THE PERPETUAL ENTERPRISE MACHINE

Seven Keys to Corporate Renewal Through Successful Product and Process Development

Editors: H. Kent Bowen, Kim B. Clark, Charles A. Holloway, Steven C. Wheelwright

The Perpetual Enterprise Machine

This page intentionally left blank

The Perpetual Enterprise Machine

Seven Keys to Corporate Renewal Through Successful Product and Process Development

Editors

H. Kent Bowen
Kim B. Clark
Charles A. Holloway
Steven C. Wheelwright

New York Oxford Oxford University Press 1994

Oxford University Press

Oxford New York Toronto
Delhi Bombay Calcutta Madras Karachi
Kuala Lumpur Singapore Hong Kong Tokyo
Nairobi Dar es Salaam Cape Town
Melbourne Auckland Madrid

and associated companies in
Berlin Ibadan

Published by Oxford University Press, Inc.
200 Madison Avenue, New York, New York 10016

Library of Congress Cataloging-in-Publication Data
The Perpetual enterprise machine : seven keys to corporate
renewal through successful product and process
development / H. Kent Bowen . . . [et al.].
p. cm. Includes bibliographical references and index.
ISBN 0-19-508052-1
1. Industrial project management—United States.
2. New products—United States—Management.
3. Production management—United States.
4. United States—Manufactures—Case studies.
I. Bowen, H. Kent.
HD69.P75P47 1994
658.4'04—dc20 93-43172

2 4 6 8 9 7 5 3

Printed in the United States of America
on acid-free paper

Preface

The Perpetual Enterprise Machine is the product of a unique collaborative research effort between five companies—Chaparral Steel, Digital Equipment Corporation, Ford Motor Company, Hewlett-Packard, and Eastman Kodak—and four universities—Harvard University, Massachusetts Institute of Technology, Purdue University, and Stanford University. The book is about the principles that drive outstanding development of new products and processes. But at a deeper level, it is a book about creating the future. It is about the kind of enterprise that will thrive and prosper in the years ahead: an enterprise that perpetually builds and renews itself because of its superior capabilities in creating new products and processes.

This book got its start on a fall evening in a Boston hotel room in the late 1980s. In the room were senior executives from three companies (the other two joined soon thereafter) and engineering and business academics from four universities. We were there to talk about the future of manufacturing enterprises: how we might work together to understand better what was going on and what we might do about it. The wind rattling the windows that night was the perfect background for our meeting, because winds of change were blowing in the companies and universities represented. In some the winds were at gale force, while others could see but the first rustling of the leaves. But all of us were convinced that what we taught and what we practiced had to change. Each company had its own reasons for joining the group. Chaparral, as a small but growing company that had been very successful in developing a spirit of entrepreneurship among its employees, was worried about how to keep this spirit alive as it grew. The large companies sought to understand how to revitalize their manufacturing enterprises and to relearn from Chaparral how to operate small organizational units. All of us were convinced we could learn from each other.

What came out of that meeting and many others that followed was a commitment to collaborate in creating new understanding about the future of the manufacturing enterprise. We chose to focus on the development of new products and processes, both because development is a critical process in the enterprise, but also because development is in many respects a microcosm of the larger enterprise. And we decided to practice what we intended to preach. We all believed that creating new understanding in manufacturing would require fundamental changes in the way companies and universities worked together. Moreover, we believed that within the university itself, progress would require closer relationships between schools of engineering and business. Thus, we decided that our approach must be representative of a broad, integrated effort. We formed collaborative teams, dubbed ourselves the Manufacturing Vision Group, and set to work.

In the following chapters we lay out the central themes to emerge from our study of twenty product and process development projects. We provide substantial background information on the companies and the specific projects we studied within them. The theme chapters cut across the projects and draw from them evidence and insight about the character and impact of that theme on development performance. Readers who desire to pursue further a particular illustration of a line of argument or a particular aspect of the practical realities of a discussion will find the company descriptions and the project descriptions a useful source of rich insight.

The ideas, thoughts, and words in these chapters are the result of many hours of discussion and collaboration among Vision Group members; in the end, however, particular members of the group took responsibility for the chapter drafts. While we celebrate the contribu-

tions of all members of the Vision Group, we give special mention to those who captured ideas in these drafts and then worked with the editors to yield this volume:

"The Manufacturer's Perpetual Enterprise Machine"—H. Kent Bowen

"Core Capabilities and Core Rigidities"—Dorothy Leonard-Barton, H. Kent Bowen, William Hanson, Douglas Braithwaite, Michael Titelbaum, and Gil Preuss

"Guiding Visions"—Dorothy Leonard-Barton, Douglas Braithwaite, H. Kent Bowen, William Hanson, Michael Titelbaum, and Gil Preuss

"Pushing the Performance Envelope"—Charles Holloway, James Solberg, Harold Edmondson, and Sara Beckman

"Project Leadership and Organization"—Kim Clark, Marco Iansiti, and Richard Billington

"Ownership and Commitment"—Steven Wheelwright, Thomas Eagar, and Gordon Forward

"Prototyping: Rapid Learning and Early Testing"—Philip Barkan and Marco Iansiti

"Integration within Projects"—Carolyn Woo, Steven Wheelwright, C. (Robin) Farran, David Groff, and Jack Rittler

Mark Fischetti served as rapporteur for "An Opportunity for Leadership in Learning" and, early in the writing process, helped synthesize the disparate styles, voices, and drafts of the entire manuscript.

Finally, the editors express appreciation to the numerous assistants and colleagues who aided this long process; in particular, we thank Jean Smith, who managed the manuscript generation process. The nearly impossible task of coordinating the Manufacturing Vision Group meetings at sites across the country was directed by Douglas Braithwaite, who served both as colleague and executive secretary to the group.

Boston
December 1993

H.K.B.
K.B.C.
C.A.H.
S.C.W.

This page intentionally left blank

Contents

Introduction The Manufacturing Vision Group 3

Appendix Project Summaries 7

1. The Manufacturer's Perpetual Enterprise Machine 13
2. Core Capabilities and Core Rigidities 26
3. Guiding Visions 57
4. Pushing the Performance Envelope 88
5. Project Leadership and Organization 125
6. Ownership and Commitment 165
7. Prototyping: Rapid Learning and Early Testing 202
8. Integration Within Projects 229
9. An Opportunity for Leadership in Learning 264
10. Chaparral Steel Company 293
11. Digital Equipment Corporation 315
12. Eastman Kodak Company 349
13. Ford Motor Company 372
14. Hewlett-Packard Company 393

Notes 427

Index 433

This page intentionally left blank

The Perpetual Enterprise Machine

This page intentionally left blank

The Manufacturing Vision Group

This book is one of several products to come out of the Manufacturing Vision Group (MVG), an organization of like-minded academics and company executives who were motivated by the competitive pressures of the late 1980s to share experiences and knowledge with the hope of making sense of the transformations taking place in the U.S. manufacturing industry. In particular, members shared a common interest in (1) analyzing and exploring how manufacturing firms learn, and (2) determining the impact of trends and dislocations awaiting firms as new business and manufacturing paradigms evolved.

The group members' diverse backgrounds and experiences provided a unique perspective on the probable changes manufacturing firms would undergo as a consequence of new competitors, global markets, changes in technologies, and significant shifts in national priorities. The members of the MVG agreed that the world in which manufacturers exist had changed in such profound ways that most of the accepted wisdom and operating models needed to be questioned. Yet what seemed clear to this group was transparent to many middle and senior managers: "They just don't get it!" was an oft-repeated statement. Thus, the overarching theme was learning to adjust to and even anticipate change and new paradigms.

Table 1 Manufacturing Vision Group Members

Digital Equipment Corporation	*Purdue University*	*Hewlett-Packard Corporation*
William Hanson	James Solberg	Harold Edmondson
Douglas Braithwaite	Carolyn Woo	Sara Beckman
Michael Titelbaum	Ferdinand Leimkuhler	
MIT	*Chaparral Steel Company*	*Stanford University*
H. Kent Bowen	Gordon Forward	Charles Holloway
Thomas W. Eagar	David Fornie	Philip Barkan
George Stephanopoulos		
Eastman Kodak Company	*Harvard University*	*Ford Motor Company*
C. (Robin) Farran	Dorothy Leonard-Barton	Richard Billington
David Groff	Kim B. Clark	Max Jurosek
Jack Rittler	Marco Iansiti	
Rohn Harmer	Steven Wheelwright	
John Owen	Gil Preuss	

From its inception the MVG project demonstrated an innovative cross-institutional model for research and learning. The academics came from management and engineering disciplines and represented Stanford University, Purdue University, Harvard University, and the Massachusetts Institute of Technology (MIT). Industry leaders were from Chaparral Steel Company, Digital Equipment Corporation, Eastman Kodak Company, Ford Motor Company, and Hewlett-Packard Corporation (HP). (**Table 1** lists the members and their affiliation.) The firms, which represented different industrial sectors with very different cultures and markets, varied on many dimensions, including revenues (from $500 million to $90 billion per year), number of employees, union representation for employees, and age of the corporation.

The company executives all had extensive experience heading organizations and careers that involved developing and implementing new product and process concepts. Their experience bases, however, had been developed through exposure to disparate situations; length of company product life cycles, maturity of the technology, and vintage of key competitors were a few of the many variations the MVG members and their companies brought to the project landscape. Similar discipline and cultural chasms existed between the academics. For example, Harvard and MIT could not be more different in their culture and style. The power of the MVG—the energy and light to examine critical issues through a new lens—was derived from the disparity at these institutional, disciplinary, and professional boundaries.

After approximately 18 months and a number of seminar-style discussions, a more formal research project was organized with the goal of creating an exercise from which all the institutions could learn. The MVG members selected development projects as the most interesting unit of analysis and as a means to gain insight into how companies change their product and process capabilities (and, as a result, create the capacity for further change).

The group sought to address a number of fundamental questions, including:

- How do companies carry out development projects?
- What are the company's policies, procedures, and practices?
- Are particular structures and processes commonly used?
- What are the roles of individuals and functions?
- What characteristics make development projects successful beyond the targeted project outcome of a new product or process?

It is hard to describe the electricity generated as group members toiled over this difficult territory, investing time and energy—not because of duty, but because of a desire to tackle these questions. The MVG project was outside everyone's job description. What could Chaparral Steel have in common with HP or Ford? How could a mechanical engineering design professor discuss new product development with a social science professor? How could the megaprojects be compared to projects involving only a few dozen people?

To facilitate analysis and provide "live data," the five member companies proposed several development projects for review. The MVG subsequently chose four recently completed projects from each company for a total of 20 projects. (A summary of the 20 projects, by company, is given in the Appendix to this chapter. Further descriptions of the companies and projects are given in Chapters 10 through 14.)

This final set of development projects was intended to be far-ranging in markets served and technologies incorporated. More significant, the set of projects had met with varying degrees of success. To allow the necessary breadth and depth of investigation, the group agreed to prioritize the goal of learning (rather than cataloguing successful projects) and to subjugate any potential risk of embarrassment.

The MVG project went through a project definition phase not unlike that of a corporate procedure. The group had postulated that the business paradigm was changing for manufacturing firms and wanted to measure representative characteristics within firms that might be used as a barometer of the organization's capacity for change.

The study was structured with a prescribed framework: rather than collect a large statistical sample on development projects, the MVG opted for a smaller data set where each datum was thoroughly understood—a methodology that allowed for rich debate about individual projects as well as across the set of projects. Group members presumed that this approach would help them acquire insights not readily determined through survey questions or broader interviews.

The company study teams typically included a management professor, an engineering professor, and one or two corporate managers. Each team was responsible for gathering raw data and providing preliminary analyses. The interviews with senior executives and members of the development project teams were usually conducted by the academics because they were viewed as impartial observers. After a single project in each company was studied, the data-gathering process was refined. The vision group members convened on multiple occasions to analyze preliminary observations and to fine-tune the project's structure and direction.

The group members discovered that despite the size of the company, a common set of themes existed, and that if these themes were further developed and articulated into prescriptive policies and practices within the proper context for the firm and market, the development projects would have a higher probability of success. Furthermore, the MVG concluded that successful development projects were the key to the perpetual enterprise machine.

In an important sense, this book is the product of our own development process. But the Manufacturing Vision Group has had an impact on the companies and the universities far beyond the creation of these pages. The concepts, principles, and tools discussed here have found application in many different projects across the companies; their impact has been felt in measurable improvements in lead time, productivity, and design quality. Creating an outstanding development process is a never-ending challenge, and the Vision Group companies continue to face that challenge in the markets they serve.

The universities, too, have felt the impact of the Manufacturing Vision Group. In both engineering and business, group members have launched new initiatives in research and course development intended to deepen our understanding of the manufacturing enterprise and push forward our ability to educate a new generation of leaders far more effectively than in the past. In keeping with the spirit of collaboration that guided the Manufacturing Vision Group, new programs that link engineering and business in study and teaching about manufacturing are now an important feature of the landscape.

Appendix—Project Summaries

Chaparral Steel

1. *Horizontal Caster.* This project was begun to develop a new casting process for high-grade steel. At the time, all carbon-steel makers were using a so-called vertical casting process. A horizontal caster would enable Chaparral, a minimill, to compete with the large integrated steel conglomerates in the manufacture of carbon steels and low-alloy forging-quality steels. The project resulted in the first horizontal steel caster in the world.

2. *Pulpit Controls.* This project was initiated to upgrade furnace control systems. The electric arc furnaces used by Chaparral to melt scrap were all controlled with analog instrumentation. To improve efficiency, the project team decided to develop digital controls, and despite some resistance from within the company, ended up developing the world's first digital furnace control system.

3. *Microtuff 10 Steel.* This project was intended to move Chaparral into a new market—the highest quality alloy steels, called "special

bar'' steels. Though sales never amounted to much, the new steel met all the strict quality standards and in so doing established Chaparral as a high-tech innovator, an image it had not had before.

4. *Arc Saw.* This was an attempt to develop the industry's first electric-arc saw for cutting volumes of steel. The huge saw was to use intense electrical arcs instead of saw blades to cut steel, which had never been done on the scale or throughput required for mass production. The project failed, but brought to light two important lessons about project development, one negative and one positive.

Digital Equipment Corp.

1. *RA90 Disk Drive.* This project was undertaken to develop a high-density disk drive for computers. It was divided into three subprojects that progressed in parallel but without coordination, which in the end proved troublesome. It represented the kinds of integration problems that could arise at DEC and other companies organized by function. In part due to this project, DEC began to develop a standard process that would help development teams better integrate their work.

2. *LANbridge 200.* This product, a communications network that would link several computer networks, was a follow-on to an earlier product. Because the team consisted of many of the same people who had developed the first product, work proceeded in an integrated fashion, pointing to the benefits that better integration could bring to other projects.

3. *DECstation 3100.* Facing competitive pressure, DEC launched this project to develop a new workstation based on a UNIX operating system, instead of the company's standard VMS system. It was a technical success completed in record time, but sold less than intended because of a lack of software.

4. *CDA Software.* As DEC's line of office workstations expanded, the company perceived a need to develop an overreaching computer architecture to link its desktop publishing products. The compound

document architecture (CDA) software was the solution, and it was pursued with the idea that it would become a standard for desktop publishing. The project offers insights into how DEC overcame integration difficulties.

Eastman Kodak Co.

1. *Factory of the Future.* This project was initiated to upgrade and expand the capacity of Kodak's factories that cut, spooled, and packaged 35-mm consumer films. It was begun early in Kodak's conversion from a functional structure to a line-of-business structure, and illustrated the lack of shared vision that could sometimes crop up in the old organization.

2. *Antistatic Film Coating.* To improve sales, this project was undertaken to develop a new, clear, antistatic coating for microfilm, to prevent the film from attracting dust while maximizing the perceived sharpness of the images on the film as seen by the end-user. It made use of off-the-shelf but state-of-the-art technology. The project was fully executed under Kodak's new company-wide system for managing development projects, called MAP.

3. *FunSaver Camera.* This project was begun to design and produce the world's first "single-use" camera. In this scheme the film was packaged in a simple, inexpensive plastic camera body. Once pictures were taken, the consumer handed the whole assembly to a photofinisher. The film was processed and the body was discarded or recycled. The design was based in part on existing design knowledge but was done on a unique CAD/CAM system that greatly helped integration and shortened the lead time from design to production.

4. *Panda Printer.* Panda was to be a thermal printer that could output large-format, color images of extremely high quality from digital data. Such a product was needed by the U.S. Department of Defense and top-of-the-line industrial and professional concerns. It was one of Kodak's first attempts to integrate divisions from different lines of business, and to merge both government and consumer product

specifications. As such, the project was tugged in different directions and suffered substantial cost and schedule problems, but the final product succeeded in both markets.

Ford Motor Co.

1. *1988 Lincoln Continental (FN9).* This was Ford's first attempt to build a luxury car on the new Taurus platform. It required major suspension system modifications, and was the first implementation of a 3.8-liter engine in a transverse configuration. The Continental was begun in the "old Ford," in which projects were organized by function, but by the time it was completed a new company-wide system, called C-to-C (Concept-to-Customer), for developing projects had been initiated. Spanning the transition caused some difficulties, but the car was successful.

2. *1989 Thunderbird/Cougar (MN12).* This generation of the Thunderbird was built on a new car platform that including a novel supercharged engine. It was the first project begun as lessons from the Taurus program were codified, and Ford tried to complete it under the new C-to-C system. It suffered from growing pains experienced within the C-to-C scheme.

3. *1991.5 Crown Victoria/Grand Marquis (EN53).* The Crown Victoria was a new car built on an existing platform. It was the second vehicle to use a new modular engine. The project was the first to be launched under the full C-to-C system, and showed the great benefits of the approach.

4. *FX15 Air-Conditioning Compressor.* This project represented the first time Ford tried to design in-house a compressor for automobile air-conditioning systems. The compressor was developed by Ford's Climate Control Division, which was run as a separate company and did not use the C-to-C system. However, the division did try several new methods for product development, including concurrent engineering. The compressor was a success and so were many of the new techniques.

Hewlett-Packard Co.

1. *DeskJet Printer.* This was a rush project to design a new class of low-cost computer printers based on ink-jet print technology. The development effort put forth to get it to market in nine months and at low cost was unprecedented at HP. It illustrated the company's early attempts to integrate manufacturing, marketing, and R&D. The DeskJet sold extremely well, and saved the printer division from extinction.

2. *HP150 Computer.* The HP150 was the company's first formal attempt to enter the personal computer market. Unfortunately the strategy was not fully developed, and the development team tried to design a machine that would function as both a stand-alone PC as well as a terminal for a central computer. This project made clear the difficulties in integrating development across a diverse set of autonomous corporate divisions.

3. *Logic Analyzer.* This was an attempt by HP to beat out a competitor in the newly emerging "digital oscilloscope" market. The instrument was developed in the early 1970s in HP's traditional development setting, which, like most engineering companies of the day, was organized along functional lines. It provided some interesting insights into the "old HP."

4. *Hornet Spectrum Analyzer.* This was a classic project undertaken to develop a more inexpensive version of a standard instrument, in this case a spectrum analyzer. The Hornet was targeted to reduce encroachment by competitors at the low end of the market. The project required breaking some well-entrenched product development concepts. The effort, undertaken in the "new HP," provided good contrast to the Logic Analyzer project.

Table A.1 Performance of Projects Studied

Company and project	Project date	Degree of success in meeting objectives: Met schedule	Initial market acceptance	Met technical objectives	Met business objectives
Chaparral Steel					
Horizontal Caster for high grade steel	Q2 1984–Q3 1990	3	4	5	4
Digital Pulpit Controls for arc furnace	Q1 1987–Q3 1988	2	5	5	5
Microtuff 10—New alloy steel	Q1 1987–Q2 1988	4	4	4	5
Electric Arc Saw	Q2 1985–Q3 1987	2	NA	1	1
Digital Equipment Corp.					
DECstation 3100-UNIX workstation	Q3 1988–Q2 1989	5	2	5	3
LANbridge 200 local area network	Q3 1987–Q3 1989	2	4	3	4
RA90—High-density disk drive	Q3 1981–Q4 1987	2	3	3	4
CDA—Desktop publishing software	Q4 1986–Q4 1989	3	4	4	4
Eastman Kodak					
Factory of the Future—35mm film	Q4 1986–Q1 1988	1	NA	2	2
FunSaver—Single-use camera	Q2 1987–Q3 1988	5	4	5	4
Chom 181—Antistatic coating	Q4 1985–Q1 1987	5	5	5	5
Panda—Large format printer	Q4 1988–Q4 1989	1	4	4	3
Ford Motor					
EN53—1991 Crown Victoria	Q1 1987–Q3 1991	2	3	5	4
MN12—1989 Thunderbird/Cougar	Q2 1984–Q1 1989	4	3	4	2
FN9—1988 Lincoln Continental	Q4 1981–Q3 1987	2	4	4	2
FX15—Air conditioner compressor	Q1 1986–Q1 1988	4	2	3	3
Hewlett-Packard					
Logic Analyzer—Digital oscilloscope	1972	3	4	4	5
Hornet—Spectrum analyzer	Q1 1985–Q3 1988	4	5	5	5
HP 150—Computer to use as a:	Q4 1981–Q4 1983				
terminal		4	4	4	2
personal computer		4	2	4	2
DeskJet—Inkjet printer	Q4 1986–Q3 1987	4	5	5	5

Note: 5 = very high; 4 = high; 3 = medium; 2 = low; 1 = very low; NA = not applicable

CHAPTER 1

The Manufacturer's Perpetual Enterprise Machine

THE QUESTION

The survival of U.S. manufacturers has become a critical issue in the 1990s as the nation emerges from the major industrial transformations of the 1970s and the global competitiveness wars of the 1980s. These historical changes, which have motivated an *ad hoc* group of academics and industry leaders—the Manufacturing Vision Group (MVG)—to meet over a period of five years, are propelling the U.S. into the future along with a new twist: successful companies have been required to transform their organizations into much leaner and more dynamic enterprises that are constantly searching for sustainable competitive advantage, increasingly driven by continually improved levels of product quality and performance at low costs. The MVG itself was driven by a strong sense of concern for their companies and their fields, asking themselves the question: How can manufacturing companies continue this breathless process, meeting customer's latent needs; maintain a competitive advantage; and sustain profitability while achieving a constant state of evolution and self-renewal?

RENEWING THE ENTERPRISE

A vision of the future is an important aspect of the dream shared by many inventors and entrepreneurs who, in their quest for a better life, have long sought to create valuable products or processes. Successful inventors and innovators view the physical world quite differently from others. They use their creativity and resourcefulness to interpret the needs of people and markets and explore possibilities, utilizing available resources, for satisfying those needs. Inventors and innovators never seem content with their surroundings or environment; they always question the current state of affairs. Inventive and innovative processes are carried out both in their minds and in the physical world. But they are not just dreamers; they are dream actuators. Inventors and entrepreneurs have the imaginative powers not only to define a future state, but to conceive of pathways to bring themselves from the present to the future. Throughout history, entrepreneurial political leaders have attempted to harness combinations of mass human will into eternal empires and inventors have envisioned the penultimate perpetual motion machine that, once put in action, would continue its motion infinitely.

The leaders of successful manufacturing firms have their own dreams of creating and maintaining ownership of an equivalent of the perpetual motion machine—something we might call the perpetual enterprise machine. But these leaders know that their companies cannot simply perpetuate the past; they know that their organization must perpetually evolve, or it risks extinction. Successful firms have mastered the art of melding the power of human will and organization. But the key to their vitality is their world-class capabilities in selecting, guiding, and completing **development projects,** which are the building blocks of renewal and change. The companies that can repeat this process again and again have discovered the manufacturer's perpetual motion machine.

Today's manufacturing world is dynamic: customer needs and the competitive environment are constantly changing as new technologies and knowledge become available at an ever-increasing rate. Since the perpetual enterprise machine is powered by a system that creates and brings new products and processes to the marketplace, the system must, like the inventive entrepreneur, continually recognize and meet customers' needs. These needs are often difficult to understand or predict, but as the system operates through successive cycles, it actually transforms the perpetual enterprise machine so that it becomes even more adept at sensing and responding to future needs.

If a particular product or process fails or if the available knowledge, skills, or organizational structure are inadequate for present or future needs, the perpetual enterprise machine learns from the failure and redirects physical and human resources. To achieve this end, the perpetual enterprise machine relies on internal and external sources of knowledge and experimentation. It must literally project itself into the future based on its acquired knowledge and by developing its own best practices and operating rules. To be perpetual, this total product, process, and service delivery system must be flexible enough to function well under conditions when markets are quasi-predictive or stable as well as when there are major disruptions or transformations in the markets and business environment. Thus, the enterprise is capable of sustaining itself through this bootstrapping and probing of the future and initiating requisite changes of the machine itself. The owners of the enterprise, as well as its employees and customers, can depend on the long term because the perpetual enterprise machine succeeds in delivering timely, high quality, cost-effective new products, processes, and services on a reliable, recurring basis.

This idealized, organic notion of the enterprise—requiring constant rejuvenation, recalibration, and redirection—encompasses elements that are driven by the dynamics of competition and the unending evolutions and revolutions occurring in science and technology. In the world of manufacturing of the 1990s, the only strategy for corporate success is to learn more rapidly than competitors and to convert that learning into commercialized products, processes, and services. Thus, the knowledge-based company capitalizes on its knowledge and redefines itself through its successful use of development projects.

DEVELOPMENT PROJECTS: THE PERPETUAL MACHINE

Development projects are a concrete way to envision the perpetual enterprise machine. The ultimate source of power derived from development projects comes from a company's discovery and systematic application of unique principles and procedures. Development projects are defined and organized, first and foremost, to create a particular new product, service, or process, but, in addition, they can be used to develop less tangible assets. These assets might include new tools or methodologies for inventing and designing products or new machines and systems for producing them. On a more subtle level, assets might also include the development of new individual skills and organizational capabilities.

The development project (or especially a set of projects) has many characteristics that render it a microcosm of the company or business unit: the project team is composed of members from many functional areas within the business unit; the success of the project is determined by the integrated outcome of many individuals' work, and not by the achievements of a single individual, function, or discipline; and many of the business systems and organizational structures that support the success of the enterprise will generally be expressed in the work of a series of development projects. Thus, the development project becomes a convenient tool for experimentation and learning about the business unit.

Like the business unit, development projects have customers and suppliers, interact with physical and social systems, involve technology and people, are aided or inhibited by organizational structures and incentives, and must be tracked on quantifiable and nonquantifiable measures. The workings of development projects provide a much more comprehensive, real-time assessment of the values, systems, and structures of the whole firm or business unit than do assessments of individual functional organizations or representations in organizational charts.

Except in very small companies, a development project includes people who depend on their functional groups for support in addition to using the established corporate systems and structures. By its nature the development project will often amplify and highlight existing problems at the interfaces and boundaries of different groups in an organization. Thus, the workings of a project capture much of the essence of the firm's integrated workings.

Because the development project is a small but representative piece of the larger entity, it is also an appropriate unit with which to try out new ideas and a place where new capabilities can be developed and nurtured. Here again, the project objectives can be directed to achieve outcomes fundamental to the perpetual enterprise machine: not only the primary goal of a new product, process, or service, but also less tangible goals, such as an atmosphere that fosters understanding, learning, improvement, and rejuvenation of the business unit's assets.

If a manufacturing firm is to accrue sustainable advantage, it must create a unique version of the perpetual enterprise machine that will enable it to meet future needs. Because sustainable advantage is determined by what an organization can do, not what it can buy, world-class development projects provide benefits that can never be acquired simply by the direct purchase of assets, such as buying patents, technology, plants, or even a complete business unit.

Seven Critical Elements of Outstanding Development Projects

The MVG gained an understanding of the role of development projects in renewing a company's assets by carefully studying 20 individual development projects. To gain this insight, the MVG established that the unit of analysis, the development project, would need to have specific characteristics (both by itself and as part of a set of projects). The projects studied were central to each company's business success—none of them was off the main track or a "sandbox" project. The MVG knew that these projects had experienced varying degrees of internal success, and had, in fact, provided mixed contributions to the overall success of the business.

Understanding development projects in general required the MVG's commitment to broad, in-depth analysis and examination of varying project elements: for example, the intricacies of thin film process technology, the synthesis skills of an individual project contributor, or the project management tools used in different divisions of the same company. The MVG realized that it could only recognize important trends or unifying concepts through analyses at multiple levels using data from many sources and perspectives.

Although each of the 20 projects had its own story to tell, the MVG found that the greatest learning came from integrating the experience and lessons from all the projects. The common challenges and patterns, despite their diversity, created the basis for identifying shared themes and distilling translatable concepts.

This book focuses on (1) what makes development projects successful, (2) what causes projects to achieve (or fall short of) their market and technology goals, and (3) how projects can be mechanisms for growth and learning for the firm given the challenges facing world-class manufacturers in a dynamic, competitive environment. In the chapters that follow, we diverge from the topics traditionally addressed in discussions of new product development, manufacturing, and competitiveness; many of these topics, important as they are, are considered in other works. Instead, we focus on the factors that help development projects succeed and the factors that inhibit the kinds of sustained learning necessary for a perpetual enterprise machine. The participants in the MVG examined or took part in hundreds of development projects, but it was through a systematic analysis of projects in five companies, as well as years of experience in industry and academia, that this diverse group reached its conclusions and consensus. To us the evidence is compelling. We hope that the readers—whether technical or management leaders in business or academia, in both small groups and large organizations—will recognize and embrace the key concepts we have identified for making development projects successful.

Given a good development project concept, a team, and the necessary resources as a starting point, what other inherent elements improve the likelihood of a project's success and create long-term benefits for the organization? The MVG found seven key elements or themes in the 20 development projects they examined **(Table 1.1)** that, when integrated into a holistic approach, become critical ele-

Table 1.1 Seven Key Elements for Outstanding Development Projects

1. **Core Capabilities and Core Rigidities** New product/process development projects should be conducted with full recognition of their interaction with core capabilities (i.e., strategically important capabilities) that are multi-dimensional and include the dimension of value. Core rigidities—the flip side of core capabilities—inhibit innovation, but new product and process development projects can act as agents of both short- and long-term change to ameliorate core rigidities in an organization.

2. **Guiding Visions** Three interlocking visions for the development project—the *product concept,* the *project vision,* and the *business unit vision*—provide the link between specific design decisions and the growth of strategic capabilities within the firm by identifying the project's learning goals, including what the product means to its users. Guiding visions are fed from many information sources, including critical market information not accessible through traditional market research.

3. **Pushing the Envelope** Understanding and managing the interrelation of performance envelopes will determine a firm's competitive position. The proper role of management and the mechanisms and needs for pushing performance envelopes are different for product envelopes, process envelopes, and envelopes associated with the firm's other internal capabilities. The degree to which performance envelopes are pushed and the perceived consequences of potential failure will influence the most effective organization, the behavior of those involved in the project, and the likelihood of project success.

4. **Project Leadership and Organization** Achieving functional or disciplinary excellence and internal/external system integrity in development projects requires innovative and appropriate project leadership and management within the organizational structure. The development of people and organizational skills and procedures for high-performance projects requires time, and the firm gains experience from systematic learning across projects.

5. **Ownership and Commitment** Challenging development projects require strong ownership and commitment from three levels: (1) the *individual project team members* gauge project ownership by their ability to make a difference and the degree to which they identify and associate their personal success with the project's success; (2) the *project team,* a central organizing unit, derives its identity from the project and its goals; and (3) *senior management* demonstrates its commitment by a clear recognition that corporate success depends on achieving project goals.

6. **Prototyping—Rapid Learning and Early Testing** Prototyping is, in its broadest sense, largely underutilized and is often misconstrued as a project hurdle or an activity to answer phase review questions. In fact, prototyping is a process for facilitating structuring and systematic learning throughout the project and builds integrity into the product/process. The practice of using more prototypes early in the project and more prototypes that represent system interactions reduces the risks of failure and increases the payoffs for improved product/process performance and project success.

7. **Integration Within a Development Project** Integration of people and visions within a development project is a process—not an event or a state—and formal, bureaucratic, or procedure-driven systems alone won't guarantee integration. Integration requires new skills for people and organizations and requires changing the way work gets done.

ments for success. The seven themes are discussed individually in Chapters 2 through 8, but here we wish to indicate their scope and range and suggest why collectively they are so powerful—why these elements, together with good project concepts, create the perpetual enterprise machine. Outstanding development projects are those that have achieved the appropriate mix and balance of (1) core capabilities, (2) guiding visions, (3) pushing the envelope, (4) leadership and organization, (5) ownership and commitment, (6) prototyping, and (7) integration.

Our study of the vision projects, as well as research in a variety of industries, underscores the importance of laying the foundation for product development projects. Projects that achieve high performance are inevitably associated with senior management processes that provide both clarity in their missions and the requisite base of capability in their execution. Two of our themes—core capabilities and guiding visions—capture the fundamental importance of the front end of the development process. The importance of that foundation lies not only in getting off to a good start; a strong foundation facilitates the attitudes, behavior, and action that are critical to successful development.

The notion of ***core capabilities*** is a familiar catch phrase often associated with the development of a corporate or business strategy. For development projects, the power of distinctive capabilities arises from the ability to work across functions, to integrate disciplines and organizations, and to bring together institutions critical to the success of the program. A core capability might be reflected as much in innovative and creative approaches to structuring project tasks and chartering projects as it is in a unique technology. There is a dark side to a core capability, however: firms that consistently over-rely on a perceived core capability as "the right answer" or fail to recognize that its advantages have been displaced by a new environment risk engendering a ***core rigidity.***

The right capabilities give development teams the wherewithal to succeed. But those means must be applied with direction and focus. In a world of uncertainty, a willingness to take risks, the ability to sort out competing demands, and the capacity to cut through confusion and noise to find excellent solutions depend heavily on ***guiding***

visions that operate at multiple levels of the organization. Outlining these visions is the task of management. Guiding visions have the clear objective of creating boundaries for the project team so it is not continually redefining its direction and goals. An effective guiding vision provides a sense of direction and creates power by providing focus without inhibiting initiative and innovation. With no guiding vision, management is inclined to be either too specific in commissioning a project team or too broad in setting objectives, which leads to floundering from lack of focus.

Core capabilities and guiding visions provide a foundation for a development project. A third theme, ***pushing the envelope,*** also addresses a fundamental organizational capability: the ability to drive renewal across the entire organization. Performance envelopes must be pushed for processes and less tangible internal capabilities as well as for products. Each type of envelope has characteristics that require different organizational responses. Projects must push these envelopes on critical dimensions. But this entails significant risk. How soon does one dare to use a new technology in a product or process? Who makes the ultimate decision that considers the risk and the opportunity to reposition the business unit? Where is the leverage across products and processes? How does one delineate the opportunities for pushing in the direction of product features as opposed to using resources to push the process envelope and change the production capability? Making those trade-offs effectively, creating processes that identify risks, putting in place approaches to managing them, and tying those choices to the project strategy and its guiding visions are the essence of pushing the envelope.

With a strong foundation, the work of the project itself can be more focused and can bring to bear the right kinds of skills, tools, and methods. But an outstanding development project is far more than the simple execution of a well-guided plan or the application of established skills. When products are complex—involving many components and parts as well as different technologies—and customer demands are sophisticated and changing, an effective development project requires leadership. It requires an organization that facilitates integration across functions and brings the voice of the customer to bear on the detailed engineering and design decisions that define the product. Thus, a critical theme in our study was ***leadership and organization*** of a type far different from the traditional hierarchical models so prevalent in modern business. Development projects create temporary organizations and require unique leadership and team skills from their members. Successful development projects seek to build a microcosm of the organization where the key members have not only a working knowledge of their function and discipline, but also the broad thinking, networking, and leadership skills usually associated with senior people in the traditional organization. Like the breadth of talent of technical and business leaders in the permanent organization, the talent of development project members increases as they progress to more senior levels of responsibility. In outstanding firms, the preparation and training processes (and the supporting organizational structures) for staffing development projects are very nontraditional and distinctly different from less successful firms.

A structure of organization and a pattern of leadership that fosters excellence in teamwork and integration are thus essential to outstanding development. But unless that organization and those who lead it create an environment in which not only individual team members, but also individuals involved in supporting the team, feel personal identification and an allegiance to the success of the total program, the development project is unlikely to achieve its potential. The alignment of the team members' personal interests with the project's objectives and interests is largely determined by the company's procedures for establishing and bolstering ***ownership and commitment.*** High levels of ownership and commitment lead to members developing a personal identity with the success of the project and the company that goes well beyond a "what's-in-it-for-me" attitude. The devotion shown by inspired development project members is comparable to that usually reserved for an avocation—for example, the after-work inventor who spends hours each week over a period of years working in the garage on a new device.

From the standpoint of the project, an effective team and strong leadership embedded in an organization that fosters ownership and commitment has a high probability of success. But there is more. Within such teams there still remains the detailed work of design, testing, and making trade-offs—the action that defines the product, develops the process, and implements an integrated system in the marketplace.

No matter what level of change and innovation a project intends, if it is to be successful, the team carrying it out must create effective processes for learning. We talk not of learning in the abstract, but in the day-to-day detailed work that ultimately defines the success of the project. In that context, the outstanding projects that we studied use ***prototyping*** as a fundamental learning strategy. Prototyping is commonly viewed as a secondary activity at the end of a set of tasks, but we believe it occupies a central role. It is an integral part of the design-build-test cycle of learning and has an almost magical effect in bringing parts of the organization together and solving problems that are difficult, even with traditional project management methods. Prototyping has leverage in its effect on the rate of learning and its usefulness as a measure of how the project is progressing and how the elements are integrated.

Where it works effectively, prototyping is a way to bring all the elements of the product and process system together to learn about its ultimate performance. At the end of the day, when all is said and done, what really matters is how that system performs—the ownership experience it delivers to customers, its cost performance in manufacturing, the excellence of its design, its time to market, and its fit with the strategy of the business. The theme that seems to differentiate those projects that achieve outstanding performance is ***integration.*** Whether we find it across functional units, disciplines, regions, or even organizations, these instances of integration share common characteristics. Perhaps most important, integration occurs at a deep level. It is not mere coordination but instead a very different pattern of framing and solving problems. Traditionally, project management has been viewed as a process of coordination for alleviating problems at the boundaries or interfaces of activities. Integration is a broader concept: it redefines the work content in the function and changes processes, both within the boundaries and at the interfaces. Effective integration ultimately leads to a complete rethinking of individual tasks in the project. Value is created because the development project is not suboptimized. By moving beyond a focus on mere coordination and the summation of locally optimized tasks, integration allows the efficiency and speed of a development project to be maximized.

Pulling these seven themes out of the richness of the project histories and the analysis that underlies their interpretation has helped us to structure our thinking and identify critical sources of difference in performance. But it is important to understand that these seven themes do not stand alone—in fact, they are closely connected. Indeed, the truly outstanding firms we have studied (both in this project and in extensive work on product development) achieve excellence because of the pattern of their total approach to development. In a fundamental sense, it is the pattern that matters.

Thus, taken together, linked in critical ways, and reinforced and understood as a whole, these seven themes underlie outstanding development projects and build a foundation for a perpetual enterprise. We wish to reemphasize that these conclusions have been derived from careful analysis of the details of how new product and process development projects work—what causes, and what inhibits, their optimal success. We believe that these seven themes are necessary foundation concepts for building successful projects, but do not claim that they are the sole factors for success. We do claim that development projects with customized versions of these seven concepts are well on their way to building a perpetual enterprise machine. But a word of caution is called for. We have also discovered that the practice of these concepts is very difficult in small and midsize organizations and extremely difficult in large organizations. Indeed, it was the search for ways to formulate and resolve some of these difficulties that led to the formation of the MVG in the fall of 1987.

THE REALITY

We began this chapter with a difficult, multidimensional question, and we end with a reminder of the reality. The MVG started as an experiment in cross-institutional learning with a focus on perhaps the most critical problem facing manufacturing firms in the 1990s: fast-paced, competitive challenges with concomitant evolution and renewal of the company. During its exploration process the MVG discovered the power of development projects—which function as the engine for the perpetual enterprise machine—and it quickly recognized the difficulties inherent in keeping that engine primed for both today's and tomorrow's needs.

In many ways, the group as a whole relearned and synthesized what each member had already experienced firsthand within his or her own organization. The five companies had all witnessed, and continue to witness, dramatic changes in their markets, and most have begun substantial initiatives to create more responsive organizations and systems. The four universities had experienced, and continue to experience, parallel challenges to their status quo: job markets, course content, and curricula are changing to accommodate the transformations in industry and the economy. Whether our institutions, corporate or academic, are renewed and become perpetual enterprises will largely be determined by our practice of the principles described in the following seven theme chapters.

CHAPTER 2

Core Capabilities and Core Rigidities

By now you've heard it countless times—that American companies are strong in design but weak in manufacturing. This imbalance, industry soothsayers have said over and over, must be rectified if the United States is to become a stronger competitor in the international marketplace.

Indeed the observation is a tired one. And it may seem remote, even untrue, to a particular manager in a particular company. But there is a message at the core of the comment for every manager in every industry—that companies all too often rely passively on traditional strengths and assume that these strengths continue to be competitively advantageous. Electronics companies pride themselves on strong engineering, but often find themselves lacking in marketing. Auto makers are masters at marketing, but often have trouble integrating with precision the thousands of parts needed for assembly of a new car. The leaders of the very best companies in the 1990s, however, are not content to rest on tradition or tolerate mediocrity. They realize that no matter how capable their firm may be in certain disciplines, it is the weak links that will put them at a competitive disadvantage.

In the last few years urgency in this effort has been added for American firms due to assertions that Japanese companies understand, nurture, and exploit their core capabilities better than their U.S.-based competitors.[1] Increasingly, leveraging the core capabilities of an organization is being suggested as the way to gain advantage in a marketplace. In fact, the terms "core competence" and "core capability" are bandied about rather loosely. The concepts are in danger of becoming so broad as to be meaningless cliches. Yet many companies are finding the process of identifying core competencies a fruitful exercise in self-examination.

Moreover, core capabilities are fundamental to the success of new development projects that companies depend on to advance a market. Core capabilities in the best companies grow stronger with each development project. Knowledge begets more knowledge, and skills more skills.[2] Furthermore, because a company becomes known for its particular strengths, it attracts the best people in those disciplines. This cycle supports itself; a company's core capabilities tend to dominate product and process development projects.

However, in this chapter, we take a hard look at the concept of core capabilities and expose a perspective too often overlooked. Few companies recognize that their basic strengths can have dysfunctional effects. Because new development projects represent a firm's response to market changes, they are the focal point for the tension between innovation and organizational status quo. They quickly become the center of a firm's struggle to maintain certain strengths and renew or even replace others. Therefore, development projects expose the down side of core capabilities: core rigidities. The same capabilities that a constitute a strength also comprise a vulnerability. Projects that go awry often do so because they do not overcome core rigidities.

Say, for example, that a computer company traditionally strong in making mainframes decides to develop a personal computer and staffs its project team with its best designers. Even though these people know they are trying to create something different, they may well set up the design process in the same manner in which they would for a mainframe. When this falls flat, the company may then try to bring in consultants to help rework the project, but will likely still run into problems because the mindset of their people is too far afield from the one needed. A core capability has become a rigidity.

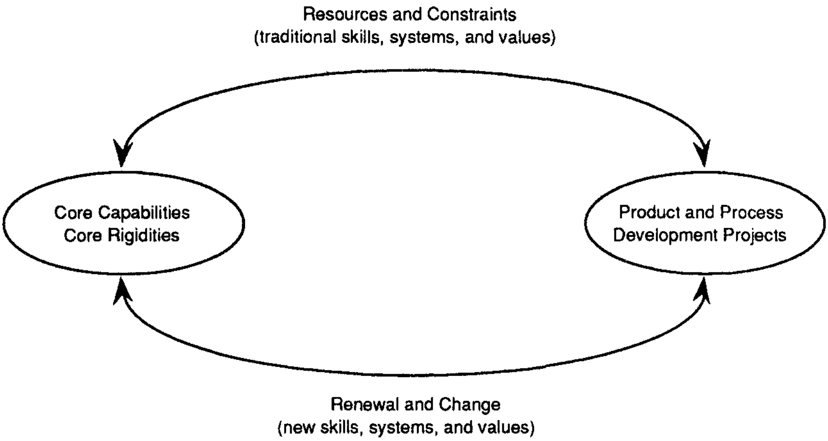

Figure 2.1. A company's strengths—its core capabilities—drive new product and process development. However, these same attributes, if not properly aligned with a project, can constrain its progress; the capabilities become rigidities. The pursuit of development projects, in turn, can improve or renew a company's capabilities, and even initiate new ones. The cycle feeds on itself and therefore must be consciously managed for the best results.

The paradoxical nature of core capabilities can pose severe challenges to management, because failure to recognize and consciously manage core rigidities can hamper project performance, compromising the company's future. Therefore, all players in a development project—the project manager, members of the project team, and others in the company who support the effort—will be more successful if they understand the multi-dimensional, systemic nature of core capabilities. They must recognize when the down side of a core capability threatens to reduce project effectiveness, and must manage development projects for their potential to aid organizational learning about capabilities as well as for the immediate project results needed (see **Figure 2.1**).

To understand how core capabilities and rigidities affect product and process development, and how they can be managed to improve the chances for project success, we examine in this chapter the basic composition of core capabilities, first through a brief example and then by dissecting capabilities into their four dimensions. Next we consider how projects are influenced by core capabilities and rigidities. Then, by dissecting actual projects from the companies studied by the Manufacturing Vision Group, we take a close-up look at how the individual dimensions of core capabilities and rigidities interact, enhancing or inhibiting development. Finally, we return to the managerial level to show how core rigidities, not always obvious, can be recognized, and how projects can be picked for the express purpose of overcoming a rigidity or turning a mediocre capability into a strong one.

DIMENSIONS OF CORE CAPABILITIES

Networking is a core capability of Digital Equipment Corporation. To be sure, networking here means a workstation or terminal on the desk of almost every Digital employee. The term also implies extensive, sophisticated software (local area and wide area networks) connecting these pieces of hardware around the globe so that any employee can reach another electronically. However, the physical systems mirror and also support a very horizontal, networked style of management. Everyone working at Digital knows that because of the high level of computer literacy and use, an electronic message is more likely to reach a fellow employee and stimulate a response than even the telephone. Moreover, extending requests for information or action through horizontal chains of informal networks is as likely to yield results as working through vertical, formal hierarchical channels. In fact, the networked approach is often *more* effective, since individual freedom and responsibility are highly prized and power is exercised through informal relations. Therefore, Digital's networking capability derives not only from the highly linked physical hardware and software systems and from the employees' skills in using those systems, but also from management practices and preferences that foster the networked task-force approach to most issues. That is, the networking capability permeates routine and culture.

The Four Critical Dimensions

Core capabilities are sometimes referred to as distinctive competences, core or organizational competencies, or firm-specific competence.[3] Discussion of their strategic importance has increased because research on diversification shows there is a positive relationship between strategies that complement and build on an existing skill or resource base in the firm and high overall corporate performance.[4] Recent research, including that of our group, continues to confirm this dynamic.

One of the key issues underlying the interest in core capabilities is finding ways to manage the tension between new technological directions and current corporate strengths. Managers are advised to build capabilities and then encourage the development of plans for exploiting them, that is, to "stick to the knitting."[5] Yet they also know that to stand still is to fall behind; therefore they must innovate. Innovation necessarily involves some degree of "creative destruction"; even seemingly minor innovations that alter the architecture of a product can undermine the usefulness of deeply embedded knowledge. Hence the development of any new product or process interacts with core capabilities, and managers need to understand that interaction. To do so, they must understand the various dimensions of a core capability.

Descriptors of core capabilities such as "unique," "distinctive," "difficult to imitate," or "superior to our competition" might seem to render the concept self-explanatory. However, these terms convey little understanding of the nature of core capabilities. Capabilities are composed of four interdependent dimensions, each described in the ensuing paragraphs: knowledge and skills, managerial systems, physical systems, and values. The last dimension—values—plays a crucial but often subtle role, and one that many people fail to recognize or address.

Knowledge and skills embodied in company employees is the dimension of core capabilities most often recognized.[6] Technical expertise, for example, constitutes a major resource that is both mined and cultivated. Other types of knowledge include methodological know-how, scientific know-why, and even interpersonal know-who—ties into critical communities such as regulatory bodies.

Managerial systems can consist of unique incentive programs, internal educational systems, or methodologies that embody procedural knowledge. As such, they can contribute importantly to a capability, and should be managed with that potential contribution in mind, not simply left to evolve on their own.

Physical systems—production lines or information systems that constitute compilations of knowledge—usually derive from many individuals, and become greater than the sum of their parts. Several of the firms our group studied considered their proprietary software simulation and test systems to be significant parts of the corporate brain, constituting a real advantage over competitors.

The fourth dimension of core capabilities is *values,* which are reflected in attitudes, behaviors, and norms that dominate in a corporation.[7] Values and norms are most often overlooked, but as we shall see they exhibit subtle yet very powerful forces on the other three dimensions. Even physical systems may embody cultural values. At Digital, for example, the computer architecture of the internal networks the company uses reflects a strong tradition of individual control versus centralized control over information. This value shows up in the way information within the company is formatted and the communication protocols that exist between individual computers. For example, DEC's landmark Ethernet system, which connects workstations and minicomputers, reflects the needs of DEC's own employees and customers in similar types of companies, many of whom are design engineers. Ethernet differs from the networking systems of the more mainframe-minded companies, such as IBM, in that if one node fails on Ethernet the whole system does not go down. This robustness may come at the cost of more standardized operating protocols, but DEC is willing to make that trade-off because, as indicated above, it places high value on enabling every employee to reach any information or any other person through the network.

There are several reasons why recognition of the values dimension of core capabilities is critical to understanding the effect of those capabilities on development projects. First, like the other three dimensions of a core capability, values operate paradoxically; the very same values, norms, and attitudes can both enable and constrain new product and process development. Second, even if the dark side of a core capability is recognized as inhibiting the development process, managers who try to alter it are unlikely to succeed if they do not recognize and address the values dimension. And third, the value embodied in a particular core capability is the dimension of that capability that takes the most managerial attention and effort to change.

Interaction Among the Four Dimensions

The major reason for emphasizing that core capabilities can be thought of as four conceptually distinct but interrelated dimensions is that all four come into play to differing degrees during a development project. Success or failure is often driven by the interplay between the dimensions. Furthermore, managers should recognize that the four dimensions may be present in very different proportions in various core capabilities, and therefore the leverage point for improving the development process differs among projects.

The four dimensions of a core capability interact to create a self-reinforcing system that enables new product and process development (see **Figure 2.2**). For example, the physical systems of a company cannot be fully utilized without a properly skilled workforce, and skills unrewarded by managerial systems or undervalued will atrophy or flee the company. Managers at Chaparral Steel are very conscious of building each dimension of a core capability as they build their products, and are aware of how building one dimension affects the

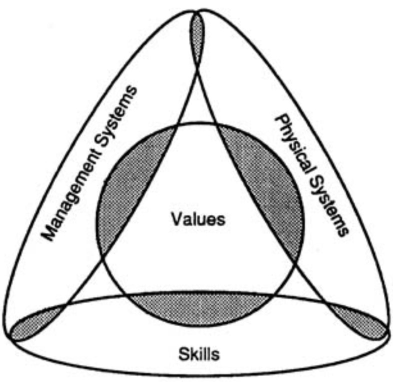

Figure 2.2. Core capabilities are composed of four dimensions. Though separate in nature, they constantly interact with each other in development projects. For example, the technical systems of a company could not be utilized without a properly skilled workforce. At the center are a company's values, which are infused through all capabilities.

others. Thus, proposals for changes of all types, from a new furnace to a profit-sharing scheme, are scrutinized for potential to enhance or disrupt the total system.

This attention to interrelationships is somewhat easier for a company like Chaparral, which is still relatively small (930 employees) and young (17 years old). Managers will have to guard that the company does not fail to evolve as it grows; they believe the flexibility to alter projects so as to keep the dimensions of core capabilities strong and integrated gets harder as companies get bigger.

Aligning Core Capabilities with Development Projects

The interaction between development projects and core capabilities differs according to how well the requirements of the project align with the core capabilities currently held by the firm (see **Figure 2.3**). Within large firms with multiple core capabilities, it is possible for a given project to be well aligned with the capabilities of one division and incompatible with those of another.

Among the 20 development projects studied by the Vision Group, for example, Hewlett-Packard's HP150 project encountered such misalignment. The HP150 was originally conceived as a terminal for use with the HP3000, an industrial computer already on the market. Development of this terminal was closely aligned with HP's traditional capabilities. As work progressed, however, senior management expanded the project's goal, to create a version that would function as a stand-alone personal computer. The attempted transformation was not completely successful because it required both new technical capabilities (e.g., a low-cost monitor) and new marketing capabilities (e.g., selling to individuals). Moreover, the project challenged traditional HP values and managerial systems. The increased system complexity represented by a stand-alone computer, such as the need for disk drives, required that the development team procure components from other divisions, each of which, true to HP tradition, was independent and entrepreneurial. Since the project was not directly aligned with the priorities and capabilities of these other divisions, and because HP as a company was not strong at that time in interdivi-

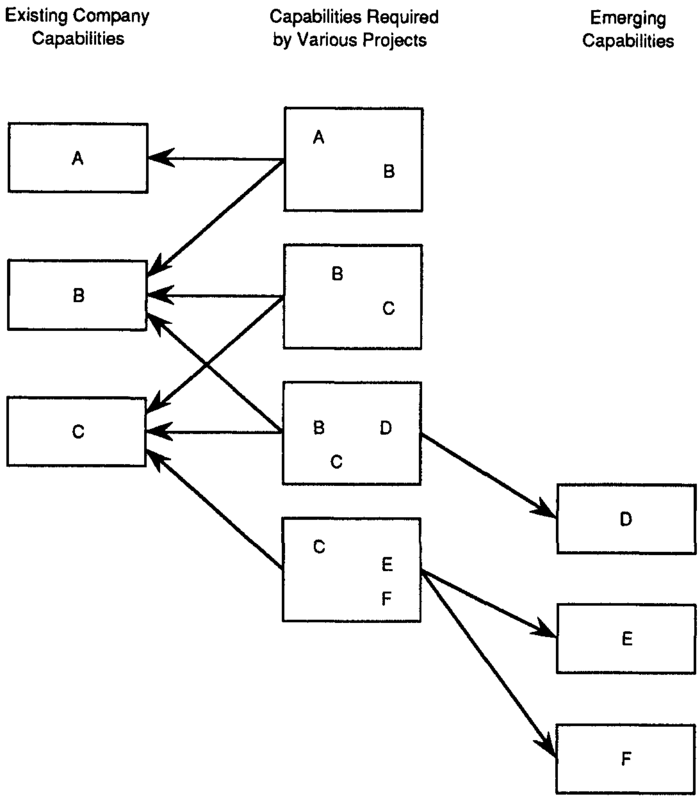

Figure 2.3. All development projects require certain core capabilities. The needs of some projects match well with the existing capabilities of a company (left). But others require new capabilities (right). If the second case is not foreseen, the project will probably fall short of its objectives. However, if recognized and planned for, the project can serve as a vehicle to develop the new capability, leading to a successful new product and a new strength for the company.

sional cooperation, the division managers had no incentive to cooperate for the greater corporate good.

The projects we studied ranged across the spectrum, from those well-aligned with traditional core capabilities to those that were not aligned—sometimes deliberately so. The latter were sometimes projects designed to launch the corporation toward a new capability. Companies were asked to identify one highly traditional core capability they strongly identified with. **Table 2.1** presents these, along with an example of one project that was highly congruent with that capa-