, changing and more violent weather patterns, deregulation, supply interruptions, and rolling blackouts and brownouts in the Northeast and California have generated considerable interest in distributed (nongrid, noncentralized), on-site, clean and reliable electricity, heat, and cooling power sources. To capture this interest while overcoming the natural resistance of cautious buyers is still a challenge. UTC Power and UTC are addressing this challenge by creating an “all in service” solution. Through a long-term contract, a customer avoids the up-front cash cost and spreads it over time, thereby better matching the cost with the energy savings.

Another value proposition involves public health. An important sign of change that should be noted by all managers is occurring in UTC Power's urban bus transportation markets. Buyers such as the city of London and AC Transit in Oakland, California, are building previously externalized health costs into their purchase decisions. A regional public transit authority, AC Transit considers the cost of respiratory and other air-pollution-related illness resulting from diesel gasoline combustion, particularly from buses. Incorporating more of the full system costs into the equation shifts the price-performance calculation for conventional bus drivetrains compared with fuel cell systems. The price of the latter looks more attractive when adjusted downward by health cost savings due to reduced particulate matter and other air pollutants from transportation.

Through product take-back, UTC Power is getting a handle on design for disassembly. The company's team must determine what parts are recoverable and recyclable and the economics of remanufacturing the leased units brought back for repair or at the end of their useful life. Extending this concept to field-installed stationary fuel cell power units, UTC Power found that the reverse logistics and reuse/recycling of materials and parts could actually make money. The notion of leasing transportation or stationary power plant fuel cell stacks has engaged UTC Power even more closely with its suppliers and buyers along the value chain to source recyclable materials and components. Successful supply-chain coordination within the company and outside is important to the success of any leasing solution and to the systems redesign for disassembly and recyclability.

Because new ideas that challenge existing ways of operating require early adopters, innovators initially tend to work with and sell to other innovators. UTC Power is building new markets through cooperation with forward-thinking internal UTC executives and staff in other business units, and combining that synergy with eager corporate buyers trying to solve urgent problems (e.g., harsh storms in tropical geographies, zero-downtime requirements for electrical power) or open-minded municipalities searching for creative cost-cutting measures.

Conclusion

As we noted at the outset of this section, VANs are necessary to implement sustainability strategies. VANs provide the horsepower to implement projects. They are the means to translate vision into competitive products or services. Whatever your business is, catalyzing VANs is essential to put your nascent strategy into action. The following are strategies for working with VANs:

- Start with a compelling vision.

- Don't take "no" for an answer; find people whose values align with yours.
- Work with innovators in other fields.

Since by definition you will be forging a new path, you will hear "no" a lot. Don't stop there: seek out those who understand the bigger vision and are inspired by the prospect of inventing the way forward with you. Source participants from your existing suppliers or find new ones inspired by your green strategic vision and the multiple gains, including financial, that would come to participating organizations that develop new capacities. Collaborate closely with other innovators in other functions or fields. Since differentiation is a moving target, call upon your VANs to help you continuously redesign and improve, moving individual participants in and out of the constellation of skill sets and leadership attributes you need. Implementing strategy requires new approaches to your existing relationships, tapping into the latent creativity that is there.

KEY TAKEAWAYS

- Innovation is carried out by teams working collaboratively.
- Create teams that foster creativity by including individuals who are open to change.

EXERCISE

1. Working with a partner, imagine a new product or process you want to create. Identify who would want it as well as what VANs and weak ties could help you implement it. How could they help? What would be the benefit for them?

4.6 Radical Incrementalism

LEARNING OBJECTIVES

1. Examine the role of incremental steps in innovation.
2. Understand how systems changes can result from combining small steps.

Some companies enter the market with a mission of challenging existing products with sustainable replacements. Their strategy is radical from the start. Others, typically larger established firms, gain momentum in sustainability innovation by building upon incremental improvements in products and systems. Business analysis often juxtaposes incremental change with radical or dramatic change; a common assumption is that the two are mutually exclusive. Moreover, literature in the sustainability field privileges the latter over the former, dismissing incremental change as timid at best and “greenwash” at worst—accusations that may indeed hold true at times. Separating the two concepts, incremental and radical, can be useful for heuristic purposes. Perhaps doing so is also psychologically satisfying; it’s either this or it’s that.

In real life, however, people in business make a series of small steps over time that add up to larger, more profound change. Sometimes early successes build momentum for bigger changes that previously were viewed as too radical or risky. Alternatively, incremental successes can build courage and internal support, stimulating requisite imagination and energy to design more radical and innovative changes. By consciously pursuing incremental changes with a radical ultimate goal and tracking progress, one can catalyze significant innovation and ultimately differentiate the firm.

Radical incrementalism⁷ involves small, carefully selected steps that result in learning that in turn reveals new opportunities. It means taking marginal, integrated progress toward more ambitious sustainability goals. Ideally, your whole company would participate in discussing and defining ideal characteristics of this goal, track milestones along the way, observe lessons, and feed this data back into the definition of the goal and the next steps forward.

7. Small steps that accumulate and inform participants and consequently stimulate more dramatic changes (often at a systems level) over time.

Others have used the term *radical incrementalism* to describe a deliberate strategy for business operations (particularly in information technology) in which a series of small changes are enacted one after the other, resulting in radical cumulative

changes in infrastructure. Our use of the concept differs in that while company strategists should have a vision of what sustainability means for their company, the incremental steps to get there necessarily shape the course. In other words, the feedback you get along the way will accelerate, alter, and inform your next actions. This is iterative and adaptive learning—one gains knowledge along the way that affects future decisions. The companies we examine here demonstrate this strategy.

Corporate adoption of green and sustainability strategies is gaining global momentum. Its implications are radical for firms, supply chains, and consumers because it represents a significant challenge to conventional ways of doing business. We present leaders here because they offer us a window to the future. In this section and the discussion of adaptive collaboration through value-added networks (VANs) in [Chapter 4 "Entrepreneurship and Sustainability Innovation Analysis", Section 4.5 "Adaptive Collaboration through Value-Added Networks"](#), we discuss the means to implement sustainability innovation. The result, for those companies that successfully pursue it, is new market space shaped to the lead firm's advantage. However, just as the journey of one thousand miles begins with a single step, so does the radical shift toward sustainability involve incremental changes.

Kaiser Permanente

Kaiser Permanente (KP) deliberately adopted a radically incremental approach to implementing its strategy. The company has a sustainability perspective on its corporate purpose (health care) that widens the meaning of "health care" to include not only medical treatment but the broader community health impacts of its facilities and operations and the materials it sources. We examine here one relatively small decision in KP's broader strategy: the company's decisions on the use of polyvinyl chloride (PVC), a material of increasing environmental concern. Specifically, we will look at KP's choices regarding flooring. KP measured everything it did to build the business case for greening each incremental step and discovered there were significant economic benefits to be gained by seemingly small changes. Moreover, these incremental decisions have had radical impacts on the company's success and have facilitated moving forward on other sustainability fronts. This discussion puts KP's incremental step on flooring in the wider context of green buildings as an important arena for companies to measure the collective impact of seemingly small decisions. We present the business case for greener buildings and the economic and environmental benefits that they generate for companies as an integral part of their strategy. Next, we will discuss SC Johnson's award-winning product sustainability assessment tool, Greenlist. As SC Johnson (SCJ) evolved its efforts to incorporate sustainability into its corporate strategy, it constructed a powerful tool to measure the range of environmental impacts of chemical inputs into its products. As a result, the company has significantly altered its environmental footprint, improved product performance, and achieved

significant cost savings. Moreover, this tool has had broader catalytic effects on SCJ's supply chain and competitors. By patenting Greenlist, SCJ hopes to widen the circle even more.

Both of our company examples, KP and SCJ, illustrate the following three radically incremental tactics:

1. Set big goals but take moderate, integrated steps.
2. Measure everything—build your business case.
3. Incorporate knowledge gained back into new product and process design.

Both KP and SCJ illustrate the tactics we advocate: set big goals but take moderate, integrated steps to get there. Both companies have religiously monitored and measured their progress to build the business case for the next ambitious step. Now both are grappling with incorporating the knowledge gained from their earlier successes into future product designs, process designs, or both.

KP is the largest health management organization in the United States, with 8.2 million members and over 500 hospitals and medical buildings under management. KP's Green Building Committee first met in 2001 to determine priority projects it would take on. Seated at the table were representatives from interior design firms, construction companies, health nongovernmental organizations (NGOs), and architects, along with KP's national environment health and safety people (labor joined later). KP's interest focused on identifying an area where the firm could move relatively quickly to eliminate a problematic chemical and thereby make a demonstrable difference for human and community health and ecological well-being. The group made the decision to investigate PVC-free flooring. Given growing research on PVC's toxicity to humans throughout its life cycle, this choice met the groups' selection criteria. It was a radically incremental step.

KP does not move precipitously. Prudent spending and sound financial performance enable KP to deliver quality care, convenience, and access and affordability. KP is also dedicated to individual and community health and is science-driven and acutely sensitive to lowering the costs of health care. In this last respect, there is no choice in the health care industry; new drugs and procedures, health care worker shortages, provider consolidation, aging populations, and the rise of chronic health conditions across population segments continually drive costs up. Careful consideration of costs therefore must be part of the equation for procurement and strategic change. Strong core values, however, including resource stewardship and leadership in improving the quality of life of the communities in which it operates, were taken seriously by senior management.

John Kouletsis, director of strategic planning and design, called the organization “fearlessly incremental” in its strategic approach. Though it takes on big issues, the company is meticulous in accumulating quantitative and qualitative evidence to support decisions, especially major changes in purchasing. Company leadership is akin to the old political notion of statesmanship. The belief that what is good for the environment and the community is good for the health maintenance organization (HMO) members and therefore good for KP’s financial success guides strategy. KP employs a systems view of health care, incorporating environmental and community aspects, and this wider perspective on health informs the company’s green strategic decisions.

Jan Stensland was half of the duo in strategic sourcing and technology for KP. Her friendly, easy-going exterior belied intensity, intelligence, and absolute dedication to achieving the multidimensional objectives of her job. She conversed equally comfortably about material costs per square foot, parts per million contaminants, construction specifications, human health, and PVC exposure research. She also tracked internal rates of return for new decisions—for example, alternative flooring technology projects under consideration to renovate dozens of medical buildings throughout California, ten states, and Washington, DC, where thousands of patients and staff would spend time over the next several decades. While health is in the forefront of her mind, her proposals must show how the company will save money or get better spaces for the same cost. The national health care crisis of escalating costs is the elephant in her office, and she stares it down with an optimizing strategy across financial, community, health, and environmental objectives.

Stensland’s team sought ways to influence KP’s suppliers’ research and development (R&D) shops to redesign products so that health care facilities would be more effective measured in terms of patient treatment, disease prevention, and costs. Thus business effectiveness is viewed in a larger social context. Stensland thinks in terms of today and fifteen years out in talks with suppliers, working through negotiations to maximize health benefits and minimize costs for multiple stakeholders.

For example, 16 percent of KP’s 8.2 million person membership suffers from asthma. The rate of children’s asthma recently has risen to an epidemic level of 27 to 30 percent in some counties in California. Chronic respiratory and immune systems problems increasingly have been linked to low exposures to different chemical compounds. There are considerable health impacts and significant monies at stake; therefore, suppliers bid with particular attention to KP’s interests. Moreover, the health care industry often follows KP’s lead. When KP was first among HMOs to move away from PVC gloves due to escalating allergic reactions and their associated costs, the industry followed, opening up opportunities for firms able to provide substitutes. However, that was only KP’s first effort involving PVC.

PVC

KP's decision in early 1999 to begin to phase out the use of PVC was commendable but controversial. PVC is ubiquitous; it is used to make many everyday materials and is a key component of medical products such as IV bags and tubing. There is also growing evidence that it is a substance of concern. According to the Healthy Building Network, dioxin (the most potent carcinogen known), ethylene dichloride, hydrochloric acid, and vinyl chloride are unavoidably created in the production of PVC and can cause severe health problems, including cancer and birth defects.

Kathy Gerwig, director of environmental stewardship at KP, views the firm taking a precautionary approach, meaning that where there is credible evidence that a material it is using may result in health and environmental harm, it should strive to replace that material with safer alternatives. As a senior manager, Gerwig is convinced there is enough evidence about the hazards of vinyl that the responsible course of action for a health care organization is to replace it with healthier commercially available alternatives that are equal or superior in performance, especially in the design and construction of their buildings.

Stensland described the company's efforts on non-PVC flooring as an ongoing effort—one piece of a larger puzzle with short-term wins and long-term goals. Thinking this intently about materials takes time but yields good results. The subcommittee assigned to investigate whether substitutes were available for PVC flooring found the inexpensive per-square-foot price of vinyl did not reflect true life-cycle, health, and environmental costs. PVC flooring was discovered to carry high maintenance costs not previously considered because they were not included in the first-cost price of the flooring. True costs are often disguised when budgets are divided between purchasing for new construction or renovation, and ongoing operations once the flooring is installed.

KP conducted pilot projects in several of its medical office buildings and hospitals, administering tests and comparing maintenance budgets in vinyl and nonvinyl flooring buildings, and interviewed the people who cleaned the floors in those facilities. These investigations revealed that up to 80 percent of flooring maintenance costs could be eliminated with the use of a rubber flooring product (Nora, from Freudenberg Building Systems) and another non-PVC flooring product, Stratica, an ecopolymeric product. The rubber and non-PVC vinyl flooring products

were more stain and slip resistant and had improved acoustic properties. But that was not the end of the story.

Qualitative issues related to flooring often translated into significant ongoing expenses. “Slips, trips, and falls” are major problems in buildings and an early indicator of problems with flooring. Accidents require expensive settlements awarded to employees and visitors to buildings. Stensland analyzed the square footage costs across buildings and examined data for two years running. The company’s new attention to the nature of, and differences across, various flooring materials uncovered two KP locations where rubber flooring was installed and for which data showed *zero* slips, trips, and falls. Furthermore, data from nurses revealed the harder vinyl floors generated more complaints and work absences by nurses who are on their feet all day. Non-PVC rubber flooring improved conditions for nurses and accomplished the environmental and health strategic goals. Analyses were conducted at multiple facilities. The magnitude of the flooring issue was significant for the company and its contract suppliers; in 2005, the company managed sixty-four million square feet of flooring. By 2015, it expects to have eighty-four million square feet under management.

However, that doesn’t solve the problem of flooring replacement in existing facilities. With regularly scheduled replacement of flooring in the more than five hundred medical buildings in the system, could PVC be eliminated there as well in a variety of areas? KP turned to the Collins and Aikman Corporation (C&A), its carpet supplier, and required that C&A develop a non-PVC carpet backing (the underlayer of carpeting contained most of the materials of concern), preferably at the same price. The manufacturer brought the new offering back to KP six months ahead of schedule. An equivalently priced new carpet backing whose performance exceeded the PVC-backed carpet was now available not just for KP but for all the manufacturer’s customers. The new material used postconsumer recycled polyvinyl buterol, the film used on safety glass for windshields that protects car passengers from broken glass in accidents. An enterprising engineer had discovered he could use the discarded sticky “waste” compound found at recyclers and brought it back into the materials stream for new applications.

By asking suppliers for alternative, safer products, KP—due to its size—has been driving the market toward products that reduce resource use and improve health conditions by eliminating chemical hazards and lowering maintenance expenses. Incremental steps are taken toward sustainability goals, pulling markets and supply chains along in what ultimately constitutes radical change: the substitution of a new, better product design for the old.

There are other examples. Refrigerants used in medical facility chiller systems have had the same problems as refrigerants in general use. When contracts for refrigerants came up for reconsideration, KP put bidders on notice that any problematic chemical in use or being phased out by 2008 could not be used in chillers. York Incorporated, an award-winning firm for its product efficiency and advanced technical designs, won the bid, producing new chillers with benign refrigerants in a unit that was 25 percent more energy efficient than the market standard. Thousands of chillers across hundreds of medical office buildings and hospitals now drive substitution of a radically more effective system for the existing products.

There are other examples of KP's radically incremental approach. One of the companies selected to provide KP's elevators produced a super energy-efficient design that addresses KP's goal for more energy-efficient equipment, helping drive and justify that supplier's improvements to its product design. Another elevator company had switched from petrochemical-based hydraulic fluids to soy-based fluids and was investigating more sustainable elevator car finish materials. In 2006 KP was talking with furniture and textile manufacturers to provide non-PVC upholstery. By 2005, KP was leading an effort to bring locally grown organic food into its hospitals, supporting local organic markets and working with food service suppliers like Sysco together with local growers to reduce fuel consumption in distribution. The goal is delivery of "clean" foods without chemical additives at reasonable cost to members and patients. The slow food movement, a grassroots and rapidly spreading effort to improve the quality of food through organic practices and limited radius distribution from the growing site, gains momentum when a company the size of KP focuses on locally grown organic produce. The head of Slow Food USA's office, and founder of Slow Food International, Carlo Petrini views the organic and local food movements that have reinvigorated farmers' markets and microbreweries across the United States as representative of a new dialogue emerging between traditional knowledge and advancing science knowledge that is creating a new business reality and a different model of business.

KP's incremental steps to upgrade facilities add up to radical change. KP has put sustainable building design and construction practices into all new construction and "rebuilds" (KP renovations) through facility templates. These practices incorporate the following:

- Implementing efficient water and energy systems
- Using the least toxic building materials
- Recycling demolition debris, diverting thousands of tons of materials from landfills
- Making use of daylight whenever possible
- Managing storm water to enhance surrounding habitats

- Reducing site development area (e.g., total gross square footage) to concentrate and limit total paving and other site disturbances
- Installing over fifty acres of reflective roofing
- Publishing an Eco Toolkit reference book and providing it to KP capital project team members and more than 50 architects and design alliance partners

KP also incorporates health and ecosystem considerations into national contracts. These considerations include the following:

- Reducing the toxicity and volume of waste
- Increasing postconsumer recycled content
- Selecting reusable and durable products
- Eliminating mercury content
- Selecting products free from PVC and di-2-ethylhexyl phthalate (DEHP)

Successful changes include replacing three DEHP-containing medical products in the neonatal intensive care units with alternatives, ensuring the continued elimination of mercury-containing medical equipment from standards, and negotiating a national recycling contract. KP's purchasing standards include 30 percent postconsumer content office paper and mercury-free and latex-free products.

In addition, KP facilities often partner with local community organizations to implement community initiatives. One example is a mercury thermometer exchange at Kaiser Permanente Riverside (CA) Medical Center. A total of 540 pounds of material were collected from 3,000 mercury thermometers. Over 1,200 digital thermometers were distributed. "Kaiser Permanente's accomplishments in environmental performance are impressive and unique," said Kathy Gerwig, director of environmental stewardship. "We hope that by changing our practices, we can drive change throughout the health care industry." GreenBiz Staff, "Kaiser Permanente Turns Green," *GreenBiz*, April 22, 2003, accessed January 7, 2011, <http://www.greenbiz.com/news/2003/04/22/kaiser-permanente-turns-green>.

KP's metrics demonstrating the benefits of its sustainability efforts include the following:

- In 2003, KP diverted 8,000 tons of solid waste from landfills.
- In 2003, KP reused or safely redeployed more than 40,000 pieces of electronic equipment, weighing 410 tons and containing 10,500 pounds of lead.

- KP eliminated 27,000 grams of mercury from KP health care operations by phasing out mercury-containing blood pressure devices, thermometers, and gastrointestinal equipment.
- KP phased out one hundred tons of single-use devices in 2003.

The impact of energy conservation measures at KP prevented the creation of more than seventy million pounds of air pollutants annually. The aggregate impact of pollution prevention activities eliminated the purchase and disposal of forty tons of hazardous chemicals. Other activities reported by the company in 2005 are as follows:

- Waste minimization resulting in the recycling of nine million pounds of solid waste
- Electronic equipment disposition resulting in the recycling of 36,000 electronic devices containing 10,500 pounds of lead
- Optimal reuse of products that led to reprocessing 53,851 pounds of medical devices and supplies
- Capital equipment redistribution
- Greening janitorial cleaning products, eliminating exposure risks for employees, lowering costs, gaining system efficiencies, and improving performance
- Recycling and reuse of 8,300 gallons of solvents
- Energy conservation resulting in the recycling of 30,000 spent fluorescent lamps

In conclusion, KP provides a compelling example of the immediate gains to be had through pursuing sustainability practices in radically incremental steps. KP's senior management team works from the premise that human health and environmental health are the same thing. As an institution engaged with human health, it makes sense for KP to be active in resolving a paradox facing the health care industry: that hazardous chemicals used in medical products and buildings have harmful effects on patients and employees. It makes sense to coordinate purchasing across member medical centers and hospitals to ensure improved health conditions for members and the communities in which they live. The opportunities are vast for KP. That means the hundreds of suppliers that provide technical and routine needs for the company and the more than two thousand minor and major construction projects under way at any one time also can take advantage of new sustainability-inspired market space opportunities. The question is which ones will step up to the challenge and follow KP into the next generation of "good business"?

Radical incrementalism means taking small, carefully selected steps that result in learning that in turn reveals new opportunities. In this case a seemingly small

decision on a seemingly innocuous issue—flooring—resulted in larger systemic changes across the company and its supply chains, even sending an urgent signal to the flooring industry. By greening its flooring, KP is improving health by eliminating a questionable material, improving working conditions and health for nurses, and reducing costs by bringing employee absences down and lowering accident liability costs. Putting the pieces together took time; KP staff members measured each step and outcome to evaluate the effects on cost and performance. Moreover, the results are driving bigger goals. Three years from the start-up of the project, KP made a new-construction standards change: no PVC vinyl flooring would be used in any future facilities. If we take into account all the other incremental changes KP is making, the systemic and company benefits are profound. KP's radically incremental steps are part of its strategy to better support community health while it grows its operations.

We turn next to sustainability ideas applied to facilities. Buildings are not just where your business activities happen. Your facilities—and the decisions you make about resources, energy, materials, and so forth—are a significant investment and can either add to or subtract from your bottom line. They can also add to or subtract from your overall strategy. Buildings and their operating systems are an excellent area in which you can realize the benefits of radically incremental steps.

Among the many industries developing innovative strategies to increase profits and address environmental and related community quality of life concerns, the building sector presents some of the most accessible incremental opportunities that can aggregate into radical returns. Compared to standard buildings, “green” buildings can provide greater economic and social benefits over the life of the structures, reduce or eliminate adverse human health effects, and even contribute to improved air and water quality. Opportunities for reducing both costs and natural system impacts include low-disturbance land use techniques, improved lighting design, high-performance water fixtures, careful materials selection, energy-efficient appliances and heating and cooling systems, and on-site water treatment and recycling. Less familiar innovations include natural ventilation and cooling without fans and air conditioners; vegetative roofing systems that cool buildings, provide wildlife habitat, and reduce storm water runoff; and constructed wetlands that help preserve water quality while reducing water treatment costs.

The building industry and growing numbers of private companies are responding to these opportunities. Valuable economic benefits are being realized in improved employee health and productivity, lower costs, and enhanced community quality of life. Since 2000, adoption of green design and construction techniques has been greatly aided and accelerated by the Leadership in Energy and Environmental Design (LEED) rating system.

LEED is a voluntary green building rating system established by architects, interior designers, and the construction industry through a consensual process during the 1990s. The US Green Building Council (USGBC), a voluntary membership coalition, developed and continues to review the LEED standards. LEED guides building owners, architects, and construction firms to use industry standards and advances in those standards for environmental and health performance across a wide range of building criteria including site design, building materials selection, and energy systems. While each modification and upgrade to the building and site may seem small unto itself, the changes combine to create a dramatically more efficient building system with far lower operating costs and more satisfied owners over the life of the structure. While there is valid criticism about some of the specifications within LEED and its impact on innovation in the materials industry, overall the system has helped green the building industry. The Healthy Building Network criticizes the USGBC and LEED for continuing to include PVC in green building specifications. Others have criticized the LEED process for inhibiting innovation because it freezes the specific definition of “green” in a moment in time. This can mean that unforeseen, even greener, innovations will be left out of the criteria.

Green buildings perform the same functions and serve the same purposes as conventional buildings but with a smaller ecological footprint. They employ optimized and often innovative design features to reduce natural systems impacts throughout a building’s life cycle and all across the supply chain of materials, components, and operations.

Green buildings provide a range of benefits to stakeholders, from developers and owners to occupants and communities. Structural, mechanical, and landscape design elements can maintain comfort and indoor air quality, conserve resources, and minimize use of toxic materials while reducing pollution and damage to local ecosystems. A broad range of green design techniques, technologies, and operational strategies are available to building architects, engineers, and owners. Every building is different, and there is no single green design formula. However, there are common design objectives and classes of benefits. The potential benefits of green building practices include the following:

- Less disruption of local ecosystems and habitats
- Resource conservation
- Decreased air, water, and noise pollution
- Superior indoor air quality
- Fewer transportation impacts

While they may entail higher up-front costs (but not necessarily) Lisa Fay Matthiessen and Peter Morris, “Costing Green: A Comprehensive Cost Database and

Budgeting Methodology,” US Green Building Council, July 2004, accessed January 10, 2011, http://www.usgbc.org/Docs/Resources/Cost_of_Green_Full.pdf.), in the long term, green buildings can make up the shortfall. Careful design choices for particular locations can reduce that difference to zero. Some of the economic benefits they generate include the following:

- **Lower capital costs.** With careful design, measures such as passive solar heating, natural ventilation, structural materials and design improvements, and energy and water efficiency can reduce the size and cost of heating and cooling systems and other infrastructure. A new bank in Boise, Idaho, was able to take advantage of such considerations to go from an initially planned LEED Silver to an actual LEED Platinum with no added cost. US Green Building Council, “Banner Bank Building: Green Is Color of Money,” 2006, available from the project profiles at <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1721>.
- **Lower operations and maintenance (O&M) costs.** On average, lower energy and water consumption reduces energy demand 25–45 percent per square foot for LEED buildings versus conventional buildings. Cathy Turner and Mark Frankel (New Buildings Institute), *Energy Performance of LEED for New Construction Buildings* (Washington DC: US Green Building Council, 2008), accessed January 31, 2011, <http://www.usgbc.org/ShowFile.aspx?DocumentID=3930>; Greg Kats, *Greening Our Built World: Costs, Benefits, and Strategies* (Washington, DC: Island Press, 2009). The US Environmental Protection Agency (EPA) reported that office buildings that meet the energy efficiency requirements of the Energy Star program use 40–50 percent less energy than other buildings. Energy Star is familiar to many people for rating the energy efficiency of appliances, but a separate Energy Star certification system also exists for entire buildings. For the comparison, see EPA, *Energy Star and Other Climate Protection Programs 2007 Annual*, October 2008, accessed January 11, 2011, http://www.energystar.gov/ia/news/downloads/annual_report_2007.pdf.
- **Increased market value.** Green buildings can increase market value through reduced operating costs, higher lease premiums, competitive features in tight markets, and increased residential resale value. For instance, a 2008 study of Energy Star and LEED-certified office buildings versus conventional ones found that the green office buildings had higher occupancy rates and could charge slightly higher rents, making the market value of a green building typically \$5 million greater than its conventional equivalent. Piet Eichholtz, Nils Kok, and John M. Quigley, “Doing Well by Doing Good? Green Office Buildings” (Program on Housing and Urban Policy Working Paper No. W08-001,

Institute of Business and Economic Research, Fisher Center for Real Estate & Urban Economics, University of California, Berkeley, 2008), accessed January 28, 2011, http://www.jetsongreen.com/files/doing_well_by_doing_good_green_office_buildings.pdf.

- **Less risk and liability.** Using best practices yields more predictable results, and healthier indoor environments reduce health hazards. Some insurers offer discounts for certified green buildings, and others offer to pay to rebuild to green standards after damage. For instance, Fireman's Fund Insurance Company, "Insurers Offer Rewards for Going Green," 2010, accessed January 11, 2011, <http://www.firemansfund.com/about-fireman-s-fund/our-commitments/about-our-green-insurance/Pages/insurers-offer-rewards-for-going-green.aspx>; or Zurich in North America, "Green Buildings Insurance Article," 2010, accessed January 11, 2011, <http://www.zurichna.com/zna/realestate/greenbuildingsinsurancearticle.htm>.
- **Increased employee productivity.** Green buildings increase occupant productivity due to better lighting and more comfortable, quiet, and healthy work environments. This improvement can be at least equal to buildings' lifetime capital and O&M costs and is the largest potential economic benefit of green buildings. For example, a survey of employees at two companies that moved from conventional buildings into LEED-certified ones found the new buildings added on average about 40 hours per year per employee in increased productivity. Amanjeet Singh, et al., "Effects of Green Buildings on Employee Health and Productivity," *American Journal of Public Health* 100, no. 9 (2010): 1665–68. Nationwide, the value of improved office worker productivity from indoor environmental improvements is estimated to be in the range of \$20–160 billion. William J. Fisk, "Health and Productivity Gains from Better Indoor Environments and Their Relationship with Building Energy Efficiency," *Annual Review of Energy and the Environment* 25 (2000): 537–66.
- **Reduced absenteeism.** Lawrence Berkeley National Laboratory calculates that improvements to indoor environments could reduce health care cost and work losses by 9 percent to 20 percent from communicable respiratory diseases, 18 percent to 25 percent from reduced allergies and asthma, and 20 percent to 50 percent from other nonspecific health and discomfort effects, saving \$17–48 billion annually. William J. Fisk, "Health and Productivity Gains from Better Indoor Environments and Their Relationship with Building Energy Efficiency," *Annual Review of Energy and the Environment* 25 (2000): 537–66.

- **Market perception of quality.** Green buildings require careful design attention and the use of best practices and display superior performance.
- **Promotion of innovation.** Green buildings employ new ideas and methods that produce significant improvements.
- **Access to government incentives.** A growing number of federal, state, and local agencies require green features and offer tax credits and other incentives such as faster, less costly planning and permit approvals.

Green buildings provide a tangible means of measuring incremental steps that can aggregate into radical system-level benefits. Moreover, they are a visible area in which to demonstrate corporate sustainability strategy—the benefits derived from greening facilities and building systems add up to significant cost savings and represent a demonstrable area in which to see near-term return on investment in green technologies and operating systems.

SC Johnson

We turn next to the example of incremental changes creating system innovations at SC Johnson. By the mid-1990s, SC Johnson (SCJ) had a very respectable record on corporate environmental responsibility. In 1975, SCJ voluntarily removed ozone-threatening chlorofluorocarbon (CFC) propellants from its products worldwide. This was three years before the US government banned CFCs. In 1992, when eco-efficiency was introduced as a cost savings measure by the World Business Council for Sustainable Development (WBCSD), SCJ of the first companies to join the WBCSD. Millions of dollars of unnecessary costs were trimmed by using fewer resources far more efficiently. The company was able to eliminate over 420,000,000 pounds of waste from products and processes over the ten-year period prior to 2004, resulting in cost savings of more than \$35 million.

In addition, the company built a landfill gas-powered turbine cogeneration energy plant that delivers 6.4 megawatts of electricity and some 40,000 pounds per hour of steam for SCJ's Waxdale manufacturing facility in Wisconsin. This energy project enabled SCJ to halve its use of coal-generated utility electricity and thereby cut its carbon emissions.

SCJ is a 120-year-old family-owned (sixth generation) firm with explicit commitments to innovation, high-quality products, environmental concerns, and the communities in which it operates. SCJ is a consumer packaged goods (CPG) company and a "chemical formulator"—a company that chooses from a menu of chemical inputs to make its consumer products. With such well-known brands as

Pledge, Windex, and Ziploc, the company had over \$6.5 billion in sales in 2006 and sold its products in more than 110 countries.

In holding up sustainability criteria as goals, SCJ had set off on a journey in which the end destination was not entirely clear, and by the new millennium company strategists knew it was time to evaluate the systems currently in place. SCJ's earlier positive results motivated the company to look for more opportunities, so it stepped back and looked at the progress it made over a decade. Company strategists discovered that while eco-efficiency had become second nature to product design at SCJ, strategy needed to shift beyond capturing relatively easy efficiencies and move deeper. They engaged outside expertise to help develop and introduce product design tools that could be used to build preferred ingredient choices into product and packaging design. The result of this assessment was the development of a new product evaluation tool, Greenlist.

Greenlist is a tool SCJ developed to improve the quality of its products through better understanding of the health and environmental impact of material inputs. In the Greenlist database are 2,300 chemicals including surfactants, insecticides, solvents, resins, propellants, and packaging. Criteria measured include the chemicals' biodegradability, aquatic toxicity, vapor pressure, and so forth. Through Greenlist, SCJ has reduced its environmental impact while simultaneously witnessing increases in production and sales growth.

Greenlist is a patented rating system (US Patent No. 6,973,362) that classifies raw materials used in SCJ's products according to their impact on the environment and human health. Greenlist has helped SCJ phase out certain raw materials and use materials considered to be environmentally "better" and "best." The result is a process that gives SCJ scientists access to ingredient ratings for any new product or reformulation and enables them to continuously improve the environmental profile of the company's products.

The Greenlist screening process covers over 90 percent of the company's raw materials volume and is continually updated as new findings emerge. Materials are assigned a score from a high of 3 to a low of 0. An ingredient with a 3 rating is considered "best," 2 is "better," and 1 is "acceptable." Any material receiving a 0 is called a restricted use material (RUM) and requires company vice presidential approval for use. If a material is unavoidable and has a low score, the goal is to reduce and eliminate its use as soon as substitutes are available. When existing products are reformulated, the scientist must include ingredients that have ratings equal to or higher than the original formula.

While some raw materials with a 0 score are not restricted by government regulatory requirements, over the years SCJ has elected to limit their use. SCJ replaces these 0-rated materials with materials that are more biodegradable and have a better environment and health profile.

An example of Greenlist in action involves one of SCJ's glass cleaner products. In 2002 and again in 2004, SCJ assessed the formulation of Windex blue glass cleaner to reduce volatile organic compounds. The reformulations reduced health and environmental impacts while increasing the product's cleaning performance by 40 percent and growing its market share by 4 percent.

When SCJ introduced Greenlist in 2001, the company set a goal to improve its baseline Greenlist score for all raw material purchases from 1.2 to 1.41 by 2007. This goal was accomplished in early 2005. In 2001, SCJ's use of "better" and "best" materials was at 9 percent of all raw materials scored, and by 2005, this number increased to 28 percent of all raw materials scored. The company uses an annual planning process to help drive these scores, and the Greenlist results are shared in the company's annual public report. SC Johnson, "RESPONSIBILITY = SCIENCE: SC Johnson Public Report 2009," accessed March 7, 2011, http://www.scjohnson.com/Libraries/Download_Documents/2009_SC_Johnson_Public_Report.sflb.ashx.

Moreover, SCJ has eliminated all PVC packaging (a step taken to eliminate risk and liability) and, as performance results remain stable or improve, the company has moved to 10 percent of surfactants made from bio-based as opposed to oil-based materials. Each change required coordination with suppliers, which have made the more efficient or benign substitute available for other customers as demand for "clean" materials grows.

SCJ has patented Greenlist, but it has made the process licensable by other companies at no charge (although SCJ's formulations remain protected). The goal is to encourage application of Greenlist thinking and analysis across industry sectors. The company has already shared its Greenlist process with the US EPA, Environment Canada, the Chinese Environmental Protection Agency, industry associations, universities, and other corporations. Moreover, the company has been able to use insights from Greenlist to work with partner suppliers to help identify and develop ingredients that are more environmentally sustainable.

To date, "the company has been recognized with over 40 awards for corporate environmental leadership from governments and non-governmental organizations, including the World Environment Center Gold Medal, and Environment Canada's Corporate Achievement Award. SCJ received the first-ever Lifetime Atmospheric Achievement Award from the US Environmental Protection Agency." Five Winds

International, “Greening the Supply Chain at SC Johnson: A Case Study,” accessed December 3, 2010, <http://www.fivewinds.com/uploads/documents/g60tzmxo.pdf>. In 2005, SCJ announced that it had entered into a voluntary partnership with the EPA under the agency’s Design for the Environment (DfE) program. SCJ is the first major CPG company to partner with EPA on the program, which promotes innovative chemical products, technologies, and practices that benefit human health and the environment. In 2006, SCJ received the Presidential Green Chemistry Challenge Award for its Greenlist process.

SCJ has evolved its sustainability strategy from well-meant but relatively piecemeal efficiency efforts to developing an award-winning, innovative product assessment tool. The company has achieved real leadership in the world of consumer products manufacturing. Not only has the company strategically positioned itself ahead of the pack by anticipating regulatory restrictions before they happen, but it has developed enviable preferred purchaser relationships with its suppliers. SCJ has simplified its materials inputs list to fewer, greener inputs and is helping suppliers develop market leadership in supplying greener inputs. Moreover, SCJ is trying to teach the world how it does what it does—and it is doing this for free.

An area in which the company has recognized it needs to take further steps is in incorporating Greenlist further upstream in the product design process. SCJ’s goal is to use the tool not only to assess existing products but also to inspire breakthrough green innovations to capture new market space. Given the company’s track record of conscious evolution of its strategy, this is not an unrealistic goal.

Radical incrementalism, as we have seen, offers a path that can both deliver real-time benefits and lead to market-shifting innovation. KP and SCJ demonstrate the tactics we advocate here: set big goals but take moderate, integrated steps to get there. Both companies have religiously monitored and measured their progress to build the business case for the next ambitious steps. Consequently, both now grapple with incorporating the knowledge gained from their earlier successes into future product designs, process designs, or both.

Being radically incremental requires having an ambitious goal of corporate sustainability, but it does not imply that you will be able to map out all the steps with clockwork accuracy. It does mean, however, that one’s incremental steps must be integrated, that each success and failure must be evaluated, and that the road map under one’s feet must be redrawn accordingly. Being radical takes courage but so does radical incrementalism. Courage and resolve builds, however, with each successful step.

KEY TAKEAWAY

Radically incremental tactics include the following:

1. Setting big goals but taking moderate, integrated steps toward those goals.
2. Measuring everything (metrics are critical)—to build your business case.
3. Incorporating knowledge gained back into the process for new product and process design.

EXERCISES

1. List the small incremental steps Kaiser Permanente and SC Johnson took and the larger changes they added up to over time.
2. Select a familiar product and list all the incremental small steps that could be applied to its design, use and disposal that would reduce the product's ecological/health footprint. As you consider these changes, look for imaginative leaps you could make to redesign the entire product, provide for the buyer's need in new ways altogether, or consolidate incremental changes into a systems redesign involving supply chain partners that could improve the product and lower costs at the same time.