OVERCOMING MIDDLE MANAGEMENT RESISTANCE TO STRATEGIC CHANGE: DESIGN FOR ENVIRONMENT (DFE) AT XEROX

by

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Submitted to the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

The development and implementation of strategy is of keen interest to many, including those in the business world. One of the most challenging issues in the implementation of business is strategy is how to overcome resistance to a desired course of action. Resistance is particularly problematic at the middle management level, as they are the most important organizational group in the implementation process, yet are often some of the most difficult individuals to convince of the need to pursue a particular strategy.

Resistance to strategic is of particular interest to those trying to promote a new class of environmental initiatives whose aim is to move firms from a compliant to a pro-active environmental stance by framing these issues as strategic in nature. One of the most promising of these is Design for Environment, or DFE, which seeks to address environmental impacts from products and processes in the design stage, where the greatest potential for fundamental technical change exists. To implement DFE, or any of these strategies, requires that companies determine how to overcome resistance.

To examine the issue of middle management resistance to the introduction of DFE, an extensive case study of Xerox Corporation, the world's leading producer of document reproduction machines, was undertaken. Xerox is on the forefront of industry DFE adoption, and has been rather successful in gaining internal acceptance. This thesis describes Xerox' DFE initiatives, the middle management resistance that they have encountered, and the methods they have used to overcome this barrier. In addition, a number of specific and general recommendations for overcoming middle management resistance to strategic change, based upon the experiences of Xerox, are presented.

Thesis Supervisor: Dr. John R. Ehrenfeld
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Chapter One

INTRODUCTION

The way that firms have managed their environmental role has changed dramatically in the past 30 years—since such responsibility has been mandated. From the regulatory compliance oriented view of the 1970s and early 1980s has emerged a more proactive view of “environmental management.” This thesis seeks to examine one of the most exciting innovations in environmental management, a unique approach known as Design for Environment, or DFE. Of particular interest is the role of middle management in the process of implementation, for without their support it is unlikely that firms will be able to successfully adopt DFE.

Thesis Organization

This chapter continues with a general discussion of the historical relationship between business and the environment, which provides the context for understanding the emergence of DFE. Following this is a discussion of the goals and methodology of the research.

Chapters two and three develop the analytic framework for examining the case study. Chapter two looks at the strategy process and the role of middle management. In particular it examines middle management’s resistance to strategic change and methods for overcoming such resistance. Chapter three discusses the Design for Environment literature as well as why DFE should be viewed as a strategic initiative.

Chapter four is the heart of the case investigation of Xerox. After reviewing the history of Xerox, several programs which are related to DFE are discussed. Following this is an extensive examination of specific DFE efforts in the five organizational groups represented by people the author interviewed.
Chapter five uses the frameworks developed in chapters two and three to examine the case of Xerox as outlined in chapter four.

Finally, Chapter six discusses policy implications of the investigation and provides a conclusion to the study.

Following this is a bibliography of sources and several appendices which provide general information about Xerox and the people who were interviewed.

**Business and the Environment**

The impact of environmental concerns upon firms has increased dramatically since the issue first arose in the mid-1960s. Regulation of company activities has expanded, the prevalence of environmental issues in the media has increased, and consumer concerns about the environmental impacts of products they buy continues to intensify. Other forces have come from within the boundaries of the firm, as employees and shareholders are beginning to demand better performance as well. As these external and internal "green" pressure upon companies has increased, their response has also changed over time.

Initial environmental efforts focused on little more than compliance with existing regulation. Only companies that were affected by legislation, such as the 1965 Solid Waste Disposal Act, 1970 Clean Air Act, and the 1977 Clean Water Act, had any environmental programs or activities within the firm. With the passage of sweeping environmental legislation, such as the 1977 Resource Conservation and Recovery Act (RCRA), and the 1980 Comprehensive Environmental Response Compensation and Liability Act, CERCLA, more commonly know as Superfund, firms were suddenly exposed to a much greater degree of financial exposure from the impact that their processes or products had upon the environment. These regulations were wide in scope because they created strict, joint and several liability for hazardous waste sites or releases. This meant that companies could be held completely liable for a toxic waste site even if their waste made up a minuscule amount of total waste, had been transported to the site by a third party in compliance with all existing laws and with no negligence. These regulations also brought about new standards of due diligence, requiring firms to thoroughly examine new properties they acquired if they wished to avoid future liability and a greater degree of caution in financial institutions'
lending policies. This quickly brought environmental issues to the forefront of many senior executives' minds, and along with it a more diligent approach to compliance.

With widespread coverage of a series of environmental catastrophes—the 1984 chemical leak in Bhopal, India, the Valdez oil spill in Prince William Sound, Alaska, accumulated chemical poisonings at Love Canal, New York and Times Beach, Missouri, and the identification of a man-made ozone "hole" over the Antarctic—public concern over environmental problems and issues heightened, as did their interest in how the corporate world was dealing with the problems that companies were creating. In the late 1980s, some leading-edge companies began to realize that mere compliance with environmental regulations was not going to satisfy future markets of "green consumers." As Porter and van der Linde (1995) note "World demand is moving rapidly in the direction of valuing low-pollution and energy-efficient products, not to mention more resource-efficient products with higher resale or scrap value." The existence, proliferation, and growing power of these green consumers means that the pursuit of environmental practices can have strategic, market-related benefits.

In addition to environmental regulations and growing consumer concern, several other factors influenced the shift from corporate compliance-oriented roles to strategic ones. First a number of consumer and industry organizations have developed voluntary guidelines and standards. Some of these guidelines form the basis for awards that different groups bestow upon companies. Other private groups have developed principles that firms may follow. Some of these are general, while others, most notably the CERES (Coalition for Environmentally Responsible Economies) Principles, mandate specific activities, procedures, and disclosures. A number of industry groups have developed guiding environmental principles to which firms must follow to gain and maintain membership. The most wide sweeping American example is the Chemical Manufacturers Association's Responsible Care program, which requires adherence to a range of environmental

1 See Roberts "Note on Contingent Environmental Liabilities," Harvard Business School Case Number 9-794-098, for a further discussion of CERCLA, RCRA, contingent liability, and due diligence.
practices as a condition of CMA membership. The International Standards Committee (ISO) is currently expected to release a set of international environmental management principles known as ISO 14000, which follow on the success of the broad ISO 9000 quality standards. ISO certification, an often formidable task requiring external auditing of a company's processes, is expected to become a de facto standard for contract eligibility and entrance into some markets.4

There are also an increasing number of environmental performance labeling programs being developed and implemented.5 Most of these are fully or partially government-supported. Product labels are typically obtained by application to an agency that evaluates whether the product meets a number of strict, pre-determined standards. The oldest and most widespread of these is the Blue Angel program in Germany, which began in 1977.6 The Scandinavian countries have joined to develop the White Swan program. Japan and Canada also have programs in place. In the United States, the EPA's Energy Star program, which sets energy use and efficiency standards for a variety of consumer products, is the country's most extensive labeling effort. No firm is required to subscribe to, participate in, or obtain certification from any of these programs. Failure to do so, however, has created competitive disadvantage in some markets and is likely to be problematic in most industrialized countries in the very near future.

Though government regulation is no longer the only reason for firms to be concerned with the environment, it is still a major factor. There is, however, a perceptible shift in the way that some companies approach the issue of regulation. Some firms are beginning to anticipate the direction of future regulation so that they can avoid legal pressures and costly remediation. For example, the issue of ozone depleting substances, notably CFCs, had a large impact on many firms, particularly those in the chemical and electronics industry, where CFCs were a primary cleaning solvent. Most firms did not anticipate the world-wide ban on some ozone-depleting


5 See “Environmental Labeling in OECD countries” Organization for Economic Cooperation and Development, for a discussion of various labeling programs.

substances and were therefore forced to bear the costs of discontinuing their use.

The CFC issue also taught an interesting lesson to many companies. To replace the chemicals that they were dependent on for cleaning, electronics firms developed a number of different alternatives the most common of which was using a natural, citrus-based terpene cleaner called d-limonene. These alternative solutions were often less costly and safer than the CFCs that they replaced. As a result, many firms realized that pursuing environmental goals could actually reduce costs due to new innovations. They started to realize that waste—whether hazardous, regulated, or otherwise—was only the manifestation of economic and (typically) technical inefficiency:

Pollution is the emission or discharge of a (harmful) substance or energy form into the environment. Fundamentally, it is a manifestation of economic waste and involves unnecessary, inefficient or incomplete utilization of resources, or resources not used to generate their highest value. In many cases, emissions are a sign of inefficiency and force a firm to perform non-value-creating activities such as handling, storage and disposal....[T]he opportunity to reduce cost by diminishing pollution should thus be the rule, not the exception.

Furthermore, some firms have begun to address environmental issues due to internal pressures. Some pressures to improve environmental performance have come from employees who are either concerned about their health from working in a plant or from living nearby or who are just generally greener. Another source of internal pressure is from shareholders, who may exert pressure for a company to be “greener.” In the early 1990’s, the CERES group, which also serves as a socially responsible investment group, led a number of publicized proxy fights at annual meetings to force firms to adopt its CERES principles. Though none of these succeeded, it did force a number of companies to address environmental issues more thoroughly. In fact the Sun Oil Company, which had been the target of an unsuccessful proxy fight, began negotiations with the CERES organization and subsequently became the first Fortune 500 company to adopt their principles.

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8 Ibid.
9 Ibid., p. 107.
Finally, there have been arguments that firms ought to be socially responsible, which includes protecting the environment.\textsuperscript{12} Paul Hawken (1993) notes that "The ultimate purpose of business is not, or should not be, simply to make money. Nor is it merely a system of making and selling things. The promise of business is to increase the general well-being of humankind through service, a creative invention and ethical philosophy."\textsuperscript{13} This philosophy also appears to be taking hold within the business world with a recent survey noting that some companies have identified "corporate citizenship," as a reason for adopting new environmental management strategies.\textsuperscript{14}

Against this backdrop there have emerged a number of environmental management strategies which seek to address current issues and capitalize on future opportunities. Design for Environment is one strategy that has garnered a considerable amount of attention from both academia and industry. In particular, a number of firms in the electronics industry have been strong advocates of DFE.

For these reasons, the Technology, Business and Environment Program at the Massachusetts Institute of Technology decided to undertake an in-depth study of DFE practices at three firms—Xerox Corporation, Digital Equipment Corporation, and IBM—supported by a National Science Foundation Grant. Unlike previous research into DFE practice, the program was interested in looking at the organizational issues surrounding the adoption and implementation of DFE. The author was involved in this research, performing the case study of Xerox, out of which this thesis has evolved.

**Thesis Overview**

The overall goal of this thesis is to demonstrate that middle management plays a central role in the adoption of strategic programs by examining the adoption of Design for Environment at Xerox Corporation. It

\textsuperscript{12}For a broad discussion of the role of corporate social responsibility in various economic ideologies, see Dnaley, John R., *The Role of the Modern Corporation in a Free Society*, University of Notre Dame Press: Notre Dame, IN, 1994.


is hypothesized that without middle management support, implementation is particularly difficult, if not impossible. In addition to validating this proposition, this thesis also seeks to elucidate particular methods used for overcoming resistance to DFE programs at the middle management level.

DFE is a particularly interesting strategy to study for several reasons. To begin with, DFE represents a radical departure from typical approaches to environmental issues. Traditionally, firms have dealt with environmental concerns only because they were compelled to for legal reasons. DFE, as well as some other programs, move beyond this to look at environmental performance as an area of strategic concern. As such, managers are encouraged to consider environmental issues in a new light, as a "want to," instead of "have to" program. Secondly, proper implementation requires coordination between environmental specialists and managers, designers and marketers—groups that are not accustomed to working together. Furthermore, DFE is a very new strategy, and so there are few models on which a company can base their program.

Aside from these intellectual issues of implementation, the author believes that understanding the adoption process is important for a number of normative reasons. First, DFE is believed to be an excellent method for firms to improve their environmental, as well as business, performance. However, the current literature and most studies have only focused upon the technical issues of DFE, ignoring implementation, which is believed to be the most critical issue in the formative stages of DFE. Though tools are necessary at some point in time, they are all useless if no one can be convinced to use them extensively. Therefore, it is hoped that by studying this particular issue, strategies for implementation that help avoid middle management resistance can be developed. This will improve the likelihood that DFE will become a widespread industry strategy, helping to reduce the environmental burden of economic activity.

To examine DFE and middle management's role in the process of implementation, the author undertook an extensive case study of Xerox Corporation's DFE program and how they have gone about implementation. After a thorough review of the history of the company and articles that employees had published about Xerox' DFE efforts, a series of interviews with key people involved in the implementation of DFE was conducted. Most of these interviews took place during a two day site visit to Xerox' primary U.S.
manufacturing facility in Webster, NY, located just outside of Rochester. Additional interviews were also conducted by phone. Interviews typically lasted one hour and were open-ended conversations between the author and the interviewee. In some instances, additional follow-up interviews were conducted as necessary. Approximately half of the conversations were tape recorded (with the individual's consent), and then transcribed following the interview. For those interviews which were not recorded, the author took extensive notes during the course of the interview. In all instances, cited comments presented in this thesis which are in quotation marks are taken verbatim from transcribed tapes, not from the author's notes. Interviews were conducted with over a dozen individuals who held positions from designer to Vice President, covering manufacturing, design and development, and environment functions.\textsuperscript{15}

\footnote{\textsuperscript{15}See Appendix 2 for a list of the names and titles of individuals who were interviewed}
Chapter Two

MIDDLE MANAGEMENT AND THE STRATEGY IMPLEMENTATION PROCESS

When looking at the implementation and adoption of a new strategic initiative in a firm, there are several levels that could be examined. Typically, most literature has focused upon the role of senior management in the formulation and implementation of strategy. Less attention has been given to the role of middle management in the strategy process and, in particular, their resistance to strategic change. The support of people at this level in the organization is, however, crucial to successful strategy implementation.

This chapter examines the literature supporting this proposition, providing a framework for the analysis of the implementation of DFE at Xerox in chapter five. The chapter begins with a look at the general role of middle management within the organization, followed by an examination of the specific role of middle management in the strategy process. The chapter continues by examining resistance to strategic change at the middle management level, concluding with a review of some of the methods for overcoming resistance to change that have appeared in the literature.

**Middle Management in the Organizational Context**

Parsons (1960) notes that while typical line organizations might be viewed as a continuum of power and authority, there exist two qualitative breaks that split organizations into three systems. He labels these the technical, managerial and community or institutional systems. Each level

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serves specific needs of an organization and has different roles regarding their relation to both internal and external systems.

In discussing the role of the technical subsystem, Parsons states that "The primary exigencies to which this suborganization is oriented are those imposed by the nature of the technical task, such as the ‘materials’—physical, cultural, or human—which must be processed, the kinds of co-operation of different people required to get the job done effectively."17 The technical system is the most basic unit of organizational structure, serving as the foundation upon which an organization is formed.

As the organization’s environment becomes ever more complex, the technical system is unable to properly address the additional duties and responsibilities which become necessary. These responsibilities include the organizational need to know what is to be produced, where resources enabling production will come from, and who will benefit from the product of their activity. To address these issues a division of labor has developed such that "the more complex technical functions are performed by suborganizations controlled and serviced—in various ways and at a variety of levels—by higher order organizations,"18 which Parsons labels the managerial system. Parsons notes two focuses of communication between the technical and managerial system: mediation between the organization and the external situation, and ‘administration’ of the organization’s internal affairs.

The third level Parsons identifies is the institutional system. This system serves to deal with interactions that exist above and beyond those necessitated by the procurement and disposal of inputs and outputs, which are coordinated and executed by the managerial and technical systems. This level serves to determine the goals of the organization. It is not, however, able to do this in a unilateral fashion, as an organization "is also part of a wider social system which is the source of the ‘meaning,’ legitimation, or higher-level support which makes the implementation of the organization’s goals possible."19 Parsons sees this level of organization as mediating between the managerial level and these greater social systems whose interests the organization, at some level, is supposed serve.20 It should be noted that in

17Ibid., pg. 60.
18Ibid., pg. 62.
19Ibid., pg. 63-64.
20Ibid., pg. 64.
discussing the institutional systems of businesses, Parsons has in mind the board of the firm and, typically, its top executive.

Distinguishing between levels in the management sub-system is something that has not been systematically addressed in the literature, with most authors taking a "know-it-when-you-see-it" or "common sense" approach. Though analytically frustrating, this may be a reasonable approach given the variety of organizational structures and operations. Despite the lack of a concise definition, authors often identify three levels or management: first level or line management, middle management, and top management. Line management is at the nexus with the technical system, directly responsible for supervising technical workers and their activity. Top management is typically equated with CEOs, presidents, heads of operating units and other similar positions. Middle management is then defined as what lies between these two extremes.

"Middle" managers are easily placed into Parsons' framework as belonging to the "management" system, for their role is internal coordination and external production and distribution contracting. Placing "top" management into the Parsons framework is more of a challenge, as they often fit into both the "management" and "institutional" systems. For purposes of the discussion at hand, however, it is appropriate and consistent with other authors to place them within the institutional system, as they are instrumental in defining and coordinating the "articulation," as Parsons calls it, between the organization and society, a role that middle managers do not hold. Furthermore, this distinction will make it easier to distinguish between the role of top and middle management in the strategy process.

The Strategy Process and the Role of Middle Management

The notion of business "strategy" is a widely discussed field filled with many viewpoints and interpretations. Some authors have framed it as a deliberate activity undertaken by individuals (Grant, 1995), while others speak of strategy as emergent, appearing in an almost ad hoc fashion (Quinn, 1989; Mintzberg, 1987). Assuming that there is at least some deliberative component, those who talk of strategy formulation offer a myriad of systems and prescriptions by which to create, implement and assess strategy. As a review of these approaches and theories is beyond the scope of this chapter, I will only present a quick discussion of the role of strategy and a model of the
strategy process congruent with Parsons’ model of organizations. From this foundation we can proceed to look at the role of middle managers within the process.

According to Grant (1995) strategy, at its most basic level, is “the overall plan for deploying resources to establish a favorable position.” He identifies three fundamental characteristics of strategy: they are important, involve large commitments of resources, and are difficult to reverse. Grant also outlines three main purposes which strategy serves. First, strategy is a support for decision making. A strategy provides a coherent framework in which decisions can be made and helps to provide metrics for deciding what decision is “best” in the context of the strategy. Furthermore, it aids in making decisions in a world dominated by bounded rationality, where all possible decisions can not be investigated to determine the optimal course of action. Second, strategy serves as a vehicle for coordination and communication. A strategy helps people to speak in a common language and understand the common goals they strive for. Finally, strategy can serve as a target. Specific strategic goals serve as a source of motivation and innovation within a firm, pressuring people to establish means to achieve a given end. These targets are what Hamel and Prahalad (1989) refer to as strategic intent. Strategies, whether deliberate or emergent, are extremely important to the success of an organization. Though they may not guarantee success, a well devised strategy will undoubtedly help one to be successful (Grant, 1995).

MacMillan (1978) developed a general model of political action in

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Figure 2-1: Policy Formulation Process

![Policy Formulation Process Diagram](image)

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organizations, which may be equated with the strategy process of a firm. This model results from overlaying models of the policy formulation process and the policy execution process. At the policy formulation level (Figure 2-1), internal and external interest groups make specific demands that are relayed through "group fiduciaries" to the top levels of an organization as policy and inducement demands. At that point mediation of issues occurs and responses, in the form of policy commitments and reciprocal contribution demands, are determined. Interactions between these groups is an iterative process that continues until an acceptable solution is found.

Following the acceptance of policy decisions by the various coalitions, the process of policy execution and implementation occurs. MacMillan's model of this is partially based on Parsons, splitting actors into three levels: technical, administrative and, though not explicitly referred to as such, institutional (Figure 2-2). According to MacMillan, the technical level is responsible for actually transforming inputs into inducement outputs. However, the high level policies developed by the institutional level do not provide enough detail to be useful at the technical level. As such, the administrative level, which we can equate with Parsons' management system and our concept of "middle" management, is responsible for interpreting the policy decisions and developing action items that can be executed by the technical level.

Specifically, MacMillan states that: "The functions of this intermediary system are to receive policy-decision signals; to interpret these signals for specific situations that arise; in terms of its interpretation of policy, to create specific tasks for the execution of the policies by the technical level; to monitor the performance of the technical level and to adjust action at the level at which action departs from policy; and
to mobilize the resources necessary to effect these technical tasks." In keeping with Parsons, MacMillan also notes that information flow is not unidirectional, with feedback provided by the answering of queries and the reception of performance monitoring signals from the level above. Additionally, at both the technical and administrative levels there is interaction with external groups, which is necessary for the implementation and execution of policies. MacMillan combines the execution and formulation models to produce a general diagram of the "flow of political action" in organizations (Figure 2-3). This figure clearly illustrates the central role of the administrative or middle management level, which maintains and coordinates actions between internal and external interest groups as well as between the technical and institutional (policy forming) systems within the organization.

Despite the central nature of middle managers within the strategy process, they have often been seen as a support system for implementation that can be charged with a given task and expected to execute unquestioningly. As Westley (1990) notes, "middle-level managers have traditionally been seen as suppliers of information and consumers of decisions made by the top-level managers, or the strategic apex, of the

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organization."\textsuperscript{23} Such a static view, however, ignores empirical evidence which demonstrates that middle managers are more than conduits of strategic change, serving as sources for ideas about strategy and strongly influencing the implementation process.\textsuperscript{24} In fact, van Cauwenbergh and Cool (1982) state that "It should be emphasized that middle management judgment, opinion, values and evaluation affect the strategy formulation and implementation process in a decisive way. For this reason we claim that middle management rather than top management occupies the central position in the strategy formulation process." [emphasis in original].\textsuperscript{25}

Such arguments, however, are not meant to imply that top management has no role in the strategy process. Van Cauwenbergh and Cool (1982) argue that top management is responsible for managing organizational culture and motivating strategic behavior at lower organizational levels.\textsuperscript{26} The Parsons and MacMillan models clearly indicate that the top level is still responsible for goal formation and policy development, which are important components of strategy formulation. In a more normative vein, top managers often desire to pursue a particular strategy or move the firm in a given direction. In such instances the source of such a strategy becomes less important, and the strategy implementation process becomes the foremost concern.

**Middle Management Resistance to Strategic Change**

The process of implementing the desired strategy of top management is, however, not always a straightforward task. A primary reason for this results from Parsons' qualitative split between top management, who has developed the strategy, and middle management, who are charged with implementing it. This results in what Van Cauwenbergh and Cool (1982)
term “incoherence” in strategic management. The only instance in which such a split would not occur is “when the goal structures of all middle-level managers are completely congruent with the goal structure of general management; and when their perceptions of goal-related cause/effect relations are also highly congruent to that of general management.” Such instances are quite rare, so that resistance to change is commonly observed. The nature of resistance is highly variable and can be both active and passive. It may be as subtle as foot-dragging in implementation or arguments against the strategy to more dysfunctional responses such as the creation of roadblocks or actual sabotage of the process.

Though an understanding of how middle managers resist strategic change may be useful, it is much more informative to understand why they resist, as it is more effective to treat the underlying cause instead of the symptoms. The literature is relatively rich in this subject, particularly resistance to change in general. To consolidate some of this discussion, a simple framework that examines resistance to change along two dimensions can be used. The first dimension, following the distinctions presented by Zaltman and Duncan (1977) identifies the level at which resistance occurs. The four categories that they have utilized are cultural, social, organizational, and psychological. On the other dimension we can look at the nature of the barrier, using the categories of barriers to understanding, acceptance and action established by Connor and Lake (1988). Quickly defining these, barriers to understanding occur when change targets do not comprehend the nature of the change; acceptance barriers appear when targets do not accept the change, challenging its underlying validity; while barriers to action are found when, regardless of intent, individuals or organizations are unable to enact change. Figure 2-4 shows this general framework and incorporates the 18 barriers which Zaltman and Duncan had segregated by level. These 18 barriers form a fairly comprehensive list into which typical problems will fall. This general framework is useful for helping to focus attention on the

27Ibid., pg. 252.
29Ibid., pg. 314, 319-320.
30For a thorough discussion of these factors, readers are referred to Zaltman and Duncan, Strategies for Planned Change, John Wiley and Sons, New York, 1977, chapter 3.
level at which resistance occurs and the nature of the barrier, as both of these are critical to understanding and overcoming resistance.

**Figure 2-4: Resistance Framework**

<table>
<thead>
<tr>
<th>BARRIER LEVEL</th>
<th>NATURE OF BARRIER</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural</td>
<td>Values and Beliefs</td>
<td>Ethnocentrism, Saving Face</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Incompat of cult &amp; chg</td>
</tr>
<tr>
<td>Social</td>
<td>Group insight</td>
<td>Rejection of outsiders, Conform it to norms, Conflict</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group solidarity</td>
</tr>
<tr>
<td>Org’l</td>
<td>Threat to power/influ.</td>
<td>org’l structure, Technological Barriers, Climate for change</td>
</tr>
<tr>
<td></td>
<td>Behav of top mgrs</td>
<td></td>
</tr>
<tr>
<td>Psych</td>
<td>perception personality factors</td>
<td>personality factors</td>
</tr>
</tbody>
</table>

As the discussion at hand focuses upon the micro elements of society, namely firms and the individuals within them, primary attention will be paid to the organizational and psychological levels. Though cultural and social levels are also important, authors discussing middle management resistance to change have tended to focus on resistance at the micro level. Guth and MacMillan (1986) present a much referenced discussion of middle-management resistance. Their general thesis revolves around commitment to formulated strategies which is typically dependent upon perceived self-interest. Guth and MacMillan place resistance into two frameworks: commitment theory and the “richer” expectancy theory, upon which they focus most of their investigation and analysis.

The commitment theory proposition of Guth and MacMillan holds that when the goals of the organization and the individual are in alignment there is a higher level of commitment to the organization, which makes the implementation of change easier. Under this theory “if the perceived degree of goal alignment is low, the individual’s commitment to the strategy will be low, so the amount of effort a middle manager would be willing to put

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31 In discussing resistance to change at the population level of organizations, however, these upper levels become more salient. See Hannan, M. T. and J. Freeman “Structural Inertia and Organizational Change,” American Sociological Review. v 49, 1984, pp. 149-164.
forward to implement the strategy will be low."\textsuperscript{32} A lack of goal alignment results in a lack of commitment (and therefore resistance to change) because adoption of the new strategy is often a threat to power and influence, a barrier to acceptance under the above framework.

Staw (1982) discusses the notion of the commitment process and "behavioral persistence" in greater detail and from a slightly different vantage point. At the psychological level, Staw argues that "commitment is built by actions in which one is responsible for large consequences" [emphasis in original].\textsuperscript{33} Four broad categories relating to such action act to bind individuals to behavior: responsibility for action, salience of the action, consequences of the action, and responsibility for consequences.\textsuperscript{34} As binding to each of these areas increases, so does commitment. High levels of commitment are identifiable by a strengthening of belief, resistance against attack or discrediting, and persistence of behavior, all of which can manifest themselves as resistance to change. Staw also posits that such individual commitment can create structural barriers to change at the organizational level. Such structural barriers create "organizational commitment" which may produce general resistance to change as well. Staw does note that commitment is not inherently undesirable, just that it is possible to be overcommitted to a particular policy or strategy that needs modification. This form of commitment, at both the psychological and organizational levels, can be seen as a barrier to action, locking individuals and groups into the current course of action, unable to escape. Commitment may also take on elements of being a barrier to understanding at the psychological level. The strengthening of belief in a current strategy may influence an individual's perception and make it difficult to understand the inadequacies of the old approach or see how a new strategy is more effective.

In Guth and MacMillan's (1986) expectancy theory approach, commitment and the alignment of personal and organizational goals is only one factor. In this model there are three factors that influence the level of support middle managers provide for strategy implementation: the


\textsuperscript{34}See Staw, pg. 102-107, for a thorough discussion of each binding agent.
probability that they will be able to successfully perform the task needed to implement the strategy; their expectation that successfully performing the tasks will actually result in the organizationally desired outcome; and the degree to which the organizational goal is aligned with their individual interests. These three distinctions roughly correspond to barriers to action, understanding, and acceptance.

The first criteria, probability of successfully performing the task, is dependent upon how extensive the barriers to action are. These appear in the form of technological or structural barriers at the organizational level and prior commitments which preclude implementation at the psychological level. The probability that successful performance will result in the desired outcome is largely a matter of perception at the psychological level, creating barriers to understanding. Finally, the issue of goal alignment, discussed previously, raises issues of power and influence that create barriers to acceptance.

Gaertner (1989) presents a similar list of factors that control middle managers responses to strategic change. These factors also correspond well with the three types of barriers. The variables and the type of barrier they represent are: personal implications of the strategy (acceptance), process of strategy implementation (action), and perception of organizational capacity to implement change (understanding).

This discussion illustrates the large number of ways in which middle managers can, and do, interfere with the implementation of new strategies. These responses occur at both the organizational and individual/psychological level and can spring from issues relating to their understanding of the change, acceptance of the change, and ability to act to bring about change. Specific issues that create resistance to change include threats to the power and influence of individuals or groups, commitment to prior strategies, perceptions about the necessity of change and an organization's ability to do so, technological and organizational barriers, and the capacity of people to implement new strategies.

Overcoming Resistance to Strategic Change

Given this resistance the normative question of how to overcome such resistance arises. This issue is extensively discussed in both the academic and popular literature, and so a complete review is not practical. Instead, this section will present some of the common themes that are discussed in the literature. In keeping with the previous discussion, the methods for overcoming resistance will be matched with the three types of barriers: understanding, acceptance, and action. Though it is important to remember the other dimension of resistance, the level of the barrier, this review will focus primarily upon overcoming the different types of barriers regardless of level. Such an approach will make the discussion clearer. However, it should be kept in mind that some of the strategies for overcoming resistance reviewed here will be applicable only at the psychological level, while others will only apply at the organizational level. Generally, though, there is some level of applicability at both levels.

Overcoming Barriers to Understanding

Overcoming a lack of understanding of the purpose, goals and methods of the change by change targets may be one of the easier problems to overcome if proper time and attention is invested at this step. Furthermore, this is one of the earliest barriers that new programs will encounter, and so problems at this level must be addressed early if a new strategy is to even make it past the formulation stage. Connor and Lake (1988) emphasize that proper resources should be committed to make sure that change targets understand the change. This is not simply a one time exercise, and must be repeated to ensure proper communication. Furthermore, much of the difficulty in understanding can come from the fact that the change targets do not use or understand the “language” that is being used by the change agents. Therefore, it is essential that change agents make a conscious effort to use terms that have meaning to the change targets and will enable them to actually understand the change.36

In the context of Guth and MacMillan’s (1986) discussion, a lack of understanding is associated with the idea that managers associate a low probability of success to a new strategy. To overcome this problem, they argue that general managers must listen to what middle managers have to say so

Chapter Two: Middle Management and the Strategy Implementation Process

they know where they are unclear on how a strategy will proceed. This process should also be encouraged in the reverse direction so that middle managers understand the general managers positions. They also point out that middle manager’s “lack of understanding,” in the form of disbelief that the program will achieve its stated goals, may actually be a lack of understanding on the part of general management about what is appropriate, accurate or implementable. If such is the case, organizations need to determine an effective way for establishing what is desired. In instances like this, they argue that it is important to focus on what is right, not who is right, to avoid damaging political battles. Zaltman and Duncan (1977) discuss reeducation as an approach to increasing the likelihood that change will be accepted.37 In the framework presented here, reeducation serves to improve the likelihood that change targets will understand the change agents and the strategies they present.

Overcoming Barriers to Acceptance

Barriers to acceptance can be some of the most difficult problems to overcome, as they are often deeply rooted in organizations and individuals. Even people who understand the need for change may still be unwilling to accept the change because of the threat to their power and influence or because of an emotional fear of the uncertainty that change brings about. To overcome these problems Connor and Lake (1988) suggest several alternatives. First, if change targets are included in the planning process, either at the strategy development or implementation levels, people may be more willing to accept the change because they have taken part in the process. This approach is also advocated by Guth and MacMillan (1986) and is consistent with Gaertner’s (1989) study that concluded that “among losers [those who have lost power or influence relative to others as a result of the strategy change], support is based much more on whether the employee believes that the process of change was conducted in a way that took adequate account of the needs of individual employees...”38 Furthermore, the inclusion of middle managers in what Westley (1990) terms “strategic conversations” will help to make managers feel included and will energize

them. Westley also notes two situations that increase the likelihood that managers will feel included and energized about the strategy process. The first of these is the extent that mechanisms exist to sustain horizontal status groups, where managers can discuss strategic issues cross-functionally. The second situation is if the organization is ideologically driven. This increases the likelihood that, given a fit between the ideology and strategy, organizational members will feel included, as they are promoting an ideology they have already accepted. However, such ideology may limit sustained levels of high energy because it can stifle innovation and responsiveness. Connor and Lake also encourage active efforts to replace change targets suppositions with facts by distributing information. Finally they note that one must deal with the emotional aspects of resistance, though they provide no specific guidance on how this is to be done. Guth and MacMillan (1986) address this to some degree when they investigate what must be done when the strategy outcome will not meet individual goals. They suggest that there are four different approaches that can be taken: inducement, persuasion, coercion and obligation. (Zaltman and Duncan (1977) also discuss persuasion and coercion). Inducement (which Zaltman and Duncan place under persuasion) entails promising a reward to the middle manager in exchange for agreeing to adopt a strategy, though finding such an inducement may be a difficult task. Persuasion is essentially a reeducation strategy, in which one attempts to convince middle managers that it is actually in their best interest to pursue the new strategy. Zaltman and Duncan, however, distinguish persuasive strategies from reeducative strategies by noting that though reeducation is always based in fact, persuasion can be "totally false." Coercion is the exercise of power to force acceptance by threatening sanctions. For such a strategy to work, the change agent must be in a position to command enough authority so that the sanctions are credible and severe enough to compel the change targets to accept the strategy. However, "the use of such power may result in both direct and retaliatory costs to the user." Obligation is based upon the personal connection that the change agent and

40 Ibid., pg. 347, 349.
42 Ibid., 153.
target have, and requires the change target to acknowledge a "debt" to the change agent and the belief that to not agree to the new strategy would violate this sense of obligation.

Overcoming Barriers to Action.

Connor and Lake (1988) note that "barriers to acting are both some of the easiest to recognize and most difficult to deal with of all the barriers."43 This is due to the fact that such barriers are often structural in nature, such as pre-existing contracts, or the lack of appropriate technologies or skills. As such, the best way to deal with these barriers is by having a long time horizon for change, in terms of both planning and implementation. They also suggest that one needs to perform cost-benefit analyses to see, for example, if a particular contract is worth buying out so that the change process can be started immediately. Guth and MacMillan (1986) note that an inability to execute a course of action can sometimes come from a general lack of self-confidence. Therefore, just providing general support and encouragement can be enough to encourage action. Another often mentioned tactic is training and development to provide people with the skills necessary to bring about change. Zaltman and Duncan (1977) speak of facilitation, providing outside assistance or support, as one method for improving the likelihood that people will act.44 The allocation of additional resources to the change process is often a successful method for overcoming barriers to action.45

General Strategies

Guth and MacMillan (1986) discuss a number of general political strategies for overcoming resistance that can apply to several types of barriers or be used to avoid resistance in the first place. They first suggest the tactic of focusing on the desired ends of a strategy instead of the means, a practice known as eqifinality. This allows middle managers to determine what they deem to be the best course of action to achieve a particular end, avoiding the need to force them to adopt an approach they may not agree with. Sometimes it will be necessary to consider a satisficing strategy, accepting an approach that

may be less than optimal. As is pointed out, it is better to succeed in implementing an acceptable strategy than to fail in adopting the optimal strategy. Their next political method is the tactic of generalization, shifting from specific to more general issues. This may expand the number of appropriate policies for achieving a particular goal and improve the odds that one of these will be acceptable to middle management. The next approach is to focus on higher-order issues, so that what may be undesirable in the short-term is recognized as beneficial in the long-term. As an example, they note that the auto and steel industries were able to get wage concessions by focusing the issues on company survival.46 The final general strategy they mention, which has already been touched on, is trying to include middle management by providing them political access to and input on important issues.47

Guth and MacMillan (1986) also make two very important general points that should be kept in mind when considering strategic change. First, it is nearly impossible to escape from the political process which accompanies any change, and so the goal is always to manage it as best as one can. As they say, "since intervention and coalition behavior exist in organizations, perform a necessary function, and influence decision outcomes, general management must recognize them, understand them, and learn to manage them."48 Second, it is not possible do implement any strategic change without at least some degree of support, commitment and cooperation on the part of middle management.

If general management decides to go ahead and impose its decisions in spite of lack of commitment, resistance by middle management can drastically lower the efficiency with which the decisions are implemented, if it does not completely stop them from being implemented. Particularly in dynamic, competitive environments, securing commitment to the strategy is crucial because rapid implementation is so important.49

46 Ibid., pg. 321.
48 Ibid., pg. 320.
49 Ibid., pg. 321.
Chapter Three

DESIGN FOR ENVIRONMENT

While most firms have determined how to comply with current environmental regulations, they are now facing difficulties determining how to successfully tap into the green markets of the future, realize gains from reducing inefficiencies, satisfy the concerns of stakeholders and prepare themselves to meet future regulatory requirements. Design for Environment is a powerful strategy that has allowed some firms to systematically address these issues.

This chapter provides an introduction to the concept of Design for Environment and reviews the current literature on the subject. After a general overview of DFE, a brief history of DFE initiatives will be presented. This will be followed by a review of current DFE literature, focusing on the frameworks, tools, and organizational issues that have been examined. Finally, DFE will be placed within the context of strategic management that was developed in the previous chapter, completing the analytical framework which will be used to analyze the Xerox case study.

Overview of DFE

Design for the Environment seeks to eliminate the environmental impacts that a particular product or process has during the course of its entire life cycle ("cradle-to-grave" or "cradle-to-cradle," as some say) by systematically assessing, evaluating, and addressing these potential problems during the design phase. 50-51

By incorporating environmental concerns into the design phase, these issues are

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addressed from the outset. Typical compliance methods, on the other hand, deal with wastes at the "end-of-pipe," rather than at the source.

DFE not only "designs-out" waste, making "end-of-pipe" treatment unnecessary, but also focuses on the environmental impacts that occur throughout the product life cycle, such as during distribution, use and at the end of the product's useful life (Figure 3-1: Product Life Cycle). During the design phase, environmental implications from production through end-of-life are formulated as goals and developed into specifications and guidelines. For example, designs can be generated that reduce product weight for improving shipping efficiency, use components with minimal power consumption or extended fluid life during product use, use only recycled or recyclable material, and provide for easy disassembly at the end-of-life. Though some of these improvements could be accomplished after the design phase, the greatest impact at the lowest cost is usually to be realized only if problems are addressed initially.

![Figure 3-1: Product Life Cycle](image)

There are numerous motivating factors that have caused firms to initiate DFE programs. Some of the more common pressures include customer awareness, eco-labeling programs, product differentiation, profitability improvement, regulatory pressures, international standards and employee satisfaction. These drivers are closely related to the numerous anticipated benefits that are expected to be reaped from DFE. First, DFE can improve a firm’s cost position. By reducing pollution firms are able to decrease the costs of compliance, treatment and remediation. Furthermore, DFE can increase efficiency by eliminating waste material and increasing the reuse, remanufacture and recycling of parts and materials. This can reduce production costs. Secondly, DFE can help firms design to meet market demand for environmental performance in the products they produce. A third benefit is that a DFE program may enable a

firm to design ahead of future regulation, so that it is not playing "catch-up" with new laws. Finally, DFE has general social benefits, as the fundamental goal is to improve the environmental performance of the firm. This may be seen as an end itself, but also can help improve a firm's image. Accordingly, DFE is seen as an effective and efficient method for addressing a company's environmental function.

It should be noted that the benefits from DFE have yet to be widely documented. As such, there is room for criticism that these improvements will never actually materialize and that environmental improvement can only come at a net cost to firms. However, as DFE is a relatively new initiative without widespread implementation, neither position has been reduced to the level of fact. Nevertheless, the preponderance of the evidence available appears to indicate that DFE will allow firms to realize the benefits enumerated above. Anecdotal evidence, primarily in the form of a number of case studies, indicates that firms are realizing significant improvements from their efforts, both environmental and economic.53

The case of Xerox presented here also supports this evidence, as discussed in Chapter 4. Some recent theoretical work also indicates how firms may achieve "innovation offsets" from environmental improvement.54 Indirect evidence comes from a recent survey of Fortune 1000 manufacturing firms in the US which indicates that, of firms utilizing some sort of DFE program, the top three reasons (out of eleven) for their program are cost reduction, competition, and potential liability, with market demand as the fifth most important reason.55 Despite a lack of extensive quantification, it appears that DFE is producing the anticipated benefits.

History of DFE

The actual term "Design for Environment" was first used by Charles Overby at Ohio University in the early to mid eighties.56 However, the term did not begin to receive wide-spread attention until the early 1990s when several people at AT&T, particularly Janine Sekutowski, Werner Glantschnig, Barry Dambach and Braden


56 Interview with Jack Azar, 22 February, 1996.
Allenby began using it in several internal and external publications.\(^57\) Perhaps the first published use of the term was in an interim report prepared for Rutgers University by Allenby in May of 1991,\(^58\) while the first widely published article on the subject appeared in the June 1991 issue of MRS Bulletin, where Sekutowski presented a brief description of the goals and purpose of DFE.\(^59\) The first major treatment of the subject appeared in the September 1991 issue of SSA Journal in an article by Allenby, where he presented related concepts, the status of DFE, and a framework for practicing DFE (a series of analysis matrices).\(^60\) This article was followed shortly by perhaps the best early article on the subject, written jointly by Allenby and Ann Fullerton of Digital Equipment Corporation.\(^61\) This article extended many of Allenby's earlier propositions and framed initial discussions of DFE.

During this same time period, Allenby organized a DFE Task Force under the auspices of the American Electronics Association (AEA). In May of 1991 this task force convened a meeting in Washington D.C. to look at DFE and investigate what various companies were doing in this general area (whether or not they were actually calling it “DFE”). Present at this meeting were representatives of Apple Computer, AT&T, The Boeing Company, Digital Equipment Corporation, IBM, Hewlett-Packard, Hughes Electronics, Motorola, Northern Telecom, Polaroid, the U.S. Air Force and Xerox.\(^62\) As a result of these and other meetings that the group held, a preliminary set of definitions for DFE were established. These were eventually published in 1993 as a series of white papers published and distributed by the AEA.\(^63\)

Since then DFE as a concept has received more and more attention. The IEEE has held the annual International Symposium on Electronics and the Environment since 1993, which has to a large degree focused on DFE issues. The proceedings of this conference serve as the richest source of information on DFE. Additional articles in academic, trade and popular journals have been published, and at least

\(^{57}\)Hinge, Shanley, AT&T DFE Case Notes, Unpublished Paper, NYU Stern School of Business, May 1996, pg. 12.
one full book has been dedicated to the topic. Several university research groups have formed to look at the issue, various consulting firms have developed practices in this area, and some software developers have produced computer DFE tools. Though DFE appears to be the moniker of choice, particularly in the electronics industry, similar approaches using different titles, such as green design, ecodesign, and environmentally conscious design and manufacturing (ECDM) have also been undertaken.  

Review of DFE Literature

Over the course of the previous five years, since DFE was first mentioned in the literature, numerous articles on the subject have been published. This section provides a brief review of the major areas that have been discussed. Three main areas of DFE thought, encompassing most of the extant literature, are examined here: general frameworks and concepts; design and development tools; and organizational issues in adoption and implementation.

Frameworks and Concepts

Design for Environment is a systemic approach to thinking about environmental, managerial and technical issues. Though it is a novel approach to these issues, in no way should it be viewed in isolation from other approaches that seek to tackle one or more of these issues. These frameworks and concepts are useful for relating DFE to other research areas and drawing parallels. Furthermore, by linking DFE to other approaches it is easier to identify synergies that may exist, which is useful for achieving normative ends. The primary distinction between the various frameworks to which DFE belongs and related concepts is their domain of influence, defined by the three broad categories which DFE seeks to bridge: design, environmental performance, and management. This section will look at frameworks in each of these areas, and conclude with an examination of some specific DFE frameworks which bring these three areas together.

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65 "Frameworks" can be considered to be approaches which either subsume DFE or are subsumed by it, while "concepts" are related approaches that can be viewed as coequal or allied with DFE.
Design Frameworks.

As DFE is, to a large extent, situated within the design process, it is illustrative to first look at a general framework for this process and briefly examine DFE's role in it. The traditional product development cycle proceeds through four different stages, as shown in Figure 3-2. It should be remembered that this is simplified and general description of a process that, in practice, can vary significantly. Nevertheless, all tasks described will probably occur at some point in all companies, though they may have different names or be partitioned in a different fashion. In the goal specification phase, the goals that a product is expected to meet are developed. At this level the task to be performed during the development process is defined, the problems to be addressed are outlined, and the most general of requirements and constraints are specified. Once the general goals of a product or process have been outlined, more specific plans for achieving these goals are developed. At the conceptual design phase a number of different concepts are usually created and evaluated to find the one that best addresses product goals. The third stage in the process is system design. Once a specific concept has been selected (or in some instances, when options have been narrowed down to a few possibilities), a more complete description of the product or process, short of the specific detail work, is produced. The fundamental engineering concepts that were established in the conceptual phase are elaborated to
ensure their feasibility and workability in the context of the product as an integrated system. When this stage has been completed, a final system layout for the product is produced. In the final stage of product development, detail and manufacturing design, the layout that has been developed is turned into a completed set of engineering drawings and production methods that will be used to produce the actual product. There are a number of DFE related tasks that should be performed at each stage in this design framework to achieve the greatest possible impact.66

There are two other more specific design frameworks, both of which have been developed recently, into which DFE fits. The first of these is DFX, which refers to a series of approaches where X represents some particular desired quality, such as manufacturability, reliability, assembly, and environment, as well as many others. The premise of DFX is that if additional time is spent in the design stage addressing specific issues it is possible to reduce costs and delays further downstream. As a framework, DFX subsumes DFE, which was a very intentional decision. Many people believe that by framing DFE as another DFX issue it will be easier to gain support from designers, for it simply becomes one additional parameter to consider during design.67 This is not a universally accepted position, as many people, including this author, believe that the environment is more than "just another parameter," a proposition that will be looked at in greater detail when organizational issues are discussed.

A concept related to DFE is concurrent engineering. This is an approach where the product and its manufacturing process are designed at the same time, instead of producing designs with little or no consideration of manufacturability that are then "thrown over the wall" to manufacturing engineers. Concurrent engineering helps to eliminate inefficient practices that are a source of significant wastes and requires design engineers to consider additional design objectives. Concurrent engineering is an allied approach which may help the implementation of DFE by encouraging various groups to work together when designing products: if designers are already accustomed to working with manufacturing engineers, they may be more willing to work with environmental specialists.

Management Frameworks.

The primary managerial framework to which DFE belongs is TQM, total quality management, and its offspring, TQEM, total quality environmental management. TQM is an incredibly broad field that is the subject of many books, articles and conferences, and thus subject to the problem of being defined in a myriad of ways. Most quality approaches, however, trace their lineage back to the work of W. Edward Demming, who initiated quality management in post-war Japan. The essence of quality management is that one must look beyond the productive process as merely a mechanical system for producing goods which detached customers consume. Instead it should be viewed as a technical and social system for meeting the needs of customers, where "customer" is defined in the broadest of all possible terms. Though an important part of quality management is the reduction of defects (by using tools such as statistical process control), the primary contribution is the focus on meeting customer needs. This is premised upon the assumption that even a product which possesses technical "quality," manufactured with no defects for example, is nevertheless of no value to a customer if it does not meet their needs; in other words, if it does not possess total quality. Numerous tools exist for achieving both types of quality, with two of the most notable being statistical process control for addressing technical quality and quality function deployment for assessing customer needs.

TQEM applies this framework to the environmental affairs of a company, with the boundaries of consideration reduced to focus upon the management of environmental affairs. Environmental quality is concerned with standard environmental issues of waste and pollution levels as well as considering customer needs, where customers include the actual consumers of a product or service as well as those within a firm who produce the product, the local community, shareholders, government regulators and even future generations (who, for example, can be thought of as future "consumers" of the air that is released through a plant's stacks). DFE is often considered to be one method for achieving TQEM within a firm. Though DFE is usually not considered as a method for identifying customers, it is undoubtedly an excellent method for addressing the needs of a wide range of customers and for improving both environmental and technical quality. Additionally, some DFE efforts, including Xerox', have been structured so that they fit within a company's general TQM initiative, which then serves as a vehicle for implementation.
Environmental Performance Frameworks

There are two primary environmental frameworks into which DFE is placed, namely sustainable development and industrial ecology. Sustainable development is a broad framework which attempts to consider how it is possible to have industrial progress that "meets the needs of the present without compromising the ability of future generations to meet their own needs." This is a relatively nascent concept that is still subject to much debate about what exactly it means to meet today's needs and how one assesses both the potential future needs and the impact of current action on those needs. DFE is often seen as a method by which one can work towards sustainable development by limiting both resource use and waste generation today and potential product impacts from use and disposal in the future. Some argue, though, that DFE merely reinforces current, unsustainable consumerist practices and so does not actually improve our chances of achieving sustainable development.

The second environmental framework into which DFE can be placed is known as industrial ecology. Industrial ecology is a "broad, holistic framework for guiding the transformation of the industrial system environmental impacts of economic activity." One definition holds that:

Industrial ecology...may be defined as the systematic study of the interactions between the human economy in all its aspects and natural biological, chemical and physical systems at all scales. The concept of industrial ecology requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view of industrial operations in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to waste product, and to ultimate disposal. Factors to be optimized include resources, energy, and capital.

Industrial Ecology suggests innovative ways in which systematic environmental impacts may be minimized; for example, the closing of material flow loops through recycling, dematerialization, protecting natural metabolism and reducing energy use and the transfer of waste heat to the natural environment. Two related concepts include industrial symbiosis and industrial metabolism. Industrial symbiosis refers to mutually beneficial cooperation between different

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industries where they seek to transform one firm's wastes into useful resources for other firms.\textsuperscript{73} Industrial metabolism, considers energy and materials flows through the industrial system from resource extraction to the disposal of waste.\textsuperscript{74} DFE is often seen as one method by which the prospects for industrial ecology can be enhanced, as it considers the entire life-cycle of a product in both economic and ecological contexts. Furthermore DFE is seen as systematically combining previously separate environmental practices, such as pollution prevention, product use extension, energy conservation, recycling, remanufacturing, and reuse, which are all instrumental in achieving industrial ecology.\textsuperscript{75}

Dambach and Allenby (1995), place the three concepts of sustainable development, industrial ecology and DFE into one overall framework (Figure 3-3).\textsuperscript{76} They argue that “industrial ecology will form the objective basis on which choices leading to more sustainable economic activity can be based; it is, to oversimplify, the science of sustainability.”\textsuperscript{77} Furthermore, they see DFE as “the means by which

industrial ecology can begin to be implemented in the real world today.” 78 Together these form a broad intellectual framework for addressing environmental issues.

In addition to these frameworks, there are a number of environmental concepts which are often mentioned in conjunction with DFE, and are important to distinguish. The first of these is product stewardship, which refers to acceptance by a producer of some level of extended responsibility for a product across the entire life cycle. Typical product stewardship approaches include the takeback of a product by its manufacturer at the end of its useful life. The Chemical Manufacturers Association has a Product Stewardship Code of Management Practice as part of its Responsible Care program. The goal of the code is to make “health, safety and environmental protection an integral part of designing, manufacturing, marketing, distribution, using, recycling and disposing of our products.” 79 DFE can help to achieve product stewardship by addressing and improving environmental performance across the life cycle. Pollution Prevention (P2) is the general approach of trying to reduce manufacturing waste from production by eliminating it before it is produced, in contrast to the typical approach of pollution control which mitigates pollution after it is produced. Many DFE initiatives help to achieve pollution prevention, but they are not synonymous. There are many ways to achieve pollution prevention without using DFE, and much of what DFE can do goes beyond mere pollution prevention. Life cycle analysis (LCA) is another common environmental initiative that is often associated with DFE. LCA is an analytical approach for determining the environmental impacts of a particular product or process over the entire life cycle from resource extraction to disposal (Figure 3-1: Product Life Cycle, page 36). LCAs are broken down into three stages of analysis: inventory, which records all of the various emissions and environmental impacts, impact assessment, which attempts to determine the relative scope and magnitude of the inventoried contributions, and improvement, which takes the impact assessment and suggests ways in which the environmental burden can be reduced. LCA is often considered to be an information support tool for doing DFE, though there are many things that LCAs can be used for that are outside the scope of DFE, such as for product comparisons or ranking.

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DFE Frameworks

Though there are a number of different frameworks for examining DFE tools (which will be discussed below), few clear treatments or general frameworks for DFE exist. Perhaps the most explicit one is presented by Fiksel (1995), where he breaks DFE down into a two sub-categories of practice, namely Design for Sustainability and Design for Health and Safety (Figure 3-4).\(^8^0\) This author, however, takes issue with the inclusion of Health and Safety issues under the umbrella of DFE. Though such issues are important, their inclusion under the rubric of DFE only serves to broaden the focus of DFE to the point where it becomes a catch-all phrase, not a workable analytic approach.

Figure 3-4: DFE Practice Areas

Allenby (1991) initially presented a two-part schema for DFE practice, which he labeled as a DFE template and a DFE Information System (DFEIS). The template, which is seen as being derived from and compatible with DFX systems, is “a generic practice that could be modified by individual firms depending on their existing design practices, level of sophistication, and other idiosyncratic requirements.”\(^8^1\) The DFEIS is the basis for developing practices and procedures and “may be thought of as the database supporting the use of the DFE methodology in specific


instances.” More recently, Dambach and Allenby (1995) identified two components, generic DFE and specific DFE (see Figure 3-3, page 44). Generic DFE envisions corporate-wide programs that act as a support system for carrying out specific DFE, such as accounting methods and general guidelines. The later category encompasses the particular tools used by designers to improve the environmental performance of particular products or processes, such as CAD/CAM programs, matrices and checklists.

Fiksel (1995) takes an approach similar to Allenby’s (1991) earlier model in describing the elements of DFE. He identifies three key parts, which fit under Allenby’s notion of a DFE template: metrics, design practices, and analysis methods. He also identifies the separate need for a DFE information infrastructure to support the application of these elements. Though these frameworks are useful, it is the contention of the author that they focus too heavily upon the technical elements of DFE, ignoring key strategic and managerial components that are as much a part of DFE as the particular technical tools and methodologies. This argument will be presented in greater detail at the end of this chapter, after some of the other important issues that current literature examines are discussed.

Tools

The area of DFE “tools” has received considerable attention in the DFE literature. Numerous approaches and methodologies have been developed as well as several computer-based design tools that are all meant to allow designers to incorporate environmental concerns into their work. Though tools are not the primary focus of the research at hand, a general overview of the subject is nevertheless in order. Lenox and Ehrenfeld (1995) presented a taxonomy of tools that provides one way to broadly consider the issue. They considered three primary dimensions for classifying tools: applicability to product development stages, applicability to product life cycle stages, and degree of decision support (Figure 3-5). Though this provides a useful method for thinking about the usefulness of a particular tool, it does not provide a convenient description of the types of tools

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available. Mizuki, Sandborn and Pitts (1996) attempted to do this by identifying five categories of tool functionality: life cycle analysis, process flow analysis, disassembly/ recyclability process analysis, manufacturability analysis and other performance optimization.86 Another way to delineate tools is to consider the application methodology that is used. This distinguishes among tools that are general guidelines, checklists, matrices, and database grounded computer tools. This latter classification will be used to quickly discuss some tools and general tool methodologies.

Guidelines are the most general of DFE “tools” that can be used. They are also among the easiest to develop and implement, representing a starting point for many companies in their use of DFE methodologies. DFE guidelines can be extremely broad, such as “design to improve the energy efficiency of products,” to very specific guidelines such as “use only ISO recycling marked, UL certified HIPS plastic composed of at least 50% PCR material obtained via closed loop recycling for the front panel product housing.” Guidelines can be used to force the consideration of any number of issues at any of the design phases. The problem with guidelines is that a certain level of expertise is required to generate them and they provide no decision support to designers for generating or evaluating alternative designs. The advantage of guidelines is that they ensure a minimum level of performance and can often be obtained from outside sources without large resource commitments.

Checklists provide more information to designers and decision makers than guidelines and may allow for some level of comparison between different alternatives. Checklists are useful proscriptively when one can establish threshold

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performance or component criteria for particular designs. For example, one may have a checklist which looks at material selection or the level of emissions during production. It may then be possible to eliminate dominated designs, such as those that use a hazardous material or has emissions above the threshold when another does not. They may also be used prescriptively to identify the minimum requirements which must be met. The difficulty with checklists is that they are qualitative and do not provide a method for evaluating tradeoff situations or identifying relative importance of different characteristics. They are, however, relatively easy to develop, easy to update, and are simple for designers to use.87

Matrices are the next level of tools that one may use in DFE practice. Matrices of various sorts are perhaps the most widely presented type of tool in the DFE literature. Most matrices are semi-quantitative in nature, and so provide a method for trade-off analysis. Quantification, though, is usually subjective in nature, often taking the form of a scale ranking based upon categories of performance. For example, if one cell represents water impacts during the manufacturing stage, it may be assigned a number between one and four, where one represents no water impacts

Figure 3-6: Typical Product Assessment Matrix

<table>
<thead>
<tr>
<th>Environmental Concern</th>
<th>Life Stage</th>
<th>Mat'l Choice</th>
<th>Energy Use</th>
<th>Solid Residues</th>
<th>Liquid Residues</th>
<th>Gaseous Residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource Extraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Manufacture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prod. Pkg. and Transp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refurbishm't, Recyling, Disposal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

87Fiksel, Joseph. “Methods for Assessing and Improving Environmental Performance,” in Design for Environment:
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and four represents high (negative) impacts. Whether to score a three or a four is typically determined by referring to an underlying support document, which identifies threshold levels and ranges for scoring. Typical matrices examine various impacts at different stages of the product life cycle or compare various design proposals on different characteristics. Some matrices are nested, in the sense that by completing one matrix you are able to generate a score for the cell of a higher order matrix. Figure 3-6 shows a typical matrix developed by Allenby and others at AT&T. 88

Allenby has been a particularly strong proponent of the matrix method, presenting a number of different matrices that can be used for various purposes, from general assessment of product and process designs to the selection of materials. 89 Recently, there have been several articles in the literature that use more advanced methods for determining tradeoffs between various component and system characteristics under several possible scenarios. 90 Matrices are more difficult to develop than guidelines and checklists as they tend to require more support and a better understanding of qualitative impacts. Another problem that they face is that in establishing ranking and scoring criteria they must often depend upon subjective determinations. Unless they are thoroughly tested or used with caution, relying solely on a matrix generated “score” may result in decisions that are incorrect. Furthermore, it can sometimes be difficult to assess and propagate uncertainty in the measurements or evaluations. However, if designed properly, matrices can overcome many of these shortcomings. Furthermore, because much environmental data is uncertain and subjective, the simple and semi-qualitative nature of matrices is more likely to make such problems apparent than in a computer program that generates “a number” without exposing the process. For these reasons, matrices are some of the most popular DFE design tools.


Chapter Three: Design for Environment

The final category consists of the most complicated of DFE tools, those which are advanced, computer-based, engineering oriented systems. Defining this category is not as straightforward as for the other three, since there are programs that do a wide variety of tasks. One possible way to break this category down further is to look at those that provide design decision support versus those that help with design generation or analysis. The best example of a decision support tool would be advanced LCA programs, which have been developed and released by several organizations.\(^9^1\) Another example might include tools for adopting “green accounting” such as total cost accounting and full cost accounting.\(^9^2\) In the category of tools that help with design generation and analysis are a wide variety of computer programs that have been developed primarily by academics and consulting groups. Many of these focus on disassembly, recycling and similar end-of-life issues, or material selection. There appears to be no comprehensive review of the available tools, though Mizuki, Sandborn, and Pitts (1996) do provide an extensive list of software tools that are available.

Organizational Issues

Though not examined as extensively as the subject of DFE tools, a number of authors have begun to examine general organizational issues surrounding DFE. The few authors that have investigated such issues agree on the basic premise that DFE is more than just introducing a new set of CAD tools or providing engineers with a list of acceptable materials. One must also establish a DFE program and determine how to encourage engineers to adopt the use of these tools. Despite the greater attention being paid to this subject, it is the contention of this author that not enough attention is being given to these issues. The following section of this chapter will examine this in greater detail. Furthermore, the primary objective of this thesis is to elucidate one particular organizational issue, the role of middle management, which is felt to be insufficiently studied and of central importance to the ultimate adoption of DFE practices. For now, however, we shall focus on what has been discussed in the literature thus far.

Fiksel (1993) briefly addressed organizational issues in one of his first articles on DFE, though has not paid considerable attention to the subject since that time. In

\(^9^1\) Recent authors have started to talk of “abridged” LCA approaches, which are simpler than full LCAs and are often implemented with the use of matrices. Full LCAs, however, are almost always complicated enough so as to require computer support. For a discussion of abridged LCAs see Graedel, T.E., B.R. Allenby, and P.R. Comrie, “Matrix Approaches to Abridged Life-Cycle Assessment,” Unpublished Paper, AT&T Network Systems, October 4, 1994.

this article he lists a number of barriers to the implementation of environmental quality programs: limited resources, organizational and cultural inertia, lack of understanding of environmental issues, inability of existing accounting systems to reflect environmental value, and designer fear that product quality or production efficiency will be compromised. To overcome this resistance, he identifies two types of permanent changes that must be instituted. First organizational norms that place value upon and encourage environmental quality must be established. Secondly, business processes need to be changed to take environmental issues into consideration. Though training and communication from top management is important, he argues that in order to properly integrate DFE into the product development process one must develop design metrics, design guidelines, design verification methods and design decision frameworks.\textsuperscript{93}

Shelton (1995) provides the most extensive discussions of this topic in the literature to date. His main premise is that DFE is primarily a technology management issue, which implies that it sits at the interface between a company’s technical capabilities, business functions, and the market. As such, the goal of DFE is to “align product development activities in order to capture external and internal environmental considerations.”\textsuperscript{94} Shelton argues that there are three organizational tasks which one performs to introduce DFE. The first of these is to perform a “big picture” assessment to establish threats and opportunities that the company faces. After this is complete, lower level groups, though still at the corporate level, focus on developing more specific corporate guidelines. After this has been accomplished, these corporate guidelines can be used to guide more specific activities at the level of product development in the business units. Shelton divides this last category into three sub-categories depending upon the position of a specific product. These three sub-goals of DFE are protecting mature products, enhancing the growth potential of existing products and developing new products. The primary differences when utilizing DFE on these various products is the degree of flexibility in changing the product and process and the amount of resources that will be available to do DFE. Thus DFE efforts on mature products will be very difficult because there is very little flexibility to change the product or manufacturing process and it is unlikely that resources will be allocated to make significant changes. Eagan


and Hawk (1996) take a similar product line approach in discussing appropriate DFE strategies, though they do not look at it from an organizational perspective.\textsuperscript{95} Shelton also addresses the importance of incorporating DFE into all stages of the product development process in order to garner maximum gain. The final point that Shelton raises is that it is best to try to diffuse DFE in an incremental fashion. Because operationalization of DFE occurs primarily at the product design level, he argues against a large centralized program that tries to force DFE on operating groups. Such an approach is likely to generate resistance from line management and invigorate "organizational antibodies." Shelton attributes problems in implementation to several primary issues: line managers skeptical of the value of DFE; a lack of fit between DFE and product development culture; unfamiliarity with the multi-functional team approach which DFE necessitates; the perception that DFE is only a cost with no benefits; and an attempt to create a central DFE organization.

Recently, Veroutis and Aelion (1996) brought up two important non-technical, organizational issues that surround DFE. The first of these is the importance of aligning DFE with the product development process. They note that "aside from the resource commitment to a DFE program implementation, integrating DFE into a company's PDP requires a commitment of time and effort in ensuring buy-in from the product development teams."\textsuperscript{96} They note that there are several methods for integrating DFE into the product development process, and that companies must search out the best method to achieve this within the context of their organization. The second point that they make centers around the environmental positioning of a company. They identify five different strategic positions that a company may take with regard to the environment: compliant, informed, market-driven, competitive advantage and sustainable development. Understanding the goals of the company is useful in identifying the most important issues and how DFE, which is appropriate for every position, can be used to address them. Interestingly, though they examine both high-level positioning and low-level product development, they do not address any mid-level organizational issues associated with DFE.

There have been a number of additional case studies that have described how particular companies have gone about implementing their DFE program.


Unfortunately, most of these do not move beyond the descriptive to discuss general strategies for addressing organizational issues. Furthermore, most articles have tended to understate any resistance or organizational problems that have been encountered. Also, as DFE is a relatively new concept, there has not been enough time to find examples of attempts to implement DFE that have failed and been abandoned (or if there are, they have yet to be discussed). There has also been a lack of discussion centering around the pivotal role of middle management in the adoption and proliferation of DFE practices.

**DFE as a Strategic Initiative**

To date, most authors looking at DFE have viewed it primarily as a tool to be used by designers to produce products and processes that create less of a burden on the environment. Those authors who have looked beyond this have generally focused on organizational issues revolving around the question of how best to get designers within a company to use the tools. There has not been any attempt to squarely frame DFE as a strategic issue. At best, it has only been considered as one method for achieving strategic ends. Furthermore, in discussing DFE no authors have addressed the role that middle management plays in the process of implementation and adoption. The lack of discussion on both of these issues is a major weakness in the extant literature on the subject of DFE. The remainder of this chapter will present the case for framing DFE as a strategic issue, while chapters four and five serve as an empirical foundation for arguing the importance of middle management.

One of the reasons that DFE has not been looked at as a strategic initiative can be traced to its origins, when there was a deliberate attempt to not frame DFE as a significant change from current practice. In fact the very choice of the term "DFE" was made so as to fit it into the realm of an existing design framework, namely DFX. As some organizations who have begun to implement DFE have found, though, it is not as simple as adding a new "X" and creating a few matrices and checklists. AT&T is perhaps the best illustration of this. Despite being on the leading edge of developing DFE concepts and tools, they have yet to find widespread acceptance or use of DFE within their organization. To a large extent this occurred because they believed that creating tools was the most important element of a DFE program, and that use would follow availability. Unfortunately, this has not been the case.97

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Though originally modeled on DFX concepts, DFE is qualitatively different than typical DFX initiatives such as Design for Assembly and Design for Manufacturing. These later programs, though expanding the traditional bounds of design criteria, nevertheless remain within the technical realm of product and process design. To “Design for Assembly” merely requires the consideration of a new set of technical production factors to be optimized along with traditional design criteria such as cost and functionality. DFE at its most basic level does fit within this framework. For example, Design for Disassembly, which is one form of DFE, is fundamentally a technical issue. In its most robust form, though, DFE requires more than just expanding the bounds of technical consideration. First, it requires an understanding of technical issues outside the boundaries of the firm and even its immediate value chain. To complicate matters more, DFE is not just technical optimization, but requires managerial involvement to understand the business climate in which the firm operates or desires to operate. Layer on top of this the need to consider larger political and social issues and it quickly become clear that full DFE is markedly different than typical DFX initiatives. Consideration of intrafirm technical issues is merely the first and easiest step in approaching DFE.

It is important to clarify DFE’s importance at these higher levels before moving on to consider DFE as a strategic issue. The workings of DFE at the intrafirm technical level should be evident, as that has been where most research and practice has been focused. This is where many of the DFX issues that are grouped under DFE fall, such as design for pollution prevention and disassembly, as well as efforts to use recycled materials, improve energy efficiency, and reduce packaging. Technical issues at the value chain level include the sourcing of recyclable or reusable subassemblies, efficient transportation methods, and end-of-life recovery and reuse. Some companies are now beginning to address this issue. At the external level come a number of very challenging issues, many of which are associated with performing accurate life cycle analyses, which are essential for weighing options. To properly design for the environment it is essential to identify the location of the greatest impacts, and thus the greatest opportunities for improvement.

DFE ought to consider a number of managerial issues as well. First, the selection of technical design tools and the adoption of policies, guidelines and standards is a managerial decision. Furthermore, as the literature on quality management has demonstrated, to properly design one needs to understand what it is that needs to be designed. Such a determination should not occur solely within
the firm, but must consider all of the relevant customers. As such, DFE needs to address environmental issues in the markets for which the product will be developed. One challenge to management is coping with the fact that, in contrast to the inherent validity of customer preferences in other areas, what the customer desires may not be good for the environment. In such instances managers must determine how to resolve this conflict. One possible method is educating the customer, so that they will eventually prefer the environmentally “better” product. In addition, a company must determine the type of environmental marketing strategy, if any, that it will implement. Finally, management needs to decide where in relation to environmental issues they wish to position the firm. This is an area that some firms on the forefront of DFE activity have started to examine.

The last area of consideration for DFE is the socio-political system in which the firm operates. The decisions that the firm makes occur within the context of these larger systems. As such, firms act in response to external pressures that are put upon it, such as government regulation or social pressure to “be green.” At the same time, the actions of firms serve to change the social and political system in which it is embedded. This includes conscious action, such as lobbying, to more subtle influences, such as the introduction of products that change how people interact with the world. DFE exists within this system as well, and thus is subject to the demands of the socio-political system, and also a force in creating change within such systems. Few firms, if any, have addressed this aspect of DFE.

Perhaps the best way to encapsulate the notion that DFE ought to address all of these areas is to say that “designing” for the environment entails not only the design of products and processes, but of managerial and socio-political systems as well. To think otherwise is problematic for two reasons. First, because of the interdependent nature of the systems, it is not possible to maximize efficacy in one system without addressing all of the other systems. Therefore, one can not expect to reap all of the environmental benefits from technical design changes without also improving the design of managerial and socio-political systems. For example, one may be able to design a product that is completely recyclable, but it is of limited benefit if there is not a system for recovering the goods (a managerial problem) or if anti-trust issues prevent reuse (a political problem). The second issue is that by

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99 Surprising as it may seem, IBM’s recycling and remanufacturing are currently hampered by a 1956 anti-trust consent decree which restricts IBM’s ability to freely take back products that it produces. Though the market reasons for this agreement no longer exist (namely the fear that IBM would become a monopolist in the computer market), it
focusing only on one level, the potential positive impacts that a DFE program may achieve are limited. If only technical solutions are considered there will be little advance in managerial and socio-political systems, despite the fact that there exists considerable potential for advances in those areas. It is for these reasons that Design for Environment is and ought to be considered more than a technical tool for changing product and process layouts.

It follows from this discussion that DFE is a strategic initiative. This is reinforced by the fact that DFE is poised to meet the three criteria for strategies that Grant developed, namely that they are important, involve large commitments of resources, and are difficult to reverse. DFE initiatives are important undertakings, for it is a central strategy by which a firm can work towards sustainable development, which is essential for long-term survival. DFE should also meet the criteria for requiring a large commitment of resources. Though many efforts which fall under DFE require only minimal resource commitments, the full implementation of DFE requires the modification of many existing systems within a firm, such as development, design, production, procurement, marketing and assessment as well as the creation of new systems to handle product recovery, reuse and recycling; environmental information collection and analysis; and environmental technology development. Finally, full adoption of DFE is an act that is difficult to reverse because of the fact that adoption helps to create a new culture, one where environmental issues are considered important. To change the culture back to one where such issues are not important would require deliberate action. Furthermore, by publicly committing to a particular course of action, such as being a leader in corporate environmentalism, it becomes difficult to step away from such commitment without suffering large negative consequences. Whether or not a particular DFE program is strategic or not depends on the particular company. What has been demonstrated here is that DFE is capable of being a strategic initiative, and, in the mind of the author, ought to be.

Therefore, if a particular DFE program can be shown to be a strategic initiative, it then follows, based upon the discussion presented in chapter two, that middle managers will play a fundamental role in the implementation of DFE. Furthermore, resistance on their part will substantially limit a company's ability to pursue DFE as a strategic goal, unless particular actions are taken to overcome their

\[\text{has been extremely difficult for IBM to get the restrictions lifted. See Davis, John Bremer, "Product Stewardship and the Coming Age of Takeback," Business and the Environment, Cutter Information Corp., 1996, pp. 90-91.}\]
resistance to change. This proposition will be empirically examined in the following two chapters by looking at the adoption of DFE at Xerox Corporation.
Chapter Four

XEROX CORPORATION AND DESIGN FOR ENVIRONMENT

To investigate the ideas developed in the previous two chapters, an extensive case study of Xerox Corporation was undertaken. Xerox is the leading producer of plain paper copy machines, particularly in the mid- and high-volume (in terms of copy rate) ranges. Xerox is also involved in other document related businesses, such as the reproduction of engineering documents, printing, publishing, electronic document handling and reproduction, out-service document handling and advanced computer document processing. They operate around the world with wholly or partially owned subsidiaries in England, Brazil, Canada, China, Korea and India. The English subsidiary, Rank Xerox, which Xerox owns a 71% stake in, also oversees Xerox operations throughout Europe. Xerox also owns a 50% share of Fuji Xerox, which is an independently run Japanese company.

Xerox is also one of a number of companies, primarily electronics firms, which are at the forefront of development and deployment of DFE practices. Jack Azar, who heads up Xerox’ DFE initiatives, has been actively involved in the work of both the AEA and IEEE in promoting DFE in the electronics industry. With the assistance of Dr. Azar, the author was able to do an extensive study of DFE at Xerox. The majority of the information presented in this chapter is based upon literature surveys and interviews with over a dozen Xerox employees (see Appendix 2 for a list of people interviewed and titles). Most were interviewed in one-hour open-ended interview sessions conducted during a two-day site visit by the author to Xerox’ primary U.S. manufacturing facility in Webster, NY. Additional interviews were also conducted by phone after the site visit. Furthermore, several other individuals were contacted by phone only. What follows is a
review of DFE activity at Xerox which will be used in chapter five to support the arguments made in the previous two chapters.

**Overview of Xerox Corporation**

Before moving on to consider the environmental and DFE oriented initiatives that Xerox has undertaken, it is instructive to first provide a general introduction to Xerox. This section provides a quick introduction to the history of Xerox. Following this a discussion of two particular programs that are relevant to the discussion of DFE. The first of these is Xerox' quality initiative, Leadership Through Quality. This program is extremely important to the corporation and can be viewed as the ultimate foundation upon which DFE has been built at Xerox. The second area of consideration is Xerox' model for product development, into which DFE has been incorporated.

**History**

What we now know as Xerox Corporation was originally founded in 1906 as the Haloid Company. Haloid was a very small company that specialized in the making of photographic paper. Operating in Rochester, New York, Haloid existed in the shadow of Kodak. In 1945 Joe Wilson, Jr., son of the President of Haloid, joined the company, eventually becoming president and CEO. Wilson was particularly intent on trying to move Haloid out of the shadow of Kodak and was constantly scouting for new technology that might help to reach that goal. In 1947 he satisfied this drive by acquiring the rights to a process known as xerography ("dry writing") that had been developed by Chester Carlson. For the next twelve years the company consumed all available resources trying to perfect a product based on xerography that would simply and easily make plain paper copies (at that time all copies were made using mimeograph or similar chemical technology that required special papers and/or chemical development). Finally, on September 16, 1959 the company introduced the 914 (because it could make copies on paper up to 9” X 14” in size). This was the world’s first automated plain paper copier, and was able to make up to 15 copies at a time. In March of 1960 Haloid made the first shipments of the 914, which would prove to be one of the most successful product launches in history.

Following the introduction of the 914 the company underwent massive growth. In 1959 the company had sales of only 32 million dollars. By

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100 See Appendix 2 for a company timeline.
1962 sales had tripled to 104 million dollars and by 1968 they had reached one-and-a-quarter billion dollars in sales, carving itself a niche of history as the fastest that a company had ever reached that level of sales. The number of employees also grew incredibly, from 900 in 1959 to 24,000 in 1966. Fueling their growth was a massive expansion in the number of copies that people were making. It was estimated that in the mid 1950s only about 20 million copies were made annually in the U.S. By 1966 the copier had essentially become a business necessity with over 14.5 billion copies being made annually, and almost all of them on Xerox machines, which held a 95% market share as late as 1970.

Given the size of the market, it was inevitable that competitors would eventually try to enter the market. Xerox had managed to flourish unchallenged during the entire 1960s due to the incredible complexity of producing a photocopier and the patent thicket that they had created. Nevertheless, in 1970 IBM introduced the Copier I. Xerox immediately sued for patent violations while IBM countersued charging anti-competitive behavior. This set of an entire decade of legal wrangling between Xerox and not only IBM but several other companies who also made anti-competitive charges as well as the Federal Trade Commission, which brought similar anti-trust proceedings. While Xerox was enmeshed in lawsuits, the company began a long slow slide into near death. Development languished as they tried to develop the ultimate in copying technology. They completely ignored emerging Japanese companies which were targeting low-end users of copiers, which Xerox ignored. By the time that they had settled all of the various cases (which was not until 1982, with Xerox winning most cases), Xerox was no longer the king of the market, having seen its market share erode to 13% by 1982. They had not produced a major new product line since the early 1970s. Between 1980 and 1982 they were forced to lay off 12,000 employees. Xerox began its turnaround with the introduction of the Marathon 10 series of copiers in 1983 and the start of its Leadership Through Quality program, which will be described in greater detail below, in 1984.

Since that time Xerox has slowly made a strong comeback. It encountered some financial difficulties in the late '80s and early '90s because of problems in its financial services business unit, which had been built up through acquisitions in the early 1980s. This caused Xerox to rethink its diversification strategy, and has since sold off all of its financial services
holdings, refocusing Xerox as "The Document Company," and restructuring the company (see Appendix 1 for an organization chart). They have expanded the copier business to include digital imaging and production as well as providing off-site document handling services. Xerox has managed to reposition itself as the premier copier company and is one of the few American companies that has successfully reclaimed significant market share from Japanese competitors. Recent financial performance has been very strong, with company posting earnings over one billion dollars for the first time in over 10 years (See Appendix 1 for consolidated financial data).

**Leadership Through Quality Program**

Though Xerox had tinkered with various quality programs since 1979⁹¹, it wasn’t until the early to mid ’80s that “quality” became a major corporate thrust. Xerox’ quest for quality began in the early 1980s when Kearns, who had been appointed CEO in the spring of 1992, began to realize that Xerox was in serious trouble and needed to make a radical change if it were to survive. After a series of task force reports and high level corporate retreats, Xerox developed the Leadership Through Quality program. This program was based on a policy that read “Xerox is a quality company. Quality is the basic business principle for Xerox. Quality means providing our external and internal customers with innovative products and services that fully satisfy their requirements. Quality improvement is the job of every Xerox Employee.”

Early efforts at training and quality improvement progressed well. An annual Teamwork Days event, which showcased the achievements of various quality improvement teams, was developed. Early success, however, gave way to a growing sense that the quality efforts were not being taken to heart and that the expected results were not being achieved. The quality approach had yet to replace the old culture that existed within Xerox. For example, in 1985 Xerox launched the 4045 desktop laser printer, which was too expensive, did not meet customer functionality needs and had a terrible installation satisfaction rating of about 50%. 1986 was a particularly tough year during which the document organization did very poorly, with Xerox

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kept in the black primarily from the performance of its financial services unit.\textsuperscript{102}

To determine why the Leadership Through Quality effort was faltering, a major assessment was started in March of 1987. They found that most people agreed with the general thrust of the program, but that quality performance objectives were generally not being met. The reasons for this were seen as two-fold: first, profit was still viewed as a superior goal to quality, and second, there was not enough leadership and coaching was not occurring. In general, they found that units with high quality had internalized the quality goals while lower performing units viewed it as something thrust upon them by corporate management. They also found a lack of inspection to ensure the use of quality tools, brought about in part by the fact that there had been no training in inspection methods. Finally, there was a perception that people who did not adhere to quality principles were still being promoted. To address these problems, several changes were made to reinvigorate the Leadership Through Quality program. A training course on evaluation was developed for the top three levels of management. The review process for promotion was modified to include belief and implementation of Leadership Through Quality as a key criteria. The three corporate objectives of improving return on assets, increasing market share, and improving customer satisfaction, which had been developed in 1983 and listed as coequal, were modified so that improving customer satisfaction became the primary goal, with the expectation that that would drive ROA and market share growth. Finally, senior management placed more focus on Leadership Through Quality objectives and made it a significant part of operations reviews. These moves were seen as sending a signal through the organization that quality was a serious goal for Xerox and that people could no longer wait for it to "blow over."\textsuperscript{103}

After this assessment and the subsequent refocusing upon quality goals and principles, the institutionalization and positive results that Xerox had expected started to materialize. For example, groups were pushing customer satisfaction levels to the 100\% level, laggard groups began to catch up and adopt quality principles, manufacturing defects went down, the number of

\textsuperscript{102}Ibid., pp. 218-223.
\textsuperscript{103}Ibid., pp. 229-236.
Overcoming Middle Management Resistance to Strategic Change: DFE at Xerox

vendors was reduced from 4000 to less than 400, delivered part inspection was nearly eliminated by screening vendors better, product costs were reduced by 50 percent, Taguchi methods were adopted, and just-in-time delivery was utilized. Revenue for the document processing organization increased from $8.7 billion in 1984 to $13.6 billion in 1990, income went from $348 million to $599 million, return on assets increased from 9 percent in 1987 to 14.6 percent in 1990, and market share increased from 12 percent in 1984 to 19 percent. Defective parts were reduced from ten thousand per million in 1980 to 325 per million by the end of the 80's, machine performance during the first month after install increased 40 percent between 1985 and 1988, machine uptime for successive models was improved, customer satisfaction improved 38 percent between 1984 and 1988, labor overhead was reduced by 50 percent and materials overhead was reduced by 40 percent.

In late 1988 senior management decided that Xerox should apply for the Malcolm Baldridge National Quality Award. The goal was not so much to win the award, but to use it as a vehicle for conducting a rigorous assessment quality within the company. Nevertheless, in November of 1989, Xerox was informed that it had been selected as one of two companies to win the Baldridge Award for 1989. At the time that Xerox won the Baldridge award they had invested over four million man hours and $125 million dollars in educating all of their workforce. It was estimated at the time that 75% of its workers were members of at least one of 7,000 quality improvement teams.

At the heart of the quality program was a training program that was designed to “cascade” through the company. Starting with the senior managers, one “family group,” people who worked together on a daily basis, went through the program together. After completion, the individuals who had gone through the training would then become a co-trainer when they went through it again with their subordinates. In this way all employees, except for the CEO and the bottom rung of employees, went through the training twice, once as a trainee and once as a trainer. In February of 1984 CEO

104 Ibid., pp. 240-246.
105 Ibid., pp. 255-256.
106 Ibid., pp. 246-255.
Kearns and his senior management group went through the training, beginning the cascade of training.\textsuperscript{108}

The Leadership Through Quality program also identified a number of fundamental quality principles which were used to guide the program:

- Understand customers’ existing and latent requirements.
- Provide all external and internal customers with products and services that fully satisfy their requirements.
- Employee involvement and teamwork, through participative problem solving, is essential to improve quality.
- Error-free work is the most cost-effective way to improve quality.\textsuperscript{109}

Customer satisfaction, both internally and externally, was seen as the basic foundation of the quality program. To achieve this satisfaction a number of business processes were developed and deployed. First, employee involvement was encourage and promoted by the extensive use of Quality Improvement Teams (QITs). Second, an extensive problem-solving process was developed. This process consisted of six primary steps:

- Identify a problem within the group’s area of expertise and develop a clear understanding of it.
- Analyze the problem by gathering data and applying the appropriate statistical tools.
- Generate through brainstorming a number of potential solutions to solve the problem.
- Select and plan the solution by evaluating all options and reach a consensus on the optimum solution.
- Implement the solution by working with those who are directly or indirectly affected by it.
- Evaluate the solution to determine the extent to which it solves the problem.\textsuperscript{110}

The next method for achieving customer satisfaction is through the extensive use of benchmarking and measurement. The importance of measurement is embodied in the process of management by fact. Finally, to encourage employees to use quality tools, Xerox has placed considerable


attention on rewarding and recognizing both team and individual performance.

Currently, Xerox has undertaken an initiative to revitalize their Leadership Through Quality Program as part of CEO Allaire's Xerox 2000 strategy that was initiated in February of 1994. The decision to revitalize the program was made after a major assessment of the Leadership Through Quality program was undertaken in 1993. Despite the fact that many of the underlying quality precepts were still valid, it was felt that the company suffered from "concept clutter" and that there was a need to consolidate the various quality tools that had been developed. To clarify its activities, a Xerox Management Model was developed (Figure 4-1). Underlying each of the six basic business practices are a number of specific practices. Each of these practices also has an associated desired state to guide activity, which is assessed by measurements which are tied to the practice. These practices are deployed by use of Xerox' Management for Results program. This process involves the setting of direction, deploying of direction, and the managing of direction to implement the desired strategy.\textsuperscript{111}

Xerox strongly believes that their Leadership Through Quality program was the primary reason behind their resurrection from near death. They have improved their return on assets from a low of just over 5% in 1984 to 16.1% in 1994, substantially improved sales, regained status as a premium producer, and achieved growth in their stock price. They have dedicated themselves to continuous

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure4-1.png}
\caption{Xerox Management Model}
\end{figure}

improvement and are diligently trying to avoid a repeat of their 1970s malaise and 1980s breakdown.

Product Development Process

The current model of product development at Xerox encompasses five distinct stages: Pre-concept, Concept, Design, Development and Production. To this is often added the Launch and Maintenance stages, though they are not a part of product development proper. In the Pre-concept Phase, product strategy and "voice of the customer" requirements are established.112 A business case is developed113 and technologies and product architecture (size, software, etc.) are selected.114 Approximately one half of product development time is spent in this stage.115 In the Concept Phase, the Product Delivery Team is formed.116 This multi-functional team reviews the sets of all available Worldwide and Multi-National Design Standards, culling from these a subset of standards that are applicable to the particular project and that they intend to pursue. This team is also responsible for developing the actual systems and subsystems. At the end of the Concept Phase, and integrated test prototype should have been developed.117 In the Design Phase, the prototype is evaluated and further work continues. During the Demonstration Phase, the final product configuration is established. "The strategy developed in the Pre-Concept Phase and the plans developed in the Concept Phase and updated in the Design Phase are now implemented."118 In Production, the new product is produced on the new manufacturing lines and prepared for initial launch. At the end of each stage of the product development process, the product must pass through a Phase Gate review. The status of the product is compared with certain exit requirements that were initially developed. "Issues and problems identified during the assessment are classified as ordinary, major or critical. Critical problems stop program progression to the next phase. Major and ordinary problems do not stop phase transfer; however, there must be a plan of action for resolution in the next phase."119

113 , pg. 22.
114 Interview with Dan Schirmer, Eugene Yang and Augie Ange, 25 April 1996.
115 Ibid.
117 Interview with Dan Schirmer, Eugene Yang and Augie Ange, 25 April 1996.
118 Xerox Corporation, "Asset Recycling: The Future is Here," pg. 23.
In addition to the five official Phase Gate reviews, there is a considerable amount of informal peer review that occurs. Other people, from other parts of the development project, as well as people from outside of the project are brought in to informally assess the product and to ask questions about it. Both the product and design engineer's performance is evaluated on whether costs can be recouped over the life of the machine, and not so much on initial unit manufacturing costs. Xerox uses the term "Total Cost of Ownership" to describe this.\textsuperscript{120}

\textbf{Evolution of EH&S and Environmental Management}\textsuperscript{121}

In 1980 Xerox formalized its commitment to the environment creating an official Environment, Health and Safety (EH&S) organization. James C. MacKenzie was appointed to direct this organization, and is still in that capacity today. At that time Xerox adopted its first environmental policy: "Xerox corporation is committed to the protection of the environment and the health and safety of its employees, customers and neighbors. This commitment is applied worldwide in developing new products and processes."\textsuperscript{122}

After the tragic chemical leak in Bhopal, India in December 1994, many companies realized the magnitude of the potential for disaster that existed. Xerox was no exception. In fact "As soon as Bhopal happened, within a month we had letters to everybody to get out and see what the story was and do a risk assessment and see...whatever the situation was."\textsuperscript{123} This began the process of a worldwide assessment of all facilities and sites. In January of 1985 the EH&S group was directed to begin a worldwide assessment of all environmental risks and to examine methods for their elimination. Proactive changes were made by minimizing chemical storage, eliminating or build secondary containment systems for all underground storage tanks, and by trying to eliminate the use of hazardous chemicals. For example, "At a Xerox facility situated near a nursing home, the stored tanks of chlorine were first reduced, then removed, and finally chlorine was eliminated altogether.

\textsuperscript{120} Interview with Dan Schirmer, Eugene Yang and Augie Ange, 25 April 1996.
\textsuperscript{121} See Appendix 1 for a timeline of environmental developments at Xerox.
\textsuperscript{123} Interview with James MacKenzie, 26 April 1996.
from the manufacturing process."\textsuperscript{124} In addition, Xerox also sought to find instances where ground water or soil contamination could have occurred as a result of solvent use, and then unilaterally began remedial treatment. This included treatment at facilities where local environmental laws did not necessitate corrective action. David Kearns, CEO of Xerox at the time said that "If we cannot afford to protect the environment, we should get out of the business."\textsuperscript{125}

In August of 1985 Xerox discovered that it had its own problem at its primary manufacturing facility in Webster, New York. Several wells appeared to have been contaminated by a leaking underground storage tank. There was some suspicion that this had caused the serious health problems of nearby residents. Xerox settled a lawsuit by several of the families by purchasing their land, relocating them and agreed to a four million dollar settlement.\textsuperscript{126} According to MacKenzie, "that really galvanized us to action."\textsuperscript{127}

Sixty-six sites have been identified worldwide for treatment since the assessment began in 1985. Of these, remediation has been completed at eleven. Xerox also developed a "2-phase" extraction system, first deployed 1991, which has dramatically cut both the time and cost of many remediation efforts relative to the traditional pump and treat method.\textsuperscript{128} Xerox claims that it has spent over $50 million dollars in proactive environmental remediation,\textsuperscript{129} with an expenditure of $7.3 million in 1995.\textsuperscript{130} Xerox is a Potentially Responsible Party (PRP) at 13 Superfund (CERCLA) sites, which resulted in $160,000 in expenditures in 1995.\textsuperscript{131} MacKenzie says that at most of these sites Xerox is responsible for about 1/10th of one percent of the contamination,
though there is one site where they may be responsible for one to two percent of the volume that has been found.\(^{132}\)

In the late 1980s MacKenzie said that he started to become aware of new forces, particularly in Europe, which were pointing towards the need for environmental activism that went beyond compliance. MacKenzie said that "I kept telling the management back here 'you better get our marketing people and our product design people geared up for what's coming.'"\(^{133}\) After saying this for a while, Bill Lowe, Executive Vice President of Development and Manufacturing, asked MacKenzie in the spring of 1990 to develop a strategy for recycling.\(^{134}\) MacKenzie began working with Jack Azar, who had been doing other policy and strategy work in EH&S, and Don Monafelt, who worked on developing strategy for the Supplies unit, to develop a recycling strategy. Though realizing that such a strategy needed to go beyond just recycling, the focus of what they developed was primarily recycling. In late October of 1990, they presented the strategy that they had developed to CEO Paul Allaire and other senior staff in Xerox. According to MacKenzie, Allaire asked "Well Jim, what do you want me to do?" MacKenzie replied that "I want you to support me." To this Allaire replied "I not only support you, I mandate you."\(^{135}\) This initiated the creation of what came to be know as the Environmental Leadership Program. Abhay Bhushan, who had been a manager in standards and systems integration, was appointed to coordinate environmental programs. Azar was appointed to the position of Corporate Manager, Environmental Design and Resource Conservation, and was charged with creating links to suppliers, government agencies, and industry groups and developing strategies and technologies for encouraging environmental design and technology.\(^{136}\)

In addition, an Environmental Leadership Steering Committee was formed in early 1991 to oversee and promote the activities of the Environmental Leadership Program. MacKenzie, Azar and Bhushan developed a list of people, primarily high level managers, who they thought

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\(^{132}\)Interview with James MacKenzie, 26 April 1996.

\(^{133}\)Ibid.

\(^{134}\)Interview with Jack Azar, 22 February 1996.

\(^{135}\)Interview with James MacKenzie, 26 April 1996.

might be particularly interested in these initiatives, and asked them to serve on the steering committee. Among the people who served on this committee were Phil Sliva, Vice President of Supplies, Joe Marino, Vice President of the CRU group, and John Elter, Vice President of Strategic Programs, all groups which would later be leaders in proactive environmental initiatives.\textsuperscript{137}

**DFE Throughout Xerox**

Design for Environment at Xerox has been undertaken by a number of different groups and organizations throughout the company, though not always under that particular name. The primary corporate group responsible for developing and disseminating general DFE information and knowledge is the Environmental Products and Technology group, which falls under corporate EH&S. In terms of operationalization of DFE, the focus has been on remanufacturing, which is coordinated by the Asset Recycle Management organization, which is a part of the Integrated Supply Chain group (see Xerox Organization Chart, Appendix 1) and is also a general corporate operation. Three operating groups who have been on the forefront of DFE initiatives were also investigated as part of the case study. Two of these are the Customer Returnable Unit (CRU) group, located within Manufacturing Support, and Supplies Development and Manufacturing Services. It should be noted that all four of these groups are a part of the high-level Corporate Strategic Services group, which provides support for product development groups. The final group studied is a product development organization under the Office Document Products Group. Officially titled Strategic Programs, though referred to as the Departmental Copiers Program here to remain consistent with previous publications, they are currently developing a new platform line of mid-volume copiers for the general business office market.

What follows is a discussion of the activities relating to DFE that have been undertaken by each of the five organizations. This information comes from both interviews and a review of the literature that has been published by people in these groups. This provides the background for examining and understanding the discussion of resistance to change at the middle management level in chapter five. In particular, what follows illustrates the specific activities which have been used to overcome resistance and

\textsuperscript{137}Interview with Jack Azar, 20 June 1996.
Overcoming Middle Management Resistance to Strategic Change: DFE at Xerox

demonstrates the positive results, which imply some level of success in implementation, that have been realized.

Environmental Products and Technology

In 1990, after working on the task force which had established the Environmental Leadership Program, Jack Azar was appointed to the newly created position of Corporate Manager for Environmental Design and Resource Conservation. This position formalized much of the work that Azar had been doing on an ad hoc basis. Azar was responsible for promoting and developing design tools and technologies which could be utilized within the company. He also was responsible for networking and observing suppliers, industry organizations, environmental groups and government agencies on issues relating to design and resource conservation.138

Organization

Jack Azar and his group fill the role of corporate champions and supporters of Xerox' Design for Environment initiatives. Azar, with recent support from a growing group, helped to organized several of the initial pilot projects, lobbied product development groups to pursue such activities, maintains contacts with people in similar positions at other companies, supports development of DFE tools, and collects information on market reasons for pursuing DFE. Azar has recently been promoted to the position of Associate Director, Environmental Products and Technology.

Azar currently has seven people, two of which were just hired, working for him to facilitate and develop Xerox' proactive environmental initiatives. Steve Dunn, Manager of Environmental Technology, works on addressing technical barriers by developing proactive technologies for improving product environmental performance and will help to implement the corporate environmental technology strategy when it is written.139 Catherine Genca, Manager of Resource Conservation, works on improving the environmental performance of products and deals with suppliers as well. Genca helped to develop a carbon dioxide cleaning system to replace tri-

139 Interview with Steve Dunn, 26 April 1996.
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chloroethane, an ozone depleting substance.\(^{140}\) Patricia Calkins, who had the same position prior to becoming a quality manager in the summer of 1995, helped develop a process that improved the solvent-based coating process for some items.\(^{141}\) Andrea Jacobs, Manager of Regulatory Affairs, scans worldwide regulations and requirements to find those that might apply to Xerox products and processes. Of the new people that Azar has hired, one will be doing work on environmental communication and another will be looking at life cycle issues as they relate to marketing. Azar is also currently looking to hire a Manager of Environmental Marketing and Communications to replace Abhay Bhushan, who recently left the company.\(^{142}\)

**Championing and Assessment**

When he first began, Azar would send a list of environmental requirements and guidelines directly to general managers, with the hope that they will filter down to product designers. He would make personal contact with groups and tried to lobby and explain to them why it was in their best interests to pursue these types of activities.\(^{143}\) Recently, he has released a document containing the Multi-National Standards for Environmental Requirements and Guidelines. These guidelines, which are made generally available to designers and are posted on Xerox' internal network, are in the same format as all Xerox standards. They break down environmental issues into several categories such as energy use, product labels, and regulations. For each category, particular guidelines are stated, where they are applicable, when they will become applicable, and if they are mandatory or not.

Azar has also started to conduct a survey of all business groups to find out who is doing environmental design activities. In this survey, which he has conducted the previous two years, he asks if they are doing anything to address remanufacturing, environmental market access (such as meeting Blue Angel guidelines), or other environmental initiatives in design. Two years ago 25% of new project starts said that they were addressing at least two


\(^{142}\) Interview with Jack Azar, 20 June 1996.

\(^{143}\) Interview with Jack Azar, 22 February 1996.
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of these three areas. In a survey finished in January of 1996, of the 80% of project groups worldwide who responded (not including Fuji Xerox projects unless they are integrated with Xerox or Rank Xerox), 75% are considering at least two of these areas. Azar says that he has done some follow-up assessment and that groups usually do what they say they will. This high percentage of groups working on environmental initiatives surprised even Azar, as many of them were occurring without his knowledge.144

Waste-Free Goals

Jack Azar was also responsible for developing Xerox' Waste Free Products and Waste Free Factories initiatives. The Waste Free Factory concept was developed jointly by Azar and Joe Marino of the CRU business unit (see following section on the CRU organization). Another initiative has been to achieve Waste-Free Offices. These are all major initiatives by Xerox to reduce the amount of material that is sent to landfill.

The goal of Waste-Free Products has been primarily addressed by utilizing DFE techniques in conjunction with the more narrow Asset Recycle guidelines (see the discussion of ARM in the next section). In producing Waste-Free Products, Xerox aims to:145

- Satisfy all current and projected regulatory requirements
- Satisfy criteria defined by major environmental labeling programs (e.g. German Blue Angle, U.S. E.P.A. Energy Star, Canadian Environmental Choice, etc.)
- Satisfy customer requirements
- Meet Xerox' internal asset recycling requirements

The Waste-Free Factory (WFF) program has nine areas target areas for waste management: Strategic Planning, Environmental Communications, Use of Post-Consumer Materials, Air Emissions Reductions, Solid Waste Reduction, Hazardous Waste Reduction, Water Discharge Conservation, Energy Conservation and Environmental Leadership. Xerox developed a WFF Self-Assessment Matrix in 1994 to help facilities address these target areas. In addition, specific Waste-Free Factory Goals were established, which are to be met by 1998 based upon baselines for each facility. These are:146

144 Interview with Jack Azar, 25 April 1996.
• Decrease municipal, hazardous and chemical waste by 90%
• Decrease air emissions by 90%
• Decrease water discharges by 50%
• Increase the utilization of post-consumer materials to 25% of materials purchases.
• Increase energy efficiency to within 10% of each facility's theoretical optimum.

**DFE in the PDP**

In 1993 the Product Delivery Process at Xerox was formally modified to include end-of-life considerations. Since that time, further environmentally oriented design requirements have been developed and are currently in the process of being incorporated into a new Product Delivery Process. In the current system, environmental issues are still addressed from the outset of the development process. In the Pre-Concept Phase, an environmental strategy is developed based upon the general product strategy and Voice of the Customer requirements. These strategies are then translated into a specific environmental plan during the Concept Phase. At this stage, specific environmental specifications that are to be met are developed. During the Design Phase, the prototype product is tested to see if it meets the specific environmental performance criteria that have been developed. The information that is obtained from these tests is used for developing the final product configuration during the Demonstration Phase. Continued testing, analysis and review occurs through the remaining phases of Production, Launch and Maintenance.147

**Environmental Market Analysis**

One of the most powerful tools that Azar's group uses to convince product development groups of the need for DFE is by relating information about the market's demand for more environmentally benign products and the emerging issue of "environmental quality." Currently, there is not a systematic approach to this issue, but attempts are nevertheless made to collect such information. Steve Dunn, Manager of Environmental Technology, says that there are three types of evidence that can be gathered and used to demonstrate the importance of these issues:148

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148 Interview with Steve Dunn, 26 April 1996.
Statutory Inevitability. These are examples of laws that have been passed in some areas or are soon to be passed that require a certain level of environmental performance or stewardship. Currently, Andrea Jacobs is responsible for collecting this information. This information provides the clearest message to development groups.

Market Leadership. In this category are examples of how consumers demand or prefer more environmentally benign products. Much of this information consists of anecdotal evidence, but there is a push to obtain more numerical data. They have contacted consulting firms to obtain information. They have also added environmentally oriented questions to the surveys which Xerox customers are sent at least once per year. Some of the specific information that they are attempting to discover is if people exclude products because of environmental factors, what their sensitivity to such issues is, and how they are ranked in comparison with other attributes.

Market Exclusion. This final category describes instances where environmental performance issues have contributed to Xerox being unable to make or bid on a contract. This can also include gathering evidence of potential places where they might become excluded. This information usually comes from the sales force. There have been several examples in Europe where they have not been able to meet bid requirements for environmental reasons. These are often government contracts.

There currently exists an Environmental Marketing QIT, which was initially formed in 1991 by Azar. The group initially examined how to improve customer perception of remanufactured machines, though that role has expanded significantly, conducting market research and market assessment.149 This group has representatives from the operating companies and various business divisions.150 They are currently in the process of recruiting to hire a full-time individual to do environmental marketing and communication and develop a consistent marketing strategy.151

The group has also gone about establishing a view of the world marketplace and how it will change in the near future. This information is

149 Interview with Jack Azar, 20 June, 1996.
150 Interview with Patricia Calkins, 22 March 1996.
151 Interview with Jack Azar, 25 April 1996.
seen as important in developing the strategic thrusts that Xerox will follow. (See Table 4-1)\textsuperscript{152}

<table>
<thead>
<tr>
<th>World Marketplace</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most customers require environmental products and services (e.g., waste returns)</td>
<td>1-3 years</td>
</tr>
<tr>
<td>Marketplace accepts/prefers recycled content products</td>
<td>Now-3 years</td>
</tr>
<tr>
<td>-Government purchasing policy important</td>
<td>Now</td>
</tr>
<tr>
<td>Energy efficiency key requirement</td>
<td>Now</td>
</tr>
<tr>
<td>Environment labels commonplace; recognized by public</td>
<td>Now-3 years</td>
</tr>
<tr>
<td>Recycling of business equipment well established</td>
<td>2-3 years</td>
</tr>
<tr>
<td>-Partnerships between OEMs and suppliers</td>
<td></td>
</tr>
<tr>
<td>Recycled materials (plastics) available in quantity</td>
<td>2-5 years</td>
</tr>
</tbody>
</table>

**DFE Tools**

There are a number of different tools that have been developed throughout the organization to improve Xerox' ability to do DFE type activities. Those discussed here are generally available and used throughout Xerox. Though not discussed here, some development and business groups have developed their own tools as well, notably the departmental copiers program. Perhaps the most important "tool" that has been developed is the Multi-National Standards and Guidelines. These provide the clearest direction for developers are distributed to designers and are posted on Xerox' internal network. They are in the same format as all Xerox standards and break down environmental issues into several categories such as energy use, product labels, and regulations. For each category, particular guidelines are stated, where they are applicable, when they will become applicable, and if they are mandatory or not.\textsuperscript{153} Work had been started in the Standards group to develop a DFE "Pumpkin Book," which is an extensive guide for Xerox designers. However, this project was canceled around 1994 due to other priorities.\textsuperscript{154} A life cycle model, which enables designers to look at trade-offs


\textsuperscript{153} Interview with Jack Azar, 25 April 1996.

\textsuperscript{154} Interview with Ed de Jong, 16 July 1996.
between different design parameters and life cycle costs has also been developed. This model does net present value calculations taking into account "material selection, remanufacturing return on investment, disposal costs at end-of-life and other related cost factors."\textsuperscript{155} The model also allows for sensitivity analyses to be conducted. All products above a minimal size and all nth sheet drawings are required to be marked with both end-of-life and remanufacturing codes. The remanufacturing codes indicate whether or not the piece part can be remanufactured and under what conditions. The end-of-life codes indicate if the material is hazardous and whether or not it can be recycled. Another tool that enhances Xerox' ability to reuse parts is known as signature analysis. This is a method of testing the critical performance of a particular part to determine if it can be reused. This is an essential technology for enabling asset recycling.\textsuperscript{156}

**ARM Organization**

The Asset Recycle Management (ARM) group is the primary corporate organization for coordinating Xerox' major drive for remanufacturing. This group provides technical support in the form of consultation and training. It also assigns remanufacturing engineers to design groups to help them tackle these issues. The group is also involved in developing technologies that will promote remanufacturing capability. ARM represents the most extensive, corporate-wide operationalization of DFE practice within Xerox.

**Formation of ARM**

After the October 1990 presentation to Paul Allaire and other senior management by MacKenzie, Al Dugan, who was Senior Vice President and General Manager of Manufacturing Operations at the time, chartered Dick Morabito, Vice President of Manufacturing, to form a Quality Improvement Team to look at asset recycling. This group, which had about 25 people, including Jack Azar, worked until April of 1991 developing a more specific strategy than that originally developed by MacKenzie, Azar, and Monafelt. The task force made several major recommendations to Dugan at that time.


First, they identified short term projects where asset recycling could be undertaken profitably. Second, they suggested creating a dedicated organization to coordinate and implement asset recycling throughout the corporation. Finally, they examined the product develop process and made general recommendations about how it should be changed to include asset recycling issues. Soon after this report was issued, the Asset Recycle Management organization was created. Morabito was appointed Vice President, Asset Recycle Management, and reported directly to Dugan.

**ARM Mission, Objectives and Deliverables**

The mission of the ARM organization was laid out in an internal sales document entitled *Asset Recycling: The Future is Here*. The mission is:

Asset Recycle Management (ARM) is a Worldwide Asset Recycle organization that provides strategic planning, new product technical support and environmental linkages to enable Development & Manufacturing (D&M) and its customers to achieve Corporate priorities through profitable utilization of unserviceable parts and equipment consistent with environmental goals.  

Furthermore, a number of business and environmental objectives were outlined as well. The Worldwide Recycle Business Objectives were:

- Improve Return on Assets (ROA) by recycling machines, assemblies and parts efficiently  
  - Enhance velocity of recycling to capture a competitive advantage  
  - Full utilization of worldwide excess inventories to increase profits  
  - Early recycle of unserviceables to increase cash savings and reduce inventories  
  - Early involvement in product design to improve product life cost  
  - Co-location of recycle with new build manufacturing to increase flexibility  
- Improve customer satisfaction  
- Increase market share through meeting customer requirements for environmentally friendly products

The Worldwide Environmental Objectives were:

- Full support of corporate goal committed to leadership in environmental protection  
- Incorporate environmental requirements into the design of parts and assemblies earlier in the product development cycle  
- Increase use of recycled/recyclable materials in parts and equipment

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158 Ibid., pg. 17.
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- Reduce volume of materials landfilled
- Increase use of environmentally friendly materials in the workplace
- Reduce pollution and contamination of the environment\textsuperscript{159}

Given these broad goals, ARM was charged with delivering a number of specific results:

- Recycle strategy direction for Xerox Corporation that is consistent with environmental requirements, corporate goals and customer requirements.
- Support for Product Delivery Teams and Manufacturing Resources Teams in delivering recycling capabilities consistent with the recycle strategies.
- Support for Worldwide Marketing and the operating companies in developing and implementing recycle strategies for environmental responsibilities.
- Positioning Xerox Corporations as an industry benchmark for environmental responsibilities.
- Increase cash flow and improve ROA
- Facilitate removal of barriers to recycle strategy success (legal, performance measurements)
- Enable Asset Recycling at product launch\textsuperscript{160}

**ARM in the Product Development Process**

One of the first things that the ARM organization tackled was trying to modify Xerox' Product Deliver Process (PDP) so that Asset Recycling issues could be effectively addressed and dealt with before the product was launched and returns began to come in from the field. The new PDP was officially inaugurated in early 1992. The primary goals of changing the way that the PDP worked was to enable Asset Recycling by incorporating a recycling strategy during product design so that Asset Recycling could occur from product launch, preventing the accumulation of field returns. In order to support these changes in the Product Development Process, ARM engineers are assigned to product development groups to work with them during the course of the development cycles. These engineers become a regular member of the Product Delivery Team.

**ARM Training**

In order to facilitate the implementation of Asset Recycling goals and objectives within the various business groups and development teams,

\textsuperscript{159} Ibid., pg. 18.
\textsuperscript{160} Ibid., pg. 20.
several training programs have been developed. The training is divided into three levels, each with different coverage of asset recycling for the different intended audiences. Level I training is intended to provide high level managers with an overview of asset recycling goals. This briefing session is only a few hours long and is targeted to Division Presidents, Business Managers and to the Product Architecture Team. Level II (Process) training is presented to Strategy Managers, Technical Program Managers, Process and Planning Managers, Manufacturing and Advanced Manufacturing Resource Team Managers. This afternoon long program explains the role of ARM personnel in the PDP, general strategy and design requirements and product assessment checklists. Level III (Implementation) training forms the crux of the ARM training program. It is at this level that design engineers are trained in the specifics of how to achieve asset recycling goals. The program reviews the information of Level I and Level II, and then proceeds to look in detail at issues such as Design for Environment, materials selection, remanufacturing requirements, recycled content, hazardous material avoidance and other design specification issues. In its current incarnation, Level III training consists of one eight hour general training session which can be supplemented by any number of four-hour modules that have been tailor-made to address issues that are specific to the particular development group going through training. 

Training is voluntary, though there is strong pressure for all groups to go through the program. As with most programs, it is up to individual business groups to decide whether or not it makes business sense to go through the program. Generally, though, almost everyone seems to think that it does. Ralph Sholts believes that all Vice Presidents and General Managers in the product development world have gone through the Level I training course. He also says that “in most cases, the demand for training is more broad than it is narrow. People do not do the minimum. In the first year or so we did this, we had to convince people how important it was to be trained. And now they call upon us and say ‘please come in and train these people.’ As a matter of fact, there’s been so much interest and so much sharing of information and so much financial advantage because of

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consensus through the use of knowledge gained in these training programs that some organizations are asking us to train their hands-on industrial workforce on the production lines." 162 According to Victor Berko-Boateng, an ARM engineer who first developed the training programs, over 2000 engineers have gone through Level III training. This represents most of the design engineers in most business divisions. In addition, some people have gone through the program more than once (but are only counted once in the above figures). They have also held training sessions for their various operating companies, including two in Brazil, two in Mexico, and two in Britain.163

ARM Recycling Efforts

As part of its mission, ARM is charged with developing technologies and methods to increase Xerox' ability to recycle all materials. In support of this Victor Berko-Boateng, an ARM engineer responsible for improving recycling technologies, has undertaken a number of different initiatives. The first effort that he initiated was a study of the waste stream from production facilities.164 For one month he collected all wastes, which were normally sent to landfill, from the primary manufacturing facility in Webster, New York. He hired part-time workers to sort through all of the material and separate it by waste category in a large warehouse that he had rented. Interestingly, the project was financed by "borrowing" money from Xerox, and then repaying the "loan" with the proceeds made from selling the metals and other recoverable materials to scrap dealers.165 The financial benefits that were achieved from this activity were large enough that Xerox decided to implement waste sorting in their manufacturing facilities. Now waste assessments are regularly conducted and there is waste "auditing," with people taking pictures of the material in waste receptacles to make sure that everything is in the right place.166 Waste separation on the factory floor is considered to be a very important activity that is taken very seriously.167

162 Interview with Ralph Sholts, 25 April 1996.
163 Interview with Victor Berko-Boateng, 26 April 1996.
165 Interview with Victor Berko-Boateng, 26 April 1996.
166 Ibid.
Berko-Boateng says that Xerox is not at the 100% level on sorting and recycling, but is very far along. However, he estimates that less than 40% of the financial gains from recycling have been realized.\textsuperscript{168}

His other area of investigation is currently focusing on the recycling of parts from products. A large part of this is trying to figure out methods for closed-loop recycling of engineering thermoplastics. To date, Xerox has had a fair bit of success in this area. They began by trying to recycle high impact polystyrene (HIPS), which is used as structural foam in copier doors and panels. They were successfully able to regrind the material and recompound it so that second and third generation 100% recycled content met Xerox requirements for new parts. A key step in the process was obtaining UL flammability certification for the recycled parts. This had not been done before, so Xerox had to work with UL in order to develop an appropriate process for testing the material.\textsuperscript{169} Xerox was able to successfully achieve certification for the recycled HIPS, the first company to achieve this, and has since successfully received certification for recycled ABS and PCABS. Initially, Xerox conducted the extrusion of the recycled plastic flakes by itself, but is now working with its commercial molders.

A particular challenge now is how to deal with older products that were not designed with recycling in mind, as new machines are. Since the plastics were not marked with identification codes, they have had to go back through product engineering drawings to determine material composition. So far, material composition of about 80% of parts has been determined. Some of these, however, are mixed material plastics and are currently disposed. They tried to blend this material for products, but found that it did not work. They are currently working internally and with external companies to develop technologies to use the mixed materials. In all cases, recycling is a business proposition and needs to make sense on those merits.

\textbf{CRUs}

The Customer Returnable Unit Group is charged with providing CRUs, which are used in some low and mid-volume copiers and hold the major consumable components of the copier, such as the photoreceptor, to

\textsuperscript{168} Interview with Victor Berko-Boateng, 26 April 1996.
product development groups within Xerox. This is a relatively new group that was created to consolidate the internal production of these parts. This group was also one of the first production oriented organizations to utilize DFE methods.

*Origination of CRUs*

In the 1980s some of the Japanese copier manufacturers, particularly Canon, began to pursue the development of copiers that utilized replaceable cartridges containing parts subject to wear or degradation, such as the photoreceptor. (These cartridges are different from toner containers/cartridges, and typically have a much higher value/cost). In the mid 1980s Xerox began to explore this avenue as well, particularly in the mid and low volume ranges, designating the cartridge a Customer Replaceable Unit or CRU.\(^{170}\)

Prior to 1990, cartridge development was conducted by each individual product group, with no central design or approach. "No one individual or organization had Total Life Cycle Asset Management responsibility."\(^ {171}\) The management of the process was an open loop, with little communication or coordination between designers, manufacturers, distributors and service people. Each group would do their part and pass on the product to the next function when formal transfer criteria had been met. This functional approach was not particularly efficient, and often resulted in long delays that extended time to market.\(^ {172}\) Furthermore, cartridges were designed to have but one life. Joe Marino, Vice President of the CRU group, reported that 'when people said 'what are you going to do with the cartridge,' you would say 'I'm going to throw it away.'"\(^ {173}\)

*Formation of CRU Business Group*

In the 1990s there started to be a change of perspective about how cartridges should be disposed of. Two factors were cited as being important in bringing about this paradigm shift. First, was the "voice of the customer" which started to say "I want a cartridge that is low in cost and high in quality.

\(^{170}\) In Europe, these units are typically installed by field technicians and are know as ERUs, or Engineering Replaceable Units.

\(^{171}\) Carville, Richard O., "Total Life Cycle Asset Management or Cartridge Recycling," pg. 2.

\(^{172}\) Ibid.

\(^{173}\) Interview with Joe Marino, 25 April 1996.
And I do not want to pollute my environment with a used cartridge."174 The second force was the emergence and threat of legislation in various places that required manufacturers to take-back products such as cartridges at the end of their useful life.175 In response to some of these pressures the Customer Returnable Unit business group was formed in 1992, with Joe Marino as its first Vice President. This group was organized as a cost center and internal supplier for CRUs, though product groups are not required to source units from the CRU group. Under Joe Marino's guidance the group set out to close the loop and take on added responsibility for the cartridge at the end of its normal life. According to Marino, he saw that there was an opportunity to do something with these cartridges. As the primary producer, Xerox had an advantage in reclaiming the original product and was in a better position to reclaim a greater portion of its value as an unused asset. Even if the opportunity was a small one, it was nevertheless an opportunity which could be exploited. He also felt that over time there are possibilities for gains in efficiency that will provide even greater returns.176

The business group was created with the following vision and mission:

**Vision:** The Customer Replaceable Unit (Cartridge) Business Unit will be a full service, self-sufficient business that is the preferred worldwide supplier of Customer Replaceable Units (Cartridges) and selected Critical Components.

**Mission:** The Customer Replaceable Unit (Cartridge) Business Unit exists to design, manufacture and recycle customer replaceable units/critical components and deliver benchmark Total Life Cycle QCD&E (Quality, Cost, Delivery, and Environmental) results for our Customers in order to maximize Xerox profits, enable growth to the business, and provide a challenging work environment for highly motivated employees and suppliers.177

Production of CRUs occurs worldwide, as does the collection, testing and refurbishment of returned CRUs. This is in keeping with Xerox' Produce in the Market strategy. Each particular CRU development project is assigned a single product manager that is responsible for managing the entire life cycle

175 Ibid., pg. 3.
176 Interview with Joe Marino, 25 April 1996.
177 Carville, Richard O., "Total Life Cycle Asset Management or Cartridge Recycling," pg. 3.
of the product. They work in conjunction with and have shared responsibility with functional line managers as well. Cooperation is achieved via "interlocking performance objectives and compensation schemes."\(^1^7^8\)

When a cartridge has finished its useful life, the customer is requested to package the cartridge in the box in which the new unit was shipped and attach a pre-paid UPS delivery sticker addressed to the appropriate recycling center. For some models, there is an incentive program where customers receive rebate certificates for Xerox products for returning cartridges. They also have a program where customers receive discounts if they lease the unit and agree to return it to Xerox.\(^1^7^9\) The returned cartridge is logged and stripped to a predetermined state. Remanufacturing codes on all parts indicate how they are to be disposed. All critical parts undergo testing, known as signature analysis, to ensure that they will be able to function properly through another life cycle. Parts that are unable to be remanufactured or that fail to pass performance tests are then disposed of according to codes that are indicated on the part. Ideally, the parts are recyclable, and can be reground and reused as raw-material inputs to make the same piece (closed-loop recycling). Parts that pass performance tests are then transported to manufacturing lines where they are incorporated along with new-build materials. In this way, only one product is produced that must live up to one level of quality. According to Marino: "That was an economic...decision we made in the beginning to say we weren't going to be in business to have two different standards for recovery....I don't know how to manage within a manufacturing facility, or in the field, the perception that there's two levels of quality, and I don't know how to help you assign a special unit transfer pricing environment.... It's just the performance...we're shipping to one level of quality, same as new-build."\(^1^8^0\)

**CRU business group: creating value**

As the CRU group was created as a profit center, they had the task of trying to convince the various business groups throughout Xerox that the CRU group was able to create value for them. As such, Marino had to be able to sell the project on a financial level. This was done by showing the groups

\(^1^7^8\) Ibid., pg. 4.
\(^1^7^9\) Interview with Joe Marino, 25 April 1996.
\(^1^8^0\) Ibid.
the potential savings and cost reductions that were possible if remanufacturable CRUs were used. By showing that it is possible to decrease costs and that they can advertise a "green machine," Marino has been able to get the groups to come on board. "...you've got to be competitive with your costs, but you've got to offer them the other value proposition."\(^{181}\) "But when it finally gets down to it, what you've got [to] figure out [how] to do is either convince a business division that it's going to be worth something in extra sales, or you're going to find a way to save money as a result of it."\(^{182}\) Once they have started this, they are to some extent locked into the system: "once I get them hooked with this, as a supplier, who else are they going to go to do this?" says Marino.\(^{183}\)

**CRU Pilot Program**

To test the practicality and feasibility of recovery and remanufacture, a pilot program was developed around the 5028 copier cartridge.\(^{184}\) The 5028 is a medium volume copier that produces copies at 24-30 per minute. The CRU unit is fairly large measuring approximately 14"X6"X20"a product that is not easily disposed by the customer, and therefore more likely to be returned. The 5028 was introduced in 1990, and the original CRU, like all those developed at that time, was not intended to be used more than once. The line used to build the cartridge was highly automated and not flexible enough to accommodate remanufacturing. The project was divided into three phases: a feasibility study, a pilot run, and production demonstration/on-going.

In the feasibility study a number of critical questions relating to current prospects for reuse, technical needs, infrastructure requirements, environmental benefits and resource needs were examined. The group determined that an acceptable rate of return could be made by recycling the plastic in old units to be remolded into new components. They established that this would also significantly reduce the amount of material going to landfill. As such, they decided to proceed with this approach, as well as pursue options that might allow them to remanufacture the cartridge.

\(^{181}\) Ibid.  
\(^{182}\) Ibid.  
\(^{183}\) Ibid.  
\(^{184}\) All facts about this program come from Carville, Richard O., "Total Life Cycle Asset Management or Cartridge Recycling."
In the pilot study, the actual infrastructure and procedures were developed to achieve recycling and remanufacture. Issues addressed at this stage included the examination of how best to regrind plastics, how to contain and dispose of the two and a half to three pounds of waste toner in each unit, and what to do with miscellaneous wastes such as packaging and metal clips and screws (they are all sold to third party reprocessors/recyclers). In addition it was at this stage that more thorough investigations into the reuse of parts was undertaken. Further studies of the 5028 cartridge unit indicated that it was feasible to redesign the cartridge so that remanufacturing capability could be enhanced. Some of the changes that were made include:

- The top cover, which had a tendency to warp and so could not be reused, was redesigned to improve rigidity and allow reuse.
- The cleaning and charge frames were separated, eliminating the need to replace both systems when only one failed.
- Brominated fire retardants, often used in resins were eliminated in anticipation of pending legislation in Europe that would have banned them. Though the new resin formulation was more expensive, overall costs were still reduced by redesigning the new frame so that strengthening additives such as fiber glass were not needed.

In the production demonstration and on-going phase, the recycling plants (two in North America, one in South America and one in Europe) were brought up to capacity to strip, test, refurbish and reprocess incoming CRUs. These plants then send the components to the primary manufacturing facility where they are incorporated into the new-build line. Initial return rates for the program were estimated by Joe Marino to be around 5-7%. Currently, the return rate for the 5028 unit is about 60%. Of the units that are returned, 53% of the parts are reused, 21% of the plastic parts are reground and remolded, 24% is recycled into secondary uses and only 2% by weight goes to landfill.

**Supplies**

The Supplies Development and Manufacturing Services is an organization within Xerox that produces and markets consumables for Xerox products, primarily toner, photoreceptors and paper. SD/MS, headed by Vice President Philip Sliva, is part of the Corporate Strategic Services group. The supplies group operates 14 plants in six locations. It is a high margin business that typically runs at very high capacity.
Beginning of Environmental Initiatives

Formal proactive environmental initiatives in the Supplies Development and Manufacturing Services began with the formation of a QIT by Dominic Sherony (Manager, Technical Services Sector) in mid 1993 to look at the disposition of empty toner containers. Prior to this some work had been done on utilizing Post-Consumer Recycled (PCR) material and in container weight reduction. The QIT moved to the next level, however, by looking at the problem more from the perspective of the market.185

This team had "representatives from the various technical, production, and marketing organizations affected."186 The goals of the team were:

- Satisfy Customer requirements regarding empty toner containers.
- Comply with existing and pending environmental regulations both stateside and abroad (Blue Angel etc.).
- Ensure new products designed for environmental friendliness.
  Change current products where possible to make more environmental friendly.
- Provide environmental support as needed to other Business units, programs, and projects.187

The resulting tasks that the task force identified followed the three Rs of product stewardship: Reduce, Recycle and Reuse. The first two were seen as short term projects while the last one was longer term.

Reduction

One of the "reduction" initiatives was aimed at increasing the use of post-consumer recycled (PCR) material in toner container bottles, thereby reducing Xerox' reliance on virgin material. The primary motivation for using PCR were state regulations that mandated the use PCR resins on or before 1995. Xerox also saw this as providing an important market pull for recycled plastic resins. The team was able to qualify the toner containers for 100% PCR use. This was used for a short time, but market fluctuations pushed the price to $0.20 above that for virgin material and supplies were not steady, so Xerox went back to using virgin material.188 According to Karl

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185 Interview with Karl Mueller, 18 July 1996.
187 Ibid.
188 Ibid., pg. 270.
Mueller, though, supplies and prices have stabilized and they are currently making the qualified bottles from 100% PCR again.\textsuperscript{189}

The second reduction oriented project sought to reduce the weight of toner containers so that less material would be needed in the first place. Xerox, in conjunction with its suppliers, was able to reduce the weight of some containers by as much as 20\%, though the typical range was 10-15\%. It was estimated that in 1994 this resulted in the diversion of 240 tons of material from landfill. Though initially intended as a one-time project, it was realized that future technological advances might allow for further weight reductions and so there is intent to revisit the issue of weight reduction periodically.\textsuperscript{190}

\textit{Recycling}

After working on these initiatives, the team sought to find ways to recycle empty toner container and other supply containers (such as fuser oil bottles and binding tape reels).\textsuperscript{191} The primary motivating factor for this initiative was pressure from Kinko's copies, a large national account, as well as from several other customers who did not want to just throw the container's away. Though the bottles were made of recyclable material, they were not "blue boxable" due to contamination by residual toner. Though toner is non-toxic and itself is primarily made of plastic, it is nevertheless and impurity that can impede its usefulness as stock material. Xerox therefore set out to locate independent recyclers who would agree to take the containers and not landfill them. The initiative was publicly launched in January of 1994. Over the course of the next six months Xerox contracted with a total of six regional waste handlers to accept, free of charge, empty toner cartridges.\textsuperscript{192} Some of these handlers cleaned the containers before shredding them, while others were able to use the material without cleaning. The recycling initiative was a voluntary program and customers had to pay to ship the used products to one of the recycling centers. The return rate for this program was quite low. Those who developed the program were not generally satisfied

\begin{footnotes}
\footnote{189}{Interview with Karl Mueller, 26 April 1996.}
\footnote{191}{Ibid., pg. 270.}
\footnote{192}{Interview with Karl Mueller, 18 July 1996.}
\end{footnotes}
with this approach. It was seen as a stop-gap program to provide at least some options for customers until Xerox could work out a more effective system.\textsuperscript{193} Eventually, all but one of the recycling contractors was eliminated.\textsuperscript{194}

**Reuse**

The biggest problem with the recycling approach was that the value of the containers is relatively low, so that the cost of shipping greatly exceeds the benefits that can be realized by recycling them. Xerox therefore decided to move up the recycling value chain and on Earth Day 1995 launched its campaign to reuse old toner container bottles. Customers are now able to return used bottles free of charge by attaching pre-paid UPS labels to the box in which they were delivered. The containers are sent to one of two reuse facilities which receives two to three truckloads per day. (Both of these facilities also serve as remanufacturing centers for CRUs). The average return rate for the program is 14%, though it reaches as high as 35% for the 5090 toner bottles. Currently, the bottles are qualified for six uses, though Mueller suspects that polyethylene bottles could be used more than that. Currently, about 70\% of all containers that Xerox manufactures can be reused, and an additional 10\% are reground and recycled. The remaining 20\% of containers, most of which are paper tubes, are pyrolized or landfill. In all cases, Xerox engineers are working to improve the reusability and recyclability of the various containers.\textsuperscript{195}

Interestingly, this initiative costs Xerox money, and has no economies of scale: "the more we return, the more it costs us."\textsuperscript{196} The primary source of costs in the reuse program is the cost of shipping containers individually by UPS, which consumes most, if not all, of the advantages that come about from reusing the containers. They continue to look for ways to reduce this cost and are in ongoing negotiations with UPS.

**Departmental Copiers**

In the early 1990s Xerox initiated a major "clean-sheet" development project to produce a new platform line of mid-volume copiers. John Elter, an

\textsuperscript{193}Ibid.  
\textsuperscript{194} Interview with Karl Mueller, 26 April 1996.  
\textsuperscript{195} Ibid.  
\textsuperscript{196} Interview with Dominic Sherony, 25 April 1996.  

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\textsuperscript{Page 91}
"ardent supporter of the environmental initiatives"\textsuperscript{197} was chosen to lead the Strategic Programs project. From the start the "Departmental Copiers" program viewed environmental issues as a core issue, placing a strong emphasis on reuse and recycling.\textsuperscript{198}

\textbf{Terma Training}

The "environment" was to be such a central aspect of the entire development team that in the summer of 1992 Elter took a group of eleven people, from the Senior Vice President to Technician level, who were associated with the project to a program run by a company named Terma in New Mexico, which Elter had become aware of when his daughter worked there. This program sought to demonstrate the links between people and nature. After going through the program once, Elter wanted to try to bring the program back to Webster where more people could go through the program. However, the program was felt to be too extreme to be widely accepted in a corporate context. Working with Terma, which had then changed its names to Natural System Training (and is now Living Systems Training), a new curriculum was developed and another eleven people went through it in the summer of 1994.\textsuperscript{199} Ed de Jong, who became the environmental pointman for the project, and Chuck Winship had both been through the first session and went through the second program again as a control group. Once again, a wide cross-section of people were asked to participate. After this second round, some additional changes were made and the program was brought back to New York for deployment. Each summer, starting in 1994, several sessions have been held. In total about 150\textsuperscript{200} people have gone through the voluntary course.

The "Ecology of Empowerment," as the course was titled, is a four day course held each summer. The program tries to look at nature as a teacher. "The program is designed to enhance the employees' ability to positively impact the environment, harmonize their quality of work and life, promote empowerment, and build a strong teamwork culture."\textsuperscript{201}

\begin{thebibliography}{99}
\bibitem{198} Interview with Chuck Winship, 3 June 1996.
\bibitem{199} Interview with Ed de Jong, 25 April 1996; 16 July 1996.
\bibitem{201} Ibid.
\end{thebibliography}
Building Design

The emphasis on "nature" and communication is even reflected in the design and layout of the building. According to Chuck Winship, who has responsibility for facilities and was involved in the planning of the building, an attempt was made to increase communication as much as possible. People in the same functional area are arranged in large groups in a "bullpen" style of cubicles, which are primarily on the perimeter of the building. Furthermore, all of the conference rooms and development labs have windows so that people walking by can see what is occurring in the labs or at presentations. All functional areas are housed in the building, including a pilot manufacturing line. Recycling bins for all types of material are spread about the building. The dominant color scheme is blue and green. In one corner of the small cafeteria is a running "brook." Even the nameplates for cubicles and rooms have an environmental theme. On many of the walls, including in the restrooms, are whiteboards that can be printed to paper. By walking around the building it is clear that the goal was to create a "natural" setting where as much communication and interaction as possible could occur.202

Minimizing waste

The goal of waste free products, factories and offices, appears to be the well from which most of the environmental initiatives in the Departmental Copiers program spring from. Chuck Winship argues that this approach is taken to heart because it is the cheapest way to go due to the hidden costs of materials, time, people and knows that it has been shown to be cost effective in some areas, though not all.203 In designing the product, Xerox has set out to make it so that they will take everything back and reuse or recycle it in some fashion. Currently, over 90% of all material is reusable or recyclable.

Work is waste

Another theme that has driven the program is that "work is waste" and "less is better." The idea is that one should try to eliminate as many blocks as possible from a process flow diagram, which diagrams the flow of information and materials. By reducing process steps, one cuts out as many

202 The description of the building is based upon a site visit by the author, 25 April 1996.
203 Interview with Chuck Winship, 3 June 1996.
unnecessary steps as possible, thereby reducing work. Reducing work not only helps to reduce costs and save money, but helps to reduce the environmental burden associated with the product. Winship argues that from a life cycle standpoint, "labor" is the source of the greatest environmental impacts. If the machine can be made more reliable, not only are costs lowered, but you have fewer field service trips which means that you don't need to have someone drive to a site, an activity which probably has a far greater environmental impact than the actual use of the copier.

There are a number of examples of how the "work is waste" philosophy has been operationalized:

- Current copiers require field service engineers to carry around over 90 different tools. The new machine has been designed so that only five small tools are necessary for repairs.
- In an attempt to reduce the dependence on "skills and knowledge" the machine is designed to require zero adjustments.
- In designing the building, an attempt was made to reduce the distance between workers, particularly those who need to communicate often.
- The delivery system for field repair parts has been revamped. Originally, parts were ordered from a vendor by the manufacturing center. Those needed for new-build were kept at the plant and extra parts for the field were sent to a distribution warehouse. There they are packaged and shipped to regional distribution centers where service engineers pick them up. This has been changed so that service parts will be shipped directly from the vendor to the regional distribution center, eliminating two shipment steps and the associated cost and environmental impact.
- The machine is being designed so it is simple enough to allow for a customer install, so that a Xerox technician does not need to go there to help set it up.

Design and development process

In developing the departmental copier program there has been a heavy reliance upon the use of multi-functional teams and concurrent engineering practices. Throughout all of the design process, environmental considerations, primarily those relating to the waste free product goal, have played a significant role. In addition to the general sensitization received through the Terma training, most engineers have gone through ARM training as well.

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204 Ibid.
Chapter Four: Xerox Corporation and Design for Environment

The development team has designed the product while considering five, fifteen and fifty year time horizons. The long time horizons are needed due to the durable nature of the product, the desire to design a platform from which numerous derivative products can be developed, the intention to reuse and remanufacture as much of the product as possible, and the need to consider ultimate end-of-life disposal issues.

One part of the reason that the Departmental Copiers program has pursued these environmental initiatives is because of the fact that they feel it is a way in which they will be able to differentiate themselves in what has become a "commodity" market. They are also convinced that much of what they are doing will eventually be necessary in the marketplace, regardless of how regulations evolve.205

DFE as a Strategic Initiative

To properly frame our discussion of DFE at Xerox, it is important to consider whether or not it is appropriate, in light of the previous discussion, to consider their DFE initiative as strategic. Though it has been argued in Chapter 3 that DFE ought to be considered a strategic initiative, it is essential for further analysis of the case at hand to demonstrate that it is a strategic initiative at Xerox. As may be expected, this author believes that Xerox has raised its DFE and related initiatives to the strategic level.

To support this assertion, we can look at Xerox' DFE program in light of Grant's (1995) three criteria for strategic programs: they are important, involve large commitments of resources, and are difficult to reverse. Evidence of the fact that DFE is important to Xerox is given by the support that it has received from the highest levels of the organization. CEO Paul Allaire has supported initiatives at all levels, even going so far as to "mandate" that recycling and related issues be considered. Xerox has also committed itself to pursuing sustainable development and, according to the head of EH&S, DFE's role in this is "fundamental in the broadest sense."206 Furthermore, interviews and company data suggest that Xerox employees view Xerox as having a strong commitment to the environment.207 Perhaps the strongest indication that these initiatives are seen as important lies in the

205 Interview with Ed de Jong, 25 April 1996.
206 Interview with James MacKenzie, 26 April 1996.
207 Rank Xerox Limited, Environmental Performance Report, November 1995, p. 36.
central focus that they have received in the Departmental Copiers Program, which is currently one of Xerox' largest development project.

The second criteria, that there is a large commitment of resources, also appears to have been met. First, there is a unique organization, Jack Azar's Environmental Products and Technology group, which is, to a large extent, dedicated to promoting DFE efforts. Furthermore, this group is steadily growing in size. Even more significantly is the resources that have been committed to promoting asset recycling. This is a very large group with several hundreded employees providing support and research. In additional, over 2000 engineers have gone through extensive training on remanufacturing principles. Additionally, some individual business groups have committed resources to further environmental design training and practice and to remanufacturing plants. One specific sign of resource commitment, which may also be taken as an indication of importance, is the fact that the supplies group continues to push forward with toner container reuse despite the fact that the operation loses money.

Finally, it seems that it would be unlikely and rather difficult for Xerox to abandon its current efforts. This was echoed in the comments of both Sherony in supplies, who felt that Xerox has made such a public commitment that they could not turn away, and de Jong in the Departmental Copiers Program who felt that, even though some environmental issues have been sidelined for the time being, they would soon return to tackle and solve them. Furthermore, given the corporate emphasis upon remanufacturing and the large commitment of resources, it seems unlikely that they would abandon their design efforts which will enable them to maximize potential returns from remanufacturing.

Given this overall level of organizational support and emphasis, it is reasonable to classify Xerox' Design for Environment efforts as a strategic initiative. With this foundation, we can continue to examine the propositions generated earlier by looking at the role that middle management has played in the process of strategy implementation.
Chapter Five

The Role of Middle Management in the Implementation of DFE at Xerox

With the discussion of Xerox that has been presented in the previous chapter, it is now possible to relate their experiences to the frameworks developed in chapters two and three. This chapter begins with an examination of the role middle management plays in implementing DFE at Xerox. Following this is a discussion of specific ways in which middle management has resisted implementation in the various programs. With this foundation, some of the particular programs and initiatives that have helped overcome resistance are identified. Finally, the chapter concludes by discussing challenges that Xerox continues to face.

Middle Management and DFE

The first issue to be examined is the role of middle managers in developing Xerox' DFE strategy. It is necessary to demonstrate that middle managers have an important role within Xerox to argue that any resistance on their part can be problematic, and thus necessary to overcome. In general, Xerox is run as a company where middle managers have a considerable amount of power, a point emphasized by most people who were interviewed. It was often stated that policies are not mandated or forced upon individuals or business groups. Instead there is a focus on convincing people of the importance of pursuing a particular program or objective, a business process known as Management by Results. Under this collaborative management model, emphasis is placed upon achieving end results instead of the methods used to reach them. Managers therefore possess a large amount of latitude in deciding how to reach targets and goals. It was said that managers “can do
their job any way they want just as long as they meet their [profit/loss and market share] targets.”208

In the case of DFE, there is both direct and indirect evidence that middle management is highly empowered to decide how or if they will pursue this initiative. When Azar began trying to promote acceptance of DFE, it was the middle level managers that he targeted. He stated that “...if you want to get the stuff into the actual hardware/software solutions work, you’ve got to deal with...the business team managers who are developing that activity. I can’t deal with [CEO] Paul Allaire on every item like that, that wouldn’t do any good. He’s not...developing the products, he’s not in charge of all the activity there, he’s not telling them what feature they have to have in the products.”209 Because of this empowerment, the majority of DFE programs have been initiated and promoted by middle management. As discussed in chapter four, the three major DFE oriented initiatives, in supplies, CRUs and the Departmental Copiers Program, were all started by the managers in charge of those groups. Furthermore, efforts to introduce DFE have often focused upon the lobbying of middle managers. The majority of people initially on the Environmental Leadership Steering Committee, where much lobbying occurred, were middle managers, including Sliva, Marino and Elter from the three vanguard programs. Additionally, Azar’s initial efforts focused on sending suggested design guidelines and principles to the general managers of as many development groups as he could. Clearly, middle managers are the most important individuals in the implementation process, as they are the individuals targeted by change agents and most often responsible for bringing about change.

Resistance to DFE

Given that middle management has significant organizational power within Xerox, they are capable of strongly influencing both the development and implementation of policies and strategies. This can be demonstrated by looking at middle management’s resistance to strategic change, in particular resistance to the attempt to incorporate DFE into business activities. This section will look at both general indications and specific instances of resistance to DFE within Xerox.

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208 Interview with Jack Azar, 22 February 1996.
209 Interview with Jack Azar, 22 February 1996.
When individuals were asked what group within the company was most resistant to the implementation of DFE, the most common response was “middle management.” In talking about his efforts in general, Azar noted that it was the middle managers and business group managers that he needed to “wear down” to convince them of the need for DFE. According to him, when he first started promoting DFE there was “significant resistance” because people did not believe that environmental factors, such as Energy Star, ISO 14000, or recycled content were going to be important. Since they did not believe that proactive measures could have a positive impact on the bottom line, and given the fact that middle managers had profit/loss responsibility, it is not surprising that they resisted the implementation of these initiatives.\textsuperscript{210} For example, in the supplies business group, Azar noted that they required “a lot of convincing” before they would agree to support DFE initiatives.\textsuperscript{211}

The CRU business group is particularly subject to the inclinations of middle management given its position as an optional internal supplier of component parts to other development groups. The Vice President of this unit stated that this presents a problem when trying to introduce novel product strategies such as DFE. Because of the fact that the CRU group lies on the “cost side” of a development group, which he described as being unglamorous to manage, “getting on their radar screens” is the most difficult part in convincing managers to consider remanufacturable CRUs. Though not an active form of resistance, it is nevertheless a passive form of resistance that creates a barrier to action (since they do not even consider the option).\textsuperscript{212}

In the Departmental Copiers Program, both of the people interviewed indicated that middle management was the most significant source of resistance. One manager noted that this group is the most difficult to get to accept culture change (which he felt was central to DFE).\textsuperscript{213} Ed de Jong, the lead environmental coordinator for the program, also felt that the most difficult task was changing the culture of middle management. He felt it was easy for the top and bottom of the organization to want to do the right thing,

\textsuperscript{210}Interview with Jack Azar, 22 February 1996.
\textsuperscript{211}Interview with Jack Azar, 26 April 1996.
\textsuperscript{212}Interview with Joe Marino, 25 April 1996.
\textsuperscript{213}Interview with Chuck Winship, 3 June 1996.
but that it was difficult for middle managers because of the constraints they are under.\textsuperscript{214}

A number of more specific examples of resistance were also documented during the course of interviews. For example, in discussing the efforts of the supplies business group to begin reusing returned empty toner container bottles, it was noted by the manager who initiated this program that they had a difficult time convincing marketing, who were concerned about losing money, to agree to the program. Eventually they agreed to the introduction of the program because it was better than the toner container recycling program and helped satisfy customer demands.\textsuperscript{215}

When Patricia Calkins of the Environmental Products and Technology group was attempting to conduct a pilot life cycle analysis she had a difficult time getting groups to provide data. They were not willing to commit the time and energy necessary to provide such information until the value in doing so could be demonstrated. Because of this resistance, a high level analysis, which did not require extensive data, was performed. The results of this were very interesting to the business group and additional resources were committed so that a more thorough analysis could be performed.\textsuperscript{216}

In the ARM program, several examples of resistance were provided by Victor Berko-Boateng, who developed ARM training and is currently responsible for recycling technology. With regard to training, he noted that although most programs have been very receptive, those with close launch deadlines have not been as interested in bringing training to their groups. He also identified two problems relating to his recycling work. The first of these was the lack of acceptance of a recycling model, based upon volumes and costs, that he had developed. He attributed this to insufficient economic modeling, which made it of less interest to managers considering recycling. The more significant problem he encountered was the feeling that there was too much pressure placed upon him to consider currently cost-effective issues, limiting his ability to tackle technical issues that might make programs

\textsuperscript{214}Interview with Ed de Jong, 16 July 1996.
\textsuperscript{215}Interview with Dominic Sherony, 25 April 1996.
\textsuperscript{216}Interview with Patricia Calkins, 22 March 1996. See also Calkins, Patricia, “Lifecycle Assessment at Xerox,” IEEE International Symposium on Electronics and Environment, Dallas, TX, 1996, pp. 161-166.
more cost effective. Accordingly, he felt that management had created a situation of competing goals and objectives for him.\textsuperscript{217}

There were several specific examples of middle management resistance to change that were identified in the Departmental Copiers program. First, it was noted that only about 25\% of the people in the development program have gone through Terma training. Among the reasons given for low participation was that some managers would not let people take the time off to go through the program. Sometimes this may have been because of legitimate time concerns, though Chuck Winship stated that some people believe the program is "mind altering." Winship felt that it would take time to convince everyone of the value of this program because of the fact that it involved a major paradigm shift.\textsuperscript{218} This appears to be true because more people have participated in the program in each successive year that it has been offered.\textsuperscript{219} Ed de Jong also indicated that environmental issues have occasionally been pushed to the side when time has become an issue. For example, he was pulled away for several months from his environmental duties to look at a pressing design issue. Despite his absence from the coordinating position, he indicated that environmental issues were still addressed. Currently, pressure to release the product has caused environmental issues to be de-emphasized. However, de Jong insists that these issues have not been forgotten and will be brought back for consideration in the future.\textsuperscript{220}

These are but a few examples of middle management resistance to the introduction of DFE practices at Xerox. However, they provide a good cross section of reasons for resistance. These manifestations of resistance to change fit nicely within Connor and Lake's (1988) three categories of barriers. Barriers to understanding are illustrated by the fact that many managers did not believe that positive benefits could be realized by pursuing proactive environmental strategies. In the parlance of Guth and MacMillan (1986), managers did not expect that successful performance of DFE tasks would result in the organizationally desired outcome.

\textsuperscript{217}Interview with Victor Berko-Boateng, 26 April 1996.
\textsuperscript{218}Interview with Chuck Winship, 3 June 1996.
\textsuperscript{219}Interview with Chuck Winship, 3 June 1996.
This problem also manifested itself as a barrier to acceptance. Because of the fact that managers believed these programs would only cost money and that customers were not interested in environmental features, they did not accept the program, anticipating negative financial results. Thus, the strategic goals of the program did not line up with their individual goals of profit maximization. This appears to be the most significant manifestation of resistance that was reported. Another barrier to acceptance was in the Departmental Copiers program, where some managers did not accept the principles behind the Terma training and would not let subordinates take time to go through the program.

Finally, barriers to action are present in the form of time constraints that have resulted in managers avoiding ARM training and pushing environmental issues to the side in the Departmental Copiers Program. In the CRU unit, the difficulty of getting managers even to consider remanufacturable CRUs can be seen as a structural barrier to action, as they were not dependent on an internal supplier. A final barrier to action, which may be as significant as the issue goal conflict, are the current corporate culture and perceptions of individuals. The need for changing the culture was emphasized by both de Jong and Winship in the Departmental Copiers Program. This is a significant barrier to action because it limits the ability of managers to understand and accept the necessary changes required by the adoption of DFE. Taken together these issues have created numerous challenges for Xerox which they have had to address to improve the likelihood that DFE will be successfully adopted.

**Overcoming resistance to DFE**

Given that Xerox has been able to achieve significant progress and notable results with its various DFE efforts, as demonstrated in chapter four, we are led to conclude that they have been able to address, at least to some extent, middle management resistance to change. In fact, Jack Azar notes that "Today, I don't sense much resistance. There is always the issues of 'I've got to trade off things,' but at least they're listening."221 This leads to the question of how Xerox has been able to overcome this resistance.

This question will be answered by looking at various Xerox efforts, at both the corporate and business group level, which have helped to garner

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221 Interview with Jack Azar, 22 February 1996.
support for the strategic DFE efforts. Consistent with previous discussions, these will be analyzed along the lines of Connor and Lake’s (1988) three categories of barriers. Where appropriate, parallels between Xerox activities and some of the methods for overcoming resistance discussed in chapter three will be drawn.

**Overcoming Barriers to Understanding**

As mentioned before, the largest barrier to understanding was the belief of many managers that there would not be any positive benefits from pursuing DFE. To overcome this problem a considerable amount of time, energy and resources have been devoted to reeducating middle managers about the value of these programs. The most comprehensive effort is the ARM training program, particularly Levels One and Two, which are geared towards middle managers. Ralph Sholts, who directs the training programs, suspects that all Vice Presidents and general managers in the product development world have gone through the training program.\(^{222}\) These efforts not only provide a general understanding of ARM programs, but have created and spread a common language about remanufacturing that makes communication between groups and individuals easier.\(^{223}\)

Though not as structured as ARM training, Jack Azar and others in the Environmental Products and Technology group have focused a considerable amount of attention on convincing middle managers of the importance of pursuing DFE. This has primarily occurred via informal channels and personal discussions. As Azar recalled:

> So we brought all that information and eventually those thing broke. At first you start off with arguments and debates...where people are just dismissing a heck of a lot, and over time, when we keep bringing back the information from the market and the information from where the regs [sic] are heading and the information from [where] the environmental label groups are heading, you break it down. That’s what happens. But...you’ve got to wear down, I wouldn’t call it senior management, it’s more the middle management.\(^{224}\)

Azar would take any information that he had about demand for “environmental” products, such as the White House’s request for only

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\(^{222}\) Interview with Ralph Sholts, 25 April 1996.


\(^{224}\) Interview with Jack Azar, 22 February 1996.
Overcoming Middle Management Resistance to Strategic Change: DFE at Xerox

Energy Star products, and present it to managers, sometimes putting it “in their face.” In doing this Azar noted that it was essential for him to know the business to successfully convince people that these initiatives were important. Though change agent credibility was not discussed previously, it is one way to improve the likelihood that middle managers will accept a particular argument as being “true.”

There have also been activities to overcome barriers to understanding in some of the business groups that were examined. In the CRU group, one of Marino’s primary functions is to lobby various development groups to get them interested in remanufacturable cartridges. This is done by trying to educate them about the “value propositions,” such as the ability to market a green machine and to reduce costs over time. Once they have been convinced of this and sign on, they have no where else to go to obtain the same remanufacturing services, and so become locked into the new approach.

In the Departmental Copiers Program, the Terma training program has tried to sensitize people to environmental concerns, raising many issues that help participants to see the value of pursuing proactive environmental strategies. For example, Chuck Winship used to see the work is waste paradigm primarily from a cost perspective. After going through the training program, though, he now considers the same issues primarily from a resource consumption and environmental perspective.

Overcoming Barriers to Acceptance

The biggest barrier to overcome at this level was the belief that pursuit of DFE conflicted with middle managers’ goals of profit maximization. One of the primary methods for addressing this issue was through what Connor and Lake referred to as information distribution. Much of the training and discussion described as methods for overcoming barriers to understanding are also applicable to the process of overcoming acceptance barriers. By convincing people that the benefits from the adoption of DFE initiatives will actually help them to achieve their other goals, they have been more willing to accept DFE.

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225 Interview with Jack Azar, 22 February 1996.
227 Interview with Joe Marino, 25 April 1996.
Chapter Five: The Role of Middle Management in the Implementation of DFE at Xerox

One of the most effective methods for encouraging the adoption of DFE practices has been through the inclusion of managers in strategy formulation and evaluation. As mentioned previously, all three of the most active groups had managers who were involved in the initial Environmental Leadership Steering Committee, which helped guide development of Xerox' environmental strategy. It is difficult, however, to properly evaluate the causal relationship between management involvement in the committee and a decision to adopt proactive environmental stances. It is possible that they agreed to be part of the steering committee because they were already interested in such issues. Supporting the conclusion that participation brought about interest, and not vice versa, though, is the fact that Azar noted that it took a lot of convincing to get the supplies organization and Sliva, its director, to support environmental initiatives. Once they started, however, they quickly became one of the leading environmental groups in the company.228 Given the high degree of autonomy that managers have, inclusion in strategy formulation is an excellent method for generating support.

However, it is unlikely that all middle managers can, or even want to be included in strategy formulation. This may present implementation problems because managers not involved in the strategy development process are less likely to be exposed to all of the beneficial reasons for pursuing DFE. Therefore, to induce acceptance it is necessary to either persuade middle managers or demonstrate actual success to them. The former method, persuasion, has been discussed already. Demonstration of success appears to have encouraged both further adoption in initiating groups and a willingness to experiment in other groups. For example, the manager of ARM training noted that, after observing the success of the approach, some are beginning to inquire about trying to extend training to their industrial workforce.229 A trial waste separation program at the major production facility in Webster found that separation and recycling created a net positive cash flow. This observation, which had not been expected by many, led to the adoption of widespread separation and recycling at the majority of Xerox' production facilities.230 By doing a high level life cycle analysis, Patricia

228 Interview with Jack Azar, 26 April 1996.
229 Interview with Ralph Sholts, 25 April 1996.
230 Berko-Boateng, V., "Recycling of Thermoplastics in Business Equipment—Challenges and
Calkins was able to generate interest in doing a more extensive study.\textsuperscript{231} Chuck Winship of the Departmental Copiers Program indicated that managers from other programs are beginning to come and look at what is occurring in their program and are beginning to "plagiarize."\textsuperscript{232}

Pre-existing business processes on which DFE was built have also helped to overcome resistance at the middle management level. The most important of these is the Leadership Through Quality program. Jack Azar felt that Leadership Through Quality taught people how to adjust to change, which made it easier to get groups within Xerox to accept a new set of requirements. Azar went so far as to say that "I think it was critical. I don't think we could have done it in the period of time we did it in without having that background and without being that flexible and quick of foot. And we got that through LTQ."\textsuperscript{233}

Another potential reason why there has been a large degree of acceptance relates to the ideological foundation of Xerox. From the early days of Joe Wilson they have long considered themselves to be a "socially responsible" company, a culture that appears to have been maintained despite significant changes and traumatic times. Numerous people that were interviewed argued that in addition to the expected financial benefits from pursuing DFE, it was also the "right thing to do." This was most strongly illustrated by Dominic Sherony, the Technical Services director in the supplies group. He did not believe arguments that DFE would produce positive financial benefits and felt that they were merely attempts to gain acceptance within Xerox. Despite this, he was still supportive of many environmental initiatives that were occurring within the corporation and supplies. He believed that these activities were being undertaken in the name of corporate goodwill and to demonstrate to customers that Xerox is an environmentally conscious company. Furthermore, he felt that this more than just a "PR" ploy, and stated that "I believe that we are trying to be, absolutely trying to be environmentally conscious."\textsuperscript{234}

\begin{thebibliography}{9}
\bibitem{231} Interview with Patricia Calkins, 22 March 1996.
\bibitem{232} Interview with Chuck Winship, 3 June 1996.
\bibitem{233} Interview with Jack Azar, 22 February 1996.
\bibitem{234} Interview with Dominic Sherony, 25 April 1996.
\end{thebibliography}
Chapter Five: The Role of Middle Management in the Implementation of DFE at Xerox

mentioned by Westley (1990), may serve as an important mechanism for overcoming resistance to acceptance. Indeed, the pursuit of environmental objectives fits within Xerox’ culture of social responsibility and provides a motivation for people to pursue such activity.

It appears that some of the stronger methods of forcing goal alignment, in particular coercion, have not been applied. Given the consultative management model applied in Xerox, which places heavy emphasis upon cooperation and consensus, such an observation does not seem surprising. Furthermore, this leads one to suspect that change will be more permanent because it has been internalized and not forced upon particular groups. From the few groups studied this appears to be the case, with people speaking of having overcome resistance instead of circumventing it. Whether or not this is true can only be determined after these approaches have been in place for a greater length of time.

Overcoming Barriers to Action

The biggest barrier to action at the middle management level are time constraints, particularly in the Departmental Copiers Program. This is a difficult problem to deal with, especially given Xerox’ current drive to decrease time to market. Though they have not necessarily been able to overcome time constraints as a barrier, Xerox has tried to mitigate the impacts. In the Departmental Copiers Program, for example, they have already done a significant amount to implement DFE. Furthermore, de Jong claims that they will address remaining issues at a later time, when time constraints are less of a concern. In a broader sense, most people realize that it will not be possible to address all issues right from the beginning, and so view implementation as a process of continuous improvement. Though they may not get achieve everything that they wish to initially, they believe that eventually they will be able to meet their goals, at which time they will move on to address other issues.

The other barrier to action, and one that applies not only to the middle management level, is the need to change the corporate culture. This is also a difficult issue to address in a planning and implementation sense. Culture change requires time and a systematic approach. One method Xerox uses to change organizational culture is extensive training. Both the general ARM

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235 Interview with Ed de Jong, 16 July 1996.
training and, in particular, the Terma training in the Departmental Copiers Program are agents of culture change. These programs encourage people to consider issues from a different perspective and develops tools, both technical and mental, for coping with different perspectives. Another method for culture change used in the Departmental Copiers Program is to change the physical environment in which people work. By making it impossible for people to forget about the natural environment, they seek to improve the likelihood that people will become more conscious of environmental issues in their work. Unfortunately, whether or not this has had much of an effect was not addressed in this study. In general, it was noted by Ed de Jong of the Departmental Copiers Program that implementation of DFE is becoming easier as the culture of Xerox continues to change. 236

General Strategies for Overcoming Resistance

Xerox has also adopted some of the general strategies for overcoming resistance discussed by Guth and MacMillan (1986). First, Xerox is very committed to the principle of equifinality, focusing on the ends, not the means. As one manager said, “I don’t care if you do it with an end-loader or a spoon, if it suits your purposes under your financial requirements and satisfies our customer satisfaction goals, then we ought to have that flexibility.” 237 Xerox has set only very broad goals, such as those for waste free factories and products, and allowed each particular group to determine how they will meet these goals. Satisficing also appears to be an accepted approach when addressing environmental issues. Approaches that are considered less than optimal, whether from a technical or organizational standpoint, have nevertheless been accepted because they serve as an initial toe hold through which future inroads may eventually be made. For example, the toner container recycling program in the supplies group was pursued even though most involved did not see it as a particularly great solution. However, it filled some customers’ needs until they were able to develop and implement the more satisfactory reuse program. 238 Finally, DFE has been framed in terms of addressing multiple objectives, which can both focus issues at higher levels and generalize the program, expanding policy options for

236 Interview with Ed de Jong, 16 July 1996.
237 Interview with Ralph Sholts, 25 April 1996.
238 Interview with Karl Mueller, 18 July 1996.
implementation and creating as a wider base for generating support. This is reflected in the fact that DFE has been presented as a method for decreasing short-term manufacturing costs, improving return on asset figures, meeting future regulations, improving market access, providing competitive advantage through differentiation, improving general environmental performance and achieving sustainable development. Taking this broad approach allows managers to accept DFE for a variety of different reasons, regardless of whether or not they feel that all of them are valid.

**Continuing Challenges**

It is unlikely that this discussion fully addresses either all of the middle management resistance that has been encountered nor all of the particular methods used to overcome these problems. The author believes, however, that this describes the most important and significant problems and methods. Furthermore, it should not be inferred that there is no longer any resistance and that DFE has been completely implemented. Though all development groups appear to have been exposed to and are considering adoption of DFE, not all of them have started to implement the strategy. As such, it is still possible that considerable middle management resistance will be encountered in the future. In general it appears that the biggest problems may no longer lay in managerial resistance. To begin with, all Vice Presidents and general managers of the business groups who do product development have been through ARM training. It was indicated that, although it was primarily the copying groups who were originally interested in DFE, some of the printing groups have "slowly but surely come around too."\(^{239}\) Also, a survey of product development groups conducted at the end of 1995 indicated that 75% were considering environmental issues in the design process, up from 25% in 1994.\(^{240}\) Additionally, when people spoke of needs for the future, they focused upon technological tools to help designers or support full utilization of the design features that they generated. Some examples include how to deal with elastomers, how do develop an efficient take-back system, how to eliminate or reduce the use of toxic or hazardous materials, how to use recycled materials, information support systems and other "nitty gritty nuts

\(^{239}\) Interview with Jack Azar, 20 June 1996.  
\(^{240}\) Interview with Jack Azar, 25 April 1996.
and bolts” questions. The biggest non-technical need was typically seen not as trying to overcome particular pockets of resistance but of generally changing the culture of Xerox so that deployment would occur faster and more efficiently. There was a general sense that the culture was changing, and that people were coming around to the idea of the environment as a strategic concept. Perhaps the best assessment of DFE initiatives came from an individual in the Departmental Copiers Program who asked rhetorically; “Are we moving fast enough? No. Are we going in the right direction? Yes.”

Xerox has come a considerable distance in implementing their DFE strategy. They have met with significant resistance but have, to a large extent, been able to overcome it. Much remains to be done and not everyone within the company agrees with the strategy. However, it would seem that Xerox has dealt with the most difficult issue, middle management resistance, and is now faced primarily with technical issues.

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241 Interview with Jack Azar, 22 February 1996.
Chapter Six

POLICY IMPLICATIONS AND CONCLUSIONS

This final chapter seeks to draw to a close the investigation that has been conducted. Following a brief summary of the role of middle management in strategic change. The next section seeks to take what was learned from the examination of Xerox and develop a number of general recommendations for overcoming resistance to change at the middle management level. Following this a broader discussion about the need for strategic environmental management and the role of business and public policy is broached. Finally, this chapter ends with recommendations for further investigation and analysis.

Middle managers and strategic change

The investigations undertaken at Xerox support the claim presented in the literature that middle managers are a crucial link in the process of strategic change. They are perhaps the most important group from which support must be received if implementation is to succeed. Unfortunately, they are also one of the most difficult groups from which to obtain support. As noted in chapter one, the primary hypothesis of this research was that without middle management support, implementation of strategy is exceedingly difficult, if not impossible. This proposition was supported by the investigation of middle management resistance to the adoption of DFE at Xerox.

To begin with, support from middle management at Xerox is particularly important due to the level of official autonomy they are granted: their managerial model precludes the use of coercive strategies to achieve implementation. Managers are free to achieve their profit/loss and market share targets in almost any way they see appropriate. Therefore, if a particular
strategy is to be pursued, middle management must be persuaded to follow it, by convincing them that there is some particular value, monetary or otherwise, to be achieved by adopting the strategy. This makes the case of Xerox somewhat unique, because this consultative approach means that resistance tends to be more open. This issue is addressed in greater detail below.

In addition to the power that middle managers have at Xerox, almost everyone interviewed involved in promoting DFE activities noted that middle management was the most difficult group to convince of the need to do DFE. Middle managers did not recognize the strategic value of pursuing DFE initiatives. First, managers were accustomed to environmental compliance programs, which almost always came at a net cost to the business group. They could not imagine that any environmental program could actually reduce costs or improve financial performance. Furthermore, when Jack Azar began promoting DFE, many did not believe that customers would see environmental attributes as important. As such they did not recognize market access and competitive advantage benefits that could be achieved through DFE.

Encouraging the adoption of new approaches

This study of Xerox provides a number of general recommendations about how firms can implement strategic change and deal with middle management resistance. Some of these are based upon the specific actions that Xerox has undertaken, as explained in chapter 5. What may be more interesting, though, is the general management model which this author believes is responsible for much of Xerox' success. This issue will be examined first.

Benefits of Middle Management Autonomy

Because of the decision making power that middle managers at Xerox wield, they were able to resist implementation by simply not agreeing to pursue DFE. They did not resort to more subversive forms of resistance because it was not necessary. This is perhaps beneficial to change agents, because it becomes much easier to identify where resistance is located. Furthermore, because resistance is more overt, it appears that it is easier to determine why the resistance exists because middle managers are free to espouse their views of a strategy. This allows change agents to tailor their
arguments and approach to different groups and individuals so that specific concerns can be addressed.

This is in contrast to organizations where middle managers are not as free to dissent on a strategy. In such organizations, when middle managers do not believe that a strategy will work as expected, serious problems with implementation can occur. This was noted by Guth and MacMillan (1986):

Such cases, where low commitment stems from disagreement on judgments about causality, can have particular challenges when the subordinates do not agree that the strategy will work but fail to say so. Because general management has not experienced significant opposition, they can easily assume that there is high commitment to the strategy they are promulgating. Then the strategy just does not get implemented due to simple lack of commitment. Unfortunately, if they do not anticipate this source of low commitment, general management only discovers the problem after implementation failure occurs.242

Thus, in cases where resistance is concealed, one may never know where there is resistance, as change targets may be unwilling to even admit that they disagree with a program of change, let alone why there is opposition.

Additionally, in an organization with open channels of communication and high empowerment, it is more likely that when a group does finally agree to pursue a given strategy, they will put a high level of energy into implementation. Westley (1990) notes that, when middle managers are both included and allowed a dominant or co-dominant position in strategic conversations, the response will be empowerment. This in turn will make them feel included and energized, which is necessary to achieve organizational change. 243

The disadvantage of this type of approach, then, is that the change process can become unwieldy and overly time consuming. The alternate approach, mandating a strategy, though likely to reduce the problems of coordination, is nevertheless likely to generate dysfunctional responses to strategy. When strategy is mandated, underlying support for and commitment to action usually has not been developed. Therefore, even among those who do not resist the change, they may be rather apathetic and not pursue the strategy with vigor and conviction.244

244 Ibid., pp. 338-339, 346.
At Xerox, the collaborative culture encourages discussion of issues and strategy, avoiding many of the problems of subversion. When support is generated, those pursuing it are more likely to do so with conviction, because they believe that what they are doing will create some benefit. For a program such as DFE, this is essential, because a completely new view of the nature of the product and a company’s relationship to the product and its environment is required. Furthermore, the primary drawback of the collaborative approach, that it is challenging to coordinate and time consuming, is currently not an issue at Xerox. First, they have established several corporate organizations, specifically ARM, the Environmental Products and Technology group and the Environmental Leadership Steering Committee, to coordinate DFE and related activities. Furthermore, time is not an issue because they are not party to any immediate “environmental crisis” and are currently on the leading edge of industry and consumer transitions to environmental awareness. For them, it is better to generate long term commitment than immediate results.

This case suggests that when attempting to implement DFE companies should not mandate adoption. Instead, they should attempt to build support among those who will be charged with the task of implementation. By doing so, subversive or hidden resistance which is more difficult to deal with can be avoided. Though it may take longer to implement, it is more likely that, when implementation finally occurs, performance will be brought to a higher level. Additionally, this strategy allows groups to determine what approach is appropriate to their activities. Furthermore, because sustainable development does not appear to be a “passing fad,” long-term advantage will be achieved through continuously improving high performance, and not only in immediate results. It is believed that this consultative approach may work for more than just DFE and is an excellent general management model as well. Such a proposition, however, would require further investigation, though it certainly seems plausible, and many at Xerox would undoubtedly agree.

Methods for overcoming barriers

Even in a consultative management model, resistance to strategic change still occurs, and change agents must devise means of communicating value and generating support for the desired strategy. The case study of Xerox
Chapter Six: Policy Implications and Conclusions

points to a number of successful methods for generating support. What follows is a list of various approaches, how they were used at Xerox and why they appear effective. This is certainly not an exhaustive list, but one that covers what the author knows has been tried at Xerox and appears to have successfully generated support for their DFE initiatives. Adoption of similar methods at other firms, with appropriate modification, will improve the likelihood that DFE, or other initiatives for that matter, will be accepted and implemented.

**Education.** There have been formal and informal educational initiatives, targeted at both corporate and business group levels. Jack Azar and his group have been involved in a large number of informal educational attempts, directly contacting development groups and trying to convince them of the need for DFE. At the corporate level, the ARM organization has done an extensive amount of formal training aimed at teaching people about the fundamentals of asset recycling. The largest group level environmental training program is Terma in the Departmental Copiers Program. Though varying in scope, detail and method, all of these efforts attempt to convince people of the need to consider environmental issues. Terma is the broadest of approaches, trying to foster a fundamental cultural and attitudinal shift, while ARM is considerably more focused, looking at only one element of product design, namely end-of-life management. Nevertheless, they are all attempts to show the value of considering DFE practice and encouraging acceptance. Another benefit of formal educational programs, such as ARM, is that they help to develop and promote a common language. This enhances the ability of people and organizations to communicate with each other effectively, reducing uncertainty and misunderstandings.

**Demonstration.** Though education provides arguments for why a program ought to be beneficial, some may nevertheless remain unconvinced. In such instances, change targets may not be persuaded until they actually observe positive benefits. At Xerox, several pilot and test programs have been established to serve as demonstrations of the value of DFE. In the CRU group, the 5028 program was explicitly set up as a pilot test of remanufacturing and DFE initiatives. The positive results have encouraged similar efforts both within the group and outside of it. A detailed life cycle analysis of a copier was only possible after a high level analysis was performed. Finally, the Departmental Copiers Program has been labeled by
some as a "guinea pig" for testing DFE and environmental strategy concepts. The initial success has generated interest and "plagiarism."

*Involvement.* At the very beginning of Xerox' DFE efforts, support was primarily generated by involving a number of individuals in the formulation of environmental strategy. Those involved were some of the early "underwriters" of DFE initiatives. Involvement may be seen as a type of "interactive" education, where participants end up educating themselves about a particular program or approach. Involvement is particularly successful because of the high level of personal commitment that is generated by people going through the strategy development process.

*Outside support.* By providing specialized assistance Xerox has been able to avoid overburdening development groups and redundant activity. For example, groups are able to rely on the ARM organization to provide specialized engineers who know the intricacies of asset recycling. As such, they are not as pressured to develop internal competence, which might discourage adoption. Also, by creating an internal Multinational Standards document, Azar eliminated the need for individual groups to research what the various international regulations and standards are. Furthermore, the Environmental Marketing QIT has been able to do the same thing with customer requirements. These two actions reduce the amount of research that a particular group needs to do and avoids redundant and wasteful investigation.

*Piggy-backing.* 245 Xerox has been able to improve acceptance by framing DFE in the context of other initiatives that have already gained widespread acceptance. In particular, their heralded Leadership Through Quality program has allowed Xerox to position environmental issues as one more component of quality. Therefore, DFE is simply another method for improving quality and meeting customer needs. Xerox also has a very developed product development process that incorporates concurrent engineering practices. Developers and designers are thus already accustomed to considering a multitude of design criteria, so that the addition of one more, environment, is not a radical concept. Though there are advantages to framing DFE in the context of pre-existing programs, it can also become a trap.

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limiting its development. For example, if DFE is kept solely within the context of quality initiatives, one might miss opportunities outside of customer concerns. This suggests that after DFE has been successfully introduced, it should be weaned from the parent program so that it can expand beyond the limits of the program on which it was modeled.

**Raising environmental issues and DFE to the strategic level**

Though discussed in both chapters one and three, it is important to reiterate the need for firms to consider environmental issues in general, and DFE in particular, as strategic issues. This is necessary because, as was pointed out in chapter three, firms are in a position to be both responsive to and instrumental in the formation of societal norms. As such, there are both practical and philosophical reasons for a firm to adopt these practices.

In the practical vein, many firms are beginning to realize that environmental issues are becoming more important to customers, who purchase products and services; stakeholders, who benefit from firm activity; and governmental bodies, who regulate firms. As such, if firms wish to maintain their competitive stature, they must be willing to meet the requests and demands of these various constituencies. Customer requests for environmentally preferred products need to be addressed to maintain current market bases before competitors become better suited to meet the needs of your customers, and to position the firm for future expansion. Stakeholder demands must also be addressed, for otherwise both human and financial capital will leave to find use in better firms. Finally, government regulation, such as extended producer responsibility policies, is likely to become more extensive, necessitating proper responses from firms as a precursor to further operation. By raising the environment to the strategic level, these issues can be addressed in a proactive fashion so that firms are poised to meet the demands of constituencies when they arise, and do not have to grapple with issues in an ad hoc and pressured fashion. A strategic DFE initiative is one way in which this may be done.

In the second sense, firms, as major societal institutions, can be viewed as having a responsibility to improve their environmental performance. This responsibility springs from several sources. First, as mentioned in chapter one, some individuals, and even some companies, believe that firms ought to be more than vehicles for bringing profit to owners and
shareholders. They argue that organizations should help to promote more general social goals, including the preservation of the environment. Secondly, by their very actions, firms shape the behavior of individuals, other firms and other organizations, and even governments. Therefore, firms that advocate environmental responsibility are more likely to induce similar behavior in its suppliers, customers and employees. As a specific example, Chuck Winship noted that since going through the Terma training, he has stopped using weed killers on his lawn. By taking a leadership role, firms are able to promote appropriate behavior in others. Given this power, some believe, as discussed in chapter one, that firms have a responsibility to exercise it and help to move society forward.

By bringing environmental issues to the strategic level, firms actively accept some of this responsibility, for by definition a strategy addresses something "important." First, if environmental issues are considered at the strategic level, it is more likely that a firm will be able to successfully improve their environmental performance, which in turn is beneficial to society. Furthermore, strategies are typically applied at all levels and effect all activity of the firm. As such, they are visible to a large number of people and their influence effects those dealing with the firm in many different roles, increasing the amount of exposure that the strategy receives.

These views are not universally accepted, axiomatic truths. Many people do not believe that the environment is or will become important from a competitive sense, while many would take issue with the notion of the socially responsible firm. As discussed in chapter one, though, there appear to be strong indications that the environment will become important in the marketplace and more people are starting to accept the need for socially responsive firms. Given such propositions, the question of how to change the opinion of those holding other views. In a democratic society, such change can be brought about through public policy. There are actionable items at both the level of business policy and public policy. The primary goal


247 Interview with Chuck Winship, 3 June 1996.

of this thesis has been to examine particular business policies that address one particular realm of concern, namely middle management resistance. Specific policy recommendations for addressing this issue were presented in the previous section. There are other policy approaches, at both the business and public sector level, that the author feels may lead to improved environmental performance by firms. It should be noted that many of these are suppositions, and so ought to be examined by other researchers to establish their efficacy. Furthermore, these are but a few of many possible approaches and policies that could be developed. The ones presented here are, to a large extent, based upon the author’s experience with this and the other case studies conducted under the research grant.

**Business Policy.** The most important general business policy recommendation is that environmental issues need to become a priority issue for top management. Not only does top management support help to generate middle management support, as mentioned above, but it also motivates the technical level of the organization as well. Furthermore, given top management's position at the point of articulation between the organization and society, they are perhaps in the best position to promote environmental issues outside the firm as well. It is also the belief of the author that business policy towards environmental issues, and particularly initiatives such as DFE, should be focused upon the implementation of general systems and goals, not the acquisition and deployment of particular development or managerial "tools." As was mentioned in chapter 3, possessing tools is of no value if they are not actually used. Another policy recommendation is that businesses, particularly large firms, who often have greater market power, need to push environmental issues back towards their suppliers. Two caveats, which were mentioned by individuals at Xerox, apply to this approach. First, firms should be sure that they can demonstrate commitment to environmental affairs before pressuring suppliers to do so. Otherwise, suppliers may claim hypocrisy and be less interested in pursuing such initiatives. Second, firms should attempt to help suppliers meet environmental performance goals. This is likely to engender greater cooperation and also achieve better results. This is consistent with the open

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process that was successful at Xerox, and allows firms to benefit from the experience of downstream firms. Xerox is currently in the process of trying to develop such a set of supplier guidelines and requirements. Finally, numerous discussions have led to the belief that corporate quality programs provide excellent vehicles for promoting DFE related activities and improving environmental performance. The pre-existence of quality programs helps to create a particular mindset which is receptive to change and to the inclusion of a wide number of attributes into the notion of “quality.” Furthermore, the focus of quality programs on continuous improvement is conducive to improving the environmental performance of firms, which, even among the best firms, is still relatively low. 251

Public policy. In regards to the environment, public policy needs to serve the role of changing both corporate values and individual social values. Though changing the value system of either group will eventually lead to changes in the other group, it is clear that applying pressure to both will result in more rapid and significant changes.

At the individual level, public policy needs to focus upon improving consumers’ ability to obtain information about corporate environmental performance. One method which, as mentioned in chapter one, has gained considerable attention in Europe is the creation of environmental labeling schemes, which allow consumers to make more informed product choices. Additionally, general education about environmental issues ought to be expanded, as this provides the base upon which consumers can make informed choices.

At the corporate level, there are numerous approaches that can be taken. First, additional regulation can be adopted to force firms to change their environmental performance. Porter and van der Linde convincingly present a variety of arguments that show the benefits that can be achieved by thoughtful regulation. They note, however, that one must be careful when crafting regulation to avoid the inefficiencies that are often associated with some methods. 252 An alternative approach to regulation is the creation of


voluntary programs, such as the EPA’s Energy Star and 33/50 programs, that help firms to recognize the value of proactive environmental initiatives. Finally, education directed at the firm level is needed to help demonstrate the value of pursuing programs such as DFE. An excellent example of this is the U.S. Office of Technology Assistance’s book *Green Products by Design*.

**Recommendations for further investigations**

In concluding this thesis, there are a number of recommendations that the author has for further investigation into some of the ideas presented in this thesis. Some of these can be classed as ways in which the particular case and analysis presented here could be improved. The rest fall into the class of general studies that would be of particular interest or value.

There are a number of things that could be done to improve the value of the Xerox case and the study of middle management resistance. First, as is always the case, more interviews would be useful in getting a better understanding of the process at Xerox. In particular, interviews of people who are outside the leading groups would provide insight into how a “normal” group might approach DFE and environmental strategy. Another group of people would be those who are late or non-adopters, and thus show the greatest degree of resistance. Such interviews would lead to a better understanding of the strategy process and middle management. It would have also been helpful to have gone into the interviews with a more standardized set of interview questions, to insure that all issues were uniformly addressed. Finally, trying to find areas where resistance was not open and where the collaborative management process broke down would provide greater depth to the analysis.

This research also brought up a number of other possible areas of investigation. One area of analysis that would be of particular academic interest is how DFE fits into the literature on the adoption and diffusion of innovation. It is felt that some of the ideas relating to technological innovation can be applied to “innovations” such as DFE. Another area of investigation would be to look at how organizations become “infected” with

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Overcoming Middle Management Resistance to Strategic Change: DFE at Xerox

DFE. One possible hypothesis is that external "shocks," which are perceived in a non-uniform fashion by individuals within organizations, cause a receiving agent to become aware of a fundamental change in the state of the world. This perception is followed by assimilation, leading to a paradigm shift and a decision to act, in the form of some particular response, such as the creation of a DFE program. Understanding this process would help direct business policy, by describing changes that might lead to additional people recognizing the external shocks. A final area of investigation of interest to the author is the role that champions and change agents play in the diffusion and implementation of DFE. This is related to the previous area of study if one suspects that the receiving agent in the model becomes the change agent. This leads one to wonder how the position of the receiving agent within the organization influences adoption and diffusion.
APPENDIX I

XEROX BACKGROUND INFORMATION
Xerox Company Timeline

1906: Haloid Company founded, Rochester, NY as maker of photographic paper
1938: First demonstration of Xerography ("dry writing") by Chester Carlson
1944: Battelle Memorial Institute buys 3/4 rights for development money
1947: Carlson and Battelle sell rights to Xerography to Haloid Company
1949: Model A copier introduced; not automated, extremely complex, and not well received
1956: Joint venture with J. Arthur Rank Organization (motion picture company), creating Rank Xerox, based in England
September 16, 1959: 914 introduced. First automated plain paper copier; up to 15 copies at a time, 15 seconds for first copy, 7 seconds for each additional copy
March 1960: first shipments of 916
1961: Name changed to Xerox
1962: 50/50 joint venture with Fuji Film Company creating Fuji Xerox. Maintained under Japanese control
1966: Peter McColough appointed President
1969: Purchase Scientific Data Systems (SDS)
1970: Palo Alto Research Center (PARC) founded for research into digital computing
1970: Xerox headquarters moved to Stamford, Connecticut from Rochester
April 22, 1970: IBM introduces the Copier I; Xerox sues for patent infringement, IBM countersues
1971: Joe Wilson dies. McColough appointed CEO, Archie McCardell appointed president
1972: FTC files suit against Xerox
1973: SCM, an office equipment manufacturer, sues Xerox for anti-trust violations
1974: Introduction of 9200, $500 M development costs
1975: Van Dyk Research Corporation files anti-trust suit against Xerox
1975: FTC suit settled with 10 year consent decree
1975: XDS (formerly SDS) closed by Xerox
1975: Savin 750, first small Japanese copier, introduced in US
1977: David Kearns appointed President
1978: Suit with IBM settled for $25 M payment to Xerox
1979: Beginning of benchmarking programs
1980-1981: layoff of 12,000 Xerox employees
1981: Restructuring to SBU
1981: Van Dyk case ends after Supreme Court sides with Xerox
1982: SCM suit ends after Supreme Court sides with Xerox
1982: McColough retires, Kearns appointed CEO
1982: Crum and Forster, a property and casualty insurance company, purchased
February 1983: Senior management meeting in Leesburg, VA on quality.
    Birth of Leadership Through Quality Program
September 1983: Introduction of the 10 series with the 1075 and 1040
January 1984: First quality training sessions
1984: official Leadership Through Quality kick-off
1986: Paul Allaire appointed president
March 1987: Major assessment of Leadership Through Quality project
May 1988: 50 Series introduced
end 1988: all 100,000 worldwide employees finish at least 48 hours of quality training
November 1989: Xerox wins the Baldrige National Quality Award
August 1990: Paul Allaire Takes over as CEO
September 1990: Xerox introduces Total Satisfaction Guarantee good for 3 years
1993: Extensive Xerox organizational analysis
1996: Xerox completes Divestiture of Financial Services Businesses
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Xerox Environment Timeline

1960s: $1.7 M spent on sewage treatment plant for Webster, NY
1967: Began reclaiming metals from photoreceptor drums (Selenium, nickel, aluminum)
1973: Energy conservation policy established
1978: Company ban on use of PCBs and asbestos
1981: Wastepaper recycling began
1982: Began using d-limonene as cleaning agent to replace trichloroethane
1984: Exposure Limit Committee formed
January 1985: Worldwide assessment of all sites for pollution, soil and groundwater contamination. Followed up by extensive remediation efforts
1985: EH&S budget expanded at expense of local operating budgets
1987: Central asset recovery operation founded in European manufacturing operations
1990: Standardization of reusable and recyclable packaging begun (88P311 Supplier Packaging Program)
1990: Environmental Leadership Program started
1990: Environmental Leadership Steering Committee organized
1991: Xerox and Rank Xerox sign International Chamber of Commerce charter for sustainable development
1991: Return program for collection and recycling of toner cartridges launched
1992: Pilot LCA attempted
1992: Accepted delivery of nation's largest fleet of variable-fuel vehicles for use in LA basin
1992: Pilot testing of CO2 cleaning system
January 1993: Began toner container recycling effort
1993: Toner bottles qualified to be made of 100% recycled material
1993: CFC and trichloroethane eliminated from manufacturing process
1993: Reusable packaging for delivery of Xerox equipment adopted
1993: Training of design engineers in DFE practices started
1993: 3Rs training program began
1993: Product Delivery Process changed to include end-of-life considerations
1994: Commitment to make “waste free products in waste free factories with waste free offices” by 1997 made
1994: Wastewater treatment for Selenium recovery started
1994: Finished conversion to water-based paints
1994: Packaging elimination program started
1995: Started making engineering drawings with remanufacturing codes
Earth Day, 1995: Toner Container reuse program initiated
April 1996: Release of Multi National Design Standards and Guidelines for environmental issues
Environmental Awards Presented to Xerox

1995
Blue Angel Environmental (Germany) Label for Xerox 5614, 5352 and 5665 copiers.
Corporate Conservation Council Environment Achievement Award (National Wildlife Federation).
Energy Star Label for four copiers (5337, 5343, 5362, 5665), twelve printers (2230, 4003, 4004, 4505, 4510, 4517, 4520, 4900, 4915, 4920, 4925, XJ5), and four fax/printers (3002, 3004, 3006, Document WorkCenter 250).
Energy 200 Label (Switzerland).
Environmental Engineering Excellence Award (Consulting Engineers Council of New York State).
Margue Retour Award (French National Agency of Environment and Energy Management).
Massachusetts Packaging Challenge Honorable Mention (Massachusetts Department of Environmental Protection).
Stratospheric Ozone Protection Award (United States Environmental Protection Agency).
Structural Plastics Division Award, for use of 100% recycled plastics (Society of Plastics Industry).
Waste Wis$e Commendation (United States Environmental Protection Agency).

1994
Environmental Management Award (Royal Society for the Encouragement of Arts, Manufacturers, and Commerce).
First Annual New York State Governor’s Award.
Best Large Facility in Ontario for Pollution Prevention (Ontario Ministry of the Environment and Energy).
Bronze Starpack Award (Institute of Packaging)
Silver Anniversary Award for Social and Environmental Responsibility (Council on Economic Priorities).
Lifetime Achievement Award (Business Enterprise Trust).

1993
Environment Top Ten List (Winslow Management Consulting).
Gold Medal (World Environmental Center).
Champion of the Environment (NOMDA/LANDA).

1992
Selo Verde Award, for outstanding environmental initiative and education (Government of Brazil).
Distinguished Service in Environmental Planning Award (International Organization of Corporate Real Estate and Facility Planning Executives).
Honor Roll (National Environmental Development Association).
Summary of Xerox Financial Performance

(U.S. $ millions)

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<tr>
<td>Doc. Process. Revenues</td>
<td>15,603</td>
<td>14,082</td>
<td>13,165</td>
<td>14,681</td>
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<td>Total Revenue</td>
<td>16,611</td>
<td>15,088</td>
<td>14,229</td>
<td>18,261</td>
<td>17,688</td>
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<td>R&amp;D expenses</td>
<td>951</td>
<td>895</td>
<td>883</td>
<td>922</td>
<td>890</td>
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<td>SAG expenses</td>
<td>4,770</td>
<td>4,394</td>
<td>4,477</td>
<td>4,779</td>
<td>4,497</td>
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<td>Net income (loss) from continuing ops</td>
<td>1,174</td>
<td>794</td>
<td>(193)</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>Net Income (loss)</td>
<td>(1,646)</td>
<td>-</td>
<td>67</td>
<td>(1,020)</td>
<td>254</td>
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<tr>
<td>Financial Position</td>
<td></td>
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<td>Inventory</td>
<td>2,646</td>
<td>2,294</td>
<td>2,162</td>
<td>2,257</td>
<td>2,091</td>
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<td>Proper, plant &amp; equip</td>
<td>2,092</td>
<td>2,108</td>
<td>2,219</td>
<td>2,150</td>
<td>1,950</td>
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<td>Total assets</td>
<td>25,969</td>
<td>27,278</td>
<td>26,999</td>
<td>25,792</td>
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<td>Shareholder equity</td>
<td>3,878</td>
<td>4,177</td>
<td>3,972</td>
<td>3,875</td>
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<td>10,514</td>
<td>10,084</td>
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<td>Total Capitalization</td>
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<td>15,948</td>
<td>15,325</td>
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<td>16,179</td>
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<td>Primary earnings/share</td>
<td>($4.69)</td>
<td>$6.73</td>
<td>($1.84)</td>
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<td>$4.00</td>
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<td>Employees</td>
<td>85,200</td>
<td>87,600</td>
<td>97,000</td>
<td>99,300</td>
<td>100,900</td>
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APPENDIX II
INTERVIEW LIST

The following is a list of all of the individuals, categorized by the Xerox group to which they belong, that the author spoke to. For further information on the Xerox case study, interested parties are advised to contact either John Ehrenfel, director of the MIT Technology, Business and Environment Program, or Jack Azar, Associate Director, Environmental Products and Technology, Xerox Corporation:

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Patricia Calkins, EH&S Quality and Policy Deployment

ARM
Ralph Sholts, Manager, Technology Devl. and Qual, CSS/ISC ARM
Victor Berko-Boateng, Recycling Coordinator, CSS/ISC ARM
Augie Ange, Technical Specialist, CSS/ISC ARM

CRU
Joe Marino, Vice President, CRU, CSS/Manufacturing Support
Dick Carville, CRU, CSS/Manufacturing Support
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**Supplies**
Dominic Sherony, Manager, Technical Services Sector, CSS/SD&MS
Karl Mueller, Project Manager, Reduce/Reuse/Recycle
Fred Kuhn, Technical Specialist, Project Mgr., Eng. and Design Area

**Strategic Programs**
Chuck Winship, Manager, Engineering Operations and Service
Ed de Jong, Project Manager, Office Document Products

**Design Engineers**
Eugene Yang, Senior Technical Specialist, Xerox Production Systems
Dan Schirmer, Advanced Manufacturing Engineer
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