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PROACTIVE CORPORATE ENVIRONMENTAL STRATEGY AND THE DEVELOPMENT OF COMPETITIVELY VALUABLE ORGANIZATIONAL CAPABILITIES

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This article presents the results of a study conducted in two phases within a single industry context. The first phase involved comparative case studies to ground the applicability of the resource-based view of the firm within the domain of environmental responsiveness. The second phase involved testing the relationships observed during the case studies through a mail survey. It was found that strategies of proactive responsiveness to the uncertainties inherent at the interface between the business and ecological issues were associated with the emergence of unique organizational capabilities. These capabilities, in turn, were seen to have implications for firm competitiveness. © 1998 John Wiley & Sons, Ltd.

INTRODUCTION

Since the World Commission on Environment and Development Report of 1987 (commonly known as the 'Brundtland Commission Report') was published, corporate managers and management scholars have been grappling with the questions of how and why corporations should incorporate environmental concerns into strategic decision making. The Brundtland Commission Report coined the term 'sustainable development' and explicitly postulated a positive role for the business corporation in furthering the cause of environmental protection (as opposed to the negative traditional role of corporations being the 'problem' and governments being the 'solution') by integrating environmental protection with economic performance. Since the Brundtland Commission Report raised the management of environmental concerns to a strategic issue for the corporation, managers and management scholars have been debating the role of environmental strategy in the repertoire of strategic management.

One stream of literature has focused on the concept of sustainable development and has attempted to redefine broadly the global societal role of the business corporation (Gladwin, Kennelly, and Krause, 1995; Hart, 1997; Sharma, Vredenburg, and Westley, 1994; Shrivastava, 1995a; Starik and Rands, 1995: Westley and Vredenburg, 1996). Most of this literature says little about how moving to a sustainable development model will affect firm competitiveness.

Other writers have cautioned that implementing such a broad redefinition of the role of the corporation may be hazardous for the corporation's financial well-being (Walley and Whitehead, 1994). These writers advocate a return to strict cost–benefit frameworks, investing in environmental practices that have paybacks within an economic time frame through reduced costs of regulatory compliance, lower waste disposal, energy and material savings, etc. Hart and Ahuja (1996), after empirically examining firms' savings from emission reduction, conclude that while

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there are initial cost savings for most firms due to the low cost of remedying existing inefficiencies and wastes, once the 'low hanging fruit has been harvested' it becomes increasingly difficult to improve financial performance as the investments in emission reduction may exceed the savings generated.

A third stream of literature has attempted to demonstrate how firms might gain competitive advantage in ways other than waste/efficiency cost savings from environmental strategies. Porter (1991) and Porter and van der Linde (1995) argue that strict environmental regulations will give firms in their jurisdiction a competitive advantage in other markets as other jurisdictions move standards upward as well, in the same way that operating in a demanding domestic consumer market 'toughens up' a firm for international competition. Jacobs (1992), Hawken (1993) and Vredenburg and Westley (1997) explore what 'good' regulations and environmental standards might look like and how they might lead to corporate environmental innovation. Shrivastava (1995b) and Westley and Vredenburg (1991) show how firms may gain competitive advantage by gaining social legitimization. These authors rely primarily on case studies to make their arguments. Klassen and McLaughlin (1996), viewing the firm essentially as a 'black box,' find correlations between firm environmental performance and firm financial performance (as measured by stock performance) in subsequent time periods. This study suggests that environmental performance may, in fact, be associated with more than the realization of greater efficiencies within a firm, lending some support to the argument that competitive advantage may be derived from factors other than waste/efficiency savings.

Hart (1995) speculates theoretically what might be happening inside Klassen and McLaughlin's 'black box.' He applies the resource-based view of the firm (e.g., Barney and Zajac, 1994) to the domain of corporate environmental strategies.The resource-based view of the firm has gained prominence as a competitive theory of the firm (Barney and Zajac, 1994). This view argues that a firm's competitive strategies and performance depend significantly upon firm-specific organizational resources and capabilities. These capabilities are more likely to emerge during periods of greater turbulence and organizational change (Wernerfelt, 1984). Indeed, the limited empirical research in this area has found that firm capabilities evolve as a result of firm response to competitive environments (Barnett, Greve, and Park, 1994; Levinthal and Myatt, 1994). In turn, these capabilities within organizations are seen to influence competitive strategies and organizational outcomes (Ginsberg, 1994; Barney and Hansen, 1994). Developing his theoretical argument, Hart (1995) predicts that innovative environmental strategies can lead to the development of firm-specific capabilities which can be sources of competitive advantage. He argues that corporate response to calls for environmental protection is an important emerging competitive domain for businesses and might be best understood in terms of the resource-based view of the firm.

The arguments linking environmental responsiveness to organizational capabilities and performance have been theoretical to date. In the absence of empirical evidence for these relationships, cost–benefit frameworks are dominant and influence corporate managers to adopt only those limited investments in environmental practices which can yield tangible monetary benefits within an economic time frame. The objective of this article is to examine the validity of the hypothesized linkages between environmental responsiveness strategies and the emergence of competitively valuable organizational capabilities (Hart, 1995).

This research was conducted within a single industry context. The first phase of the study involved comparative case studies through in-depth interviews in seven firms in the Canadian oil and gas industry to ground the resource-based view of the firm within the domain of corporate environmental responsiveness. This study was intended to examine linkages between environmental strategies and the development of capabilities, and understand the nature of any emergent capabilities and their competitive outcomes. The exploratory study was conducted longitudinally over a period of 18 months using the same cohort of respondent companies and managers. The second phase involved testing the emergent linkages through a mail survey-based study of the Canadian oil and gas industry.

The next section describes the research methods used in the exploratory study. The article then describes the findings of the case comparisons conducted during the exploratory study. In this section, data from the exploratory study are

supplemented by literature from corporate social performance, environmental strategies, organizational learning, and the resource-based view of the firm, to explain the linkage between proactive environmental responsiveness strategies and the emergence of organizational capabilities. The article then describes the research methods and the results of the mail survey which indicate that proactive environmental strategies are associated with the emergence of competitively valuable organizational capabilities. We end with a discussion of the theoretical, research, and managerial implications of this research.

THE EXPLORATORY STUDY: RESEARCH METHOD

We begin by explaining the rationale for choosing the case method for the exploratory study, the criteria for selecting the Canadian oil and gas industry as a domain, the criteria for selecting the seven firms included in the exploratory study, the data collection method and the data analysis techniques used.

The case study is an appropriate method of empirical inquiry when the phenomena to be studied (in this case, corporate environmental responsiveness and organizational capabilities) can not be easily separated from their organizational context (Yin, 1989). Case comparisons enable an investigation of the 'what' and 'how' questions (Yin, 1989), such as: What are the different strategies of environmental responsiveness adopted by different organizations within the same industry? How do these strategies impact upon organizational competitiveness? Comparative case studies of organizations within the same industrial context facilitate comparison through replication of results, either literally (when similar responses emerge) or theoretically (when contrary results emerge for predictable reasons), to enable 'analytic generalization' (Yin, 1989). A common industrial context also facilitates control for relevant external influences such as the degree of environmental regulation, the degree of scrutiny by media and special interest groups, and industry-wide environmental standards and common practices.

The Canadian oil and gas industry was chosen as a research setting because it is an example of an industry based on nonrenewable inputs, under pressure from its external stakeholders to change its environmental practices. Further, most of the industry is located in Alberta with head offices in Calgary. This concentration in one location reduced the diversity of external influences faced by individual firms in the industry and facilitated data collection by providing easy and repeated access to managers of the firms included in the study.

Firms were picked from each size category (major, senior, intermediate, junior) and from each activity category (integrated, upstream, and downstream). This was to understand whether environmental responsiveness strategies were influenced by firm resources (as reflected by industry size categorization of 'majors,' 'seniors,' 'intermediates,' and 'juniors') as also by different sets of stakeholder groups impacted by a firm's range of activities (upstream: exploration, drilling, crude oil production; downstream: refining and marketing; or integrated).

Letters were sent out to the Chief Executive Officers (CEOs) of 15 companies requesting cooperation for the study. Twelve CEOs responded and agreed to provide access for research. Data collection was stopped after seven companies were studied and theoretical saturation seemed to have been reached, that is, new insights into the phenomena being examined were no longer gained (Glaser and Strauss, 1967). While it is possible that inclusion of more firms after this stage may lead to new insights, Glaser and Strauss (1967) stress that once theoretical saturation is reached, the phenomena to be studied have been substantially explained.

Table 1 presents the comparative characteristics of companies included in the exploratory study. Company names are disguised for confidentiality.

Data collection

During the first phase of data collection in 1993, unstructured interviews totaling 36 hours were conducted with 19 senior and middle management executives of the seven companies. The executives interviewed in each company included either the CEO or a member of the top management team, the environmental assessment manager, a staff manager, and a line/operations manager. In smaller companies, several functional areas happened to be combined into one position and fewer managers were interviewed. The managers

Table 1. Comparative company characteristics (names disguised for confidentiality)

	Buffalo	Sioux	Royal	National	U.S. Oil	Farmers	Northern
Company classification[a]	Senior	Intermediate	Major	Major	Senior	Intermediate	Junior
Range of operations[b]	Integrated	Downstream	Integrated	Integrated	Integrated (except for retail)	Upstream	Upstream
Sales	C$ 1.5 bn.	C$ 0.5 bn.	C$ 10 bn.	C$ 6 bn.	C$ 4 bn.	C$ 0.3 bn.	C$ 0.1 bn.
Employees	1500	1000	10,000	7,000	2400	700	400

[a]Company classifications within the industry are based on size in terms of a mix of sales and assets.
[b]*Integrated* oil companies include operations covering the full range of petroleum industry activities, including exploration, production, refining, and retail marketing. Companies with operations focused in the *upstream* end of business almost exclusively engage in exploration and production activities, while companies with operations focused in the *downstream* end of business engage almost exclusively in refining and marketing activities.

were identified through the snowball technique. During each interview, leads to other managers knowledgeable about environmental strategies and practices were identified. Interview transcripts were verified for accuracy by the managers. Each transcript was analyzed immediately following the interview and used as a basis to explore emerging themes in subsequent interviews. Follow-up interviews were conducted with several managers to verify themes that emerged in subsequent interviews. A literature search was conducted in tandem with data collection and analysis in order to ground the analysis theoretically (Glaser and Strauss, 1967).

In the second phase of data collection, over the next $1\frac{1}{2}$ years, the seven companies included in the first study were contacted again and 27 managers were interviewed. Each manager was interviewed between two and five times during the year. Most of these interviews were brief and were conducted over the telephone. The respondents were senior and middle managers and included 18 of the 19 managers interviewed in the first study. Nine managers were added at the suggestion of the first cohort of 18 managers as useful sources of information on environmental strategies and competitiveness of the companies. Most of these additional nine managers were in line/operating positions such as Exploration Manager, Drilling Supervisor, Marketing Manager, Refinery Manager, etc. This phase resulted in a further 33 hours of transcribed interview data. Thus a total of 69 hours of transcribed interview data were collected in two phases.

One objective of the second phase of data collection was to verify that companies had continued the environmental strategies identified in the first phase. The interviews in the second phase were specifically focused on the actions undertaken by companies to reduce the environmental impact of their operations. In terms of organizational outcomes, the interviews sought to ascertain whether managers perceived environmental practices as having had any positive or negative effects on corporate performance and competitiveness.

Interview data were triangulated, during both phases, through a qualitative content analysis of corporate public documents such as annual reports, environmental reports, company newsletters, and newspaper reports for the period 1980–95. Interviews were also conducted with officials of the regulatory body (the Alberta Energy and Resources Conservation Board, renamed in 1995 as the Alberta Energy and Utilities Board—hereafter AEUB), with officers of the industry association (the Canadian Association of Petroleum Producers—hereafter CAPP), and with representatives of two environmental groups monitoring the industry's practices. These data were used primarily to verify company interview data.

Data analysis

The interview transcripts were analyzed through the categorization and analysis of emergent concepts and ideas (Miles and Huberman, 1984) and constant comparison of these concepts (Glaser and Strauss, 1967) to identify common themes. An interview summary form (Miles and Huberman, 1984) was prepared after each interview to

highlight emergent themes, variables, and other issues of interest which would be followed up at subsequent interviews. Each interview was coded in accordance with these emerging themes and sentences relating to each different theme were entered in separate computer text files set up for each emergent theme. The number of references and intensity of support for each theme were identified within each file before deciding which themes to retain and which to drop as less theoretically significant. Connections between the significant themes were investigated in the data. A number of the themes were dropped at earlier stages of data collection when subsequent interviews revealed them as less theoretically important or part of another theoretical theme. The sifting process continued in tandem with data collection. If theoretical parallels could not be found, then the themes were abstracted into generic descriptive labels.

During the first phase of data collection in 1993, the resource-based perspective was not the focus of data analysis. However, some of the emergent themes relating to organizational outcomes suggested labels from the resource-based literature (e.g., Amit and Schoemaker, 1993; Barney, 1991; Hart, 1995). Therefore, the second phase of data collection in 1993–94 focused on the linkages between environmental strategies and organizational capabilities. The data analysis suggested a range of environmental responsiveness strategies adopted by these firms, and linkages with organizational outcomes in the form of organizational capabilities and competitive benefits.

ENVIRONMENTAL RESPONSIVENESS AND ORGANIZATIONAL CAPABILITIES

Corporate environmental strategies were examined along 11 dimensions. These were determined on the basis of the areas in which the oil and gas industry substantially impacts upon the natural environment, as well as dimensions that have been used to evaluate environmental performance in the literature. The impact of the oil industry on the natural environment is strongest in the areas of species habitat preservation at exploration and drill sites, environmental restoration of contaminated soil, risk reduction of environmental accidents and wastes, and waste reduction/reuse at production and refining sites. Dimensions taken from environmental management literature, such as those used by the Coalition for Environmentally Responsible Economies (CERES), by socially responsible investment funds (Kinder, Lydenberg, and Domini, 1992), and by the Business Council for Sustainable Development (Schmidheiny, 1992), included material use reduction and conservation, use of alternative fuels, energy conservation, less environmentally damaging products, stakeholder partnerships for environmental preservation, public disclosure, and commitment to research and employee training programs for environmental preservation.

The companies included in the study exhibited a wide range of responses in dealing with the business/natural environment interface. Some companies exhibited specific areas of excellence in reducing environmental impact, such as Buffalo's efforts in habitat/biodiversity preservation and waste reduction, Sioux's efforts in developing and selling less environmentally damaging fuels, and Royal's efforts in risk reduction. However, we looked for consistency of environmental practices across all the dimensions that were relevant to a firm's range of operations. Therefore, even though Royal, U.S. Oil, and National were very active in stringent risk reduction, they had undertaken very limited environmental practices in the other dimensions such as habitat preservation, waste reduction, lower polluting products, stakeholder partnerships to reduce environmental impact, etc. Thus, companies were considered proactive only if they exhibited a consistent pattern of environmental practices, across all dimensions relevant to their range of activities, *not* required to be undertaken in fulfillment of environmental regulations or in response to isomorphic pressures within the industry as standard business practices.

In addition to consistency across dimensions, the proactive firms (by our definition) should have exhibited a consistent pattern of such voluntary actions over time. Two significant years for the industry from the environmental perspective were 1988 and 1993. In 1988, public attention was focused on the natural environment due to evidence of thinning of the Earth's ozone layer, evidence of climate change, the *Exxon Valdez* oil spill, increased stringency of Canadian environmental regulations, and the 'Energy Options'

initiative in Canada to formulate a blueprint for a sustainable energy future. In 1993, all environmental regulations in Alberta were consolidated into one act and managers were made personally liable for environmental accidents. In order to be considered proactive, companies should have exhibited a consistent pattern of voluntary actions across all relevant dimensions before the events of 1988 catalyzed environmental action across most of the industry. Interviews with regulators, industry associations, and environmental groups, as well as an analysis of archival data for the period 1980–95, helped verify the claims made by managers about past practices. These generic strategy categories of reactive and proactive responses have been frequently used in the corporate social performance literature (Post, 1978; Sethi, 1979).

Based on the 11 dimensions of environmental response, two companies were classified as proactive and five as reactive. Buffalo Oil, a company considered proactive, has been an industry leader since 1981, in preserving natural habitats, species, and historical heritage sites impacted by its operations. This company made considerable investments in technologies and management practices to reduce its environmental impact. It undertook comprehensive environmental audits of its operations (the first audit being conducted in 1983), innovated less environmentally damaging exploration and drilling techniques (including the development of horizontal drilling techniques), and voluntarily ceased oil exploration and drilling operations in areas of high negative ecological impact since 1987. In order to 'level the competitive playing field,' it lobbied the provincial government to set aside these areas as protected preserves under the Alberta government's Special Places 2000 program. Buffalo is an industry leader in technological innovations to reduce emissions, solid waste, and energy use in its refining and manufacturing operations. It holds over 50 patents in the areas of process improvement, sulfur dioxide recovery, waste reduction and disposal, soil restoration, and less polluting fuels. It has also invested in research into cleaner-burning fuels, renewable energy sources, and fuel cell technologies.

The other proactive company, Sioux Oil, set up the first North American commercial operation to recycle used engine oil in 1980. It has since been actively engaged in developing and marketing lesser polluting fuels such as vegetable-based engine oils, ethanol-blended gasoline, methanol, compressed natural gas for automobiles, and in educating consumers about the more responsible use of fossil fuels. It has also invested in research into renewable energy sources.

On the other hand, the five companies identified as having reactive environmental strategies emphasized the reduction of risk and liabilities of environmental accidents and spills. Environmental accidents cannot be insured and can cause financial disruption, negative media exposure and damaged reputations for these companies. Royal, U.S. Oil, and National concentrated on eliminating spills and leakages while transporting oil and gas in pipelines and tankers, reducing leakages during transfers of petroleum products from tankers to underground tanks, and effective emergency response procedures in the event of an environmental accident. The regulators confirm that these three companies are exemplary at regulatory compliance. However, these three companies have not undertaken any voluntary environmental practices in the areas of habitat preservation, restoration, waste reduction (as opposed to emission/waste control as per regulations), material use reduction, development of less polluting petroleum products, and stakeholder partnerships for environmental preservation. In fact, the last dimension has been a major deficiency, with conflicts having taken place between these companies and local communities as well as environmental groups.

The smaller companies, Northern and Farmers, appointed outside consultants to ensure that their 'paper trails' are in order to show due diligence in the event of an environmental accident. They were doing the minimum to ensure regulatory compliance. This may have been due to their limited resources and smaller size resulting in a lower intensity of media attention.

The environmental strategies of the seven companies did not appear to have any association with the range of activities of the companies. Buffalo is an integrated 'senior' company, Sioux is a downstream 'intermediate' company, while the reactive companies range from integrated 'majors' to upstream 'juniors.' The ability to clearly separate the seven companies into two distinct categories based on their environmental responsiveness strategies facilitated comparison of the organizational outcomes associated with these strategies.

Environmental responsiveness and organizational capabilities

While managers of both reactive and proactive companies considered improving shareholder value an important mission, the former perceived environmental responsiveness as detracting from this objective. The proactive companies, in contrast, perceived a number of competitive benefits emerging from their environmental response. These included lower costs of processes/inputs/products, innovations in processes/products/operating systems, improved corporate reputation, and relationships with a wide range of stakeholders. In contrast, the reactive companies were unable to associate their corporate environmental responsiveness strategies with any positive organizational outcomes other than lower liabilities due to reduction in risk of environmental accidents.

These competitive benefits were perceived by the proactive company managers as the outcomes of strengths built up through environmental responsiveness strategies. These strengths were often described in terms of characteristics that identified them as organizational capabilities. Organizational capabilities are the coordinating mechanisms that enable the most efficient and competitive use of the firm's assets—whether tangible or intangible (Day, 1994). The competitive advantage of these capabilities stems from their elusive nature based on social complexity and deep embeddedness in organizations (Hart, 1995; Teece, 1987; Winter, 1987). They are often invisible (Itami, 1987), based on tacit learning (Hart, 1995; Polanyi, 1962) that is causally ambiguous (Hart, 1995; Reed and DeFillippi, 1990; Rumelt, 1987) and thus difficult to identify and imitate by competitors (Teece, 1987). These capabilities usually lack an identifiable owner in an organization and are not traded in factor markets (Barney, 1991; Hart, 1995; Reed and DeFillipi, 1990). They are path dependent upon a combination of unique organizational actions and learning undertaken over a period of time (Barney, 1991; Dierickx and Cool, 1989; Hart, 1995). They span several different functions and levels within an organization and are capable of multiple uses (Amit and Schoemaker, 1993; Barney, 1991).

During the first phase of interviews, some of the themes emerging from the interviews indicated that the perceived linkages between environmental responsiveness and competitive benefits in proactive companies were due to the emergence of certain capabilities. Hence, the second phase of data collection specifically focused on this issue by explaining the concept of capabilities and asking managers if they perceived any capabilities as having been built up as a result of their environmental responsiveness strategies. However, examples of capabilities were not suggested to managers. The managers of the reactive companies indicated the capabilities of minimizing of risk and liability (Royal, U.S. Oil, and National) and exemplary regulatory compliance (Royal and National). We did not consider these as competitively valuable capabilities because both proactive and reactive companies were required to achieve these two objectives. The managers of the smaller reactive companies, Northern and Farmers, ridiculed the notion that environmental responsiveness could have any competitive benefits for their companies.

Table 2 shows how the 'first cut' categorization of themes based on a listing of common concepts and ideas emerging from the interview transcripts in the first phase of data collection. Table 3 shows the capability themes emerging during more focused data collection in the second phase. An analysis of the interview data indicated three emergent capabilities.

Capability for stakeholder integration

This involves the ability to establish trust-based collaborative relationships with a wide variety of stakeholders, especially those with noneconomic goals. These stakeholders may include local communities, environmental groups, regulators, nongovernmental organizations (NGOs), etc. Hart (1995) suggests stakeholder integration as a capability arising as a result of product stewardship which requires the integration of perspectives of key external stakeholders such as environmental groups, community leaders, the media, and regulators into product design and development. Here it was observed that stakeholder integration emerged for the proactive companies not only as a result of product stewardship, but also as a result of habitat preservation, resource management, waste reduction, and energy conservation. These companies engaged concerned stakeholder groups in dialogue over new explo-

Table 2. Environmental responsiveness and organizational capabilities (first phase of data collection)

Capabilities	Illustrative quotes (**P** = proactive; **R** = reactive)
Stakeholder integration	(**P**) *Buffalo*: 'Our mission is to generate goodwill among our stakeholders.' 'We believe in integrating our neighbours into all aspects of our operations.' 'Our employees learn more about environmental issues from stakeholder groups than from training programs.' 'Even . . . [an anti-oil industry activist] is willing to sit down and talk to us.' 'If our stakeholders advise us against a new development, we save ourselves a lot of grief and expense later on.' 'The involvement of stakeholders into operations is an ongoing process.'
	(**P**) *Sioux*: 'The ethanol blends would not have survived without our strong relationships with farmers in Saskatchewan and with crown corporations purchasing our products.' 'Our business is built on relationships with a wide range of citizen groups.'
	(**R**) *Royal*: 'The local communities and environmental groups have genuine concerns but we know the business better than they do. We always come up with the best solutions without interference.' 'We hold open houses every six months. Members of local communities are welcome to walk in and ask questions.'
	(**R**) *Northern*: 'We have emergency response procedures in place and have circulated information to residents in the areas we operate in . . . what more are we expected to do?'
	(**R**) *Farmers*: 'To be honest, no one has a right to tell us how to run our business.'
	(**R**) *U.S. Oil:* 'We contribute to programs for protection of endangered species. We contribute to charitable causes. We run our business efficiently and expect local communities and environmental groups to trust us to do our best for environmental protection. Their involvement is more often disruptive than helpful.'
Higher-order learning	(**P**) *Buffalo*: 'Our interactions with stakeholders have opened up our minds to entirely new ways of running this business.' 'Talking openly with local communities and environmental groups opened our employees up to fresh perspectives.'
	(**P**) *Sioux*: 'We have the most exciting learning environment in the industry . . . our employees consider this is one of the best perks.'
	(**R**) *Royal*: 'We know the business better than anyone else . . . look at our profits. The issue here is not learning but squeezing increasing efficiency out of the existing operations.'
Continuous innovation	(**P**) *Buffalo*: 'In our technologically mature industry, this is the one frontier open to fresh learning, innovations, and productivity improvements.' 'A concern for environmental preservation has led to several process improvements and process cost reductions which we have patented and sold to companies in six different countries.' 'We pioneered and perfected horizontal drilling techniques . . . all because we wanted to reduce our footprint on nature.' 'Our exploration and development process, undertaken in consultation with stakeholders, has the lowest environmental impact in the entire industry.'
	(**P**) *Sioux*: 'We try to introduce at least three alternative fuels or less damaging fossil fuel products into the market every year.' 'Our past successes were based on adoption of already developed technologies. In recent years, our research and development centre has built up a strong program of research in alternative energy.'
	(**R**) *Royal*: 'This is a technologically mature industry. No one is going to make any major improvements.'
	(**R**): *U.S. Oil*: 'With 50 to 70 years of reserves left, companies will not scramble to improve processes and products.'
	(**R**) *National*: 'We should be investing in improving technologies in the Third World . . . that's where you'll get more bang for the buck.' 'It doesn't make sense to spend billions of dollars to improve sulfur dioxide recovery another 2 percent.'
	(**R**) *Farmers*: 'We use state-of-the-art equipment . . . what sort of improvements do you expect?'

Table 3. Theme analysis of organizational capabilities (second phase of data collection)

First-order themes	Second-order themes	Final themes
• The ability for an early sensing of societal concerns • Positive ties/relationships with stakeholders • Ability to solve problems collaboratively • Goodwill reserves among neighbors • Ability to work with communities and interest groups for environmental solutions • Organization-wide culture of listening to local communities and environmental groups • Capability of explaining company's point of view to external stakeholders • Goodwill reserves leading to the company receiving the benefit-of-the-doubt from regulators, communities, and environmental groups • Capability of steering new developments through public consultation process	• Ability to collaborate with stakeholders to find solutions to environmental problems • Ability to communicate with stakeholders in the environmental domain • Ability to steeer new developments effectively through public consultation processes	Stakeholder Integration (Hart, 1995)
• A knowledge base of environmental information and biodiversity data • Constant updating of the knowledge base on environmental impacts • An ability to understand the environmental impact of corporate operations • An ability to look for solutions to environmental problems from fresh angles • Formal and informal channels of environmental information exchange • Integration of line and staff functions for information exchange and dissemination around environmental practices • Feedback systems for reporting of environmental performance • Control systems to reward environmental reporting and solutions	• Line-staff cooperation and integration around environmental information exchange • Continuous expansion of knowledge about the business/natural environment interface • Ability to look for solutions to environmental problems from fresh angles	Continuous higher-order learning

Table 3. Continued

First-order themes	Second-order themes	Final themes
• Capability of constant experimentation • The ability to take a long-term view of experimental actions • A reservoir of accumulating technical operational knowledge • The ability to take a fresh perspective of traditional operations/processes • A culture of innovativeness • An ability to balance environmental objectives with ecological goals • The ability to spot opportunities in adverse situations and crises • The ability to make continuous improvements in processes, products, systems • Acting before the rest of the industry • Ability to preempt regulations • Ability to generate feasible low-cost solutions to environmental problems • Control systems to reward environmental solutions	• Ability to experiment on the business/natural environment domain • Ability to balance environmental objectives with ecological goals • Ability to spot opportunities amidst changes in social expectations and environmental regulations • Ability to innovate and continuously improve operations while reducing environmental impact	Continuous innovation (modified from 'Continuous Improvement'—Hart, 1995)
• Corporate culture of environmental leadership • Corporate culture of exemplary regulatory compliance	• Leadership in environmental regulatory compliance	This theme dropped as being abstract and not competitively valuable

rations, developments, site location, plant design, new product, and used oil recycling decisions. One catalyst may be the greater emphasis placed in Canada on public consultation, and hence stakeholder involvement, in the environmental regulation of industry (Pasquero, 1991).

The process started when Buffalo and Sioux, having decided, around 1980, to assume an environmental leadership stance, determined that it was essential to improve their managers' understanding of environmental issues through interaction with multiple stakeholders concerned with the preservation of the natural environment. The twin goals of goodwill generation among diverse stakeholder groups and reducing corporate environmental impact became important goals for both companies. Both companies provided organizational incentives to facilitate the development of employees' abilities to listen to and incorporate the viewpoints of the concerned stakeholders. Employees were rewarded not only for achieving production and financial goals, but also for achieving low levels of stakeholder complaints, negative publicity and high levels of positive feedback from stakeholder groups. Further, employees were also provided discretion through flexibility in a portion of their operating budgets to experiment with different ways of reducing environmental impact. This enabled employees to respond to some of the suggestions of external stakeholders, further improving collaborative relationships and mutual trust.

Thus, proactive companies benefited from a battery of subtle sources of social influence derived from their employees' close relationships with the representatives of these stakeholder groups. These close interactions increased the likelihood that stakeholder representatives had

positive and favorable influences on critical decisions made by these groups in respect of the proactive companies (Cialdini, 1984). Buffalo's refinery manager explained:

> This process took around five to seven years of consistent actions and behavior to seep into the organizational culture . . . New employees learned quickly that developing positive relationships with a wide variety of stakeholders is as important as satisfying customers and earning an above average return for investors.

While Buffalo's emphasis was on relationship-building with stakeholder groups at the upstream end of operations, Sioux's emphasis was on relationship-building with suppliers and customer groups which include farmers, government agencies, crown corporations, nonprofit organizations, and NGOs. These groups supported Sioux's move towards less environmentally damaging fuel alternatives. Sioux's recycled engine oil was purchased by members of these groups during the 12 years it lost money on this product, keeping the pioneering operation alive. With growing awareness of environmental degradation during the 1990s, more consumers began to buy recycled oil and the more expensive vegetable-based oils, making this operation profitable.

On the other hand, the reactive companies emphasized the role of legal and public relations departments in handling the concerns of stakeholders with noneconomic motivations. These companies' managers indicated that persuasion and image management were more important in their dealings with these groups. They perceived their actions as driven by the concerns of primary stakeholders (Clarkson, 1995) such as investors who have representation on their boards, customers who have purchasing power, and regulators who have sanctioning power. In contrast, the proactive companies' managers were more proud of their relationships with environmental groups, local communities, regulators and other groups motivated primarily by noneconomic goals such as values for the preservation of the environment. For the proactive companies, joint problem solving, information sharing and negotiations (Gray, 1989; Vredenburg and Westley, 1997) took place primarily within the framework of environmental protection and not within the framework of the economic transaction. The reactive companies assumed adversarial positions toward environmental groups and local communities who 'blocked' or opposed their business operations, arguing that these groups affected their ability to generate jobs and revenues. These companies are still actively fighting and lobbying to open up protected natural areas for development.

The environmental groups and local communities confirmed that the reactive companies do not acknowledge their stake in new developments which may have major environmental impacts. At the same time, they confirmed their positive collaborative relationships with the proactive companies based on mutual consultation for environmental preservation. They trusted these companies to try their best to reduce environmental impact in accordance with these consultations. Even the representative of Greenpeace, committed to closing down the industry, said:

> We can talk to these (proactive) companies . . . they are in a dirty business but at least they try harder than the larger companies with more resources.

According to the officials of the regulatory agency (AEUB), while no company has a perfect record in meeting emissions and solid wastes limits, the two proactive companies made more sincere efforts than others to cut down their emissions and wastes. The regulators confirmed that they give the 'benefit-of-the-doubt' to 'sincere companies' in case of minor infractions, and concentrate on companies that tend to have a 'bad attitude' toward environmental standards. In general, the regulators have an overall positive view of the larger reactive companies (Royal, U.S. Oil, and National) as well, but a negative view of the two smaller companies (Northern and Farmers) in terms of 'sincerity.' This is consistent with the definition of the reactive companies as those staying within regulatory boundaries.

Some of the competitive benefits of this firm-specific capability lie in improved corporate reputations that translate into favorable economic dealings including retail sales and increased goodwill that leads to the easing of opposition to everyday operations and development plans. The proactive companies are able to go through public consultation hearings and approval processes for new developments much faster. This leads to savings in project cost over-runs, lower interest

charges, and lower litigation expenses. The reactive companies face stiff opposition, and these hearings can go on for years without resolution. In 1994, U.S. Oil had to withdraw from a major new development in Alberta after spending over $15 million on development expenses and legal charges during 1991–94. U.S. Oil did not consult with local communities or environmental groups and try to address their concerns about the environmental impacts of the project. In contrast, Buffalo and Sioux always consult these groups before announcing new developments. If their stakeholders clearly indicate that the development is not desirable due to ecological sensitivity, these companies withdraw without spending time and money on legal battles.

The trust and credibility developed by proactive companies with a variety of stakeholder groups is a path-dependent strategic capability that can not be easily imitated by competitors. This capability is an asset, based upon over a decade of consistent flow of actions (Dierickx and Cool, 1989; Hart 1995) by the companies to reduce their impact on the natural environment in consultation with a diversity of stakeholder groups. This capability is firm-specific because it is based on fundamental changes in business philosophies and values accompanied by changes in organization design over a period of a decade or more. This capability is internally socially complex since it resides in every employee by virtue of corporate culture. At the same time, this capability is externally socially complex (Coff, 1997) based on collaborative trust-based relationships between boundary spanners and external stakeholders.

Capability for higher-order learning

An organizational mandate to improve understanding of environmental issues exposed the managers of the proactive companies to a variety of external influences, and thus sparked shared learning processes. Organizational learning is defined as 'the development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions' (Fiol and Lyles, 1985: 811). Learning within organizations is indicated by successful organizational coping with rapid environmental change (Duncan and Weiss, 1979; Hedberg, 1981; Pfeffer and Salancik, 1978; Weick, 1979) and behavioral outcomes based on shared ideology and understanding of the changes taking place (Daft and Weick, 1984; Fiol and Lyles, 1985; Starbuck, Greve, and Hedberg, 1978).

Changes in the business environment that motivate exploration of alternative organizational routines, technologies, environments, and objectives, may lead to higher-order (or higher-level—Fiol and Lyles, 1985; double-loop—Argyris and Schön, 1978) learning. Higher-order learning involves the development of different interpretations of new and existing information, as a result of developing new understandings of surrounding events (Fiol, 1994). This type of learning characterizes organizational change under conditions of ambiguity and uncertain information (Lant and Mezias, 1992; March and Olsen, 1976; Miller and Friesen, 1980; Starbuck *et al*., 1978). This is not unlike the ambiguity and lack of information that currently characterizes the business/natural environment interface in the Canadian oil and gas industry.

The strategies that an organization may adopt to deal with these ambiguities and lack of information will create a context for issue interpretation and decision-making (Daft and Weick, 1984; Ginsberg and Venkataraman, 1992, 1995; Thomas and McDaniel, 1990) and lead to higher-order organizational learning (Fiol and Lyles, 1985). Thus, environmental strategies can lead to different paths of learning and knowledge creation on the business/natural environment interface for each firm. Facilitation of experimentation (searches for alternative routines—March, 1988) by managers can lead to the recognition of new goals and the means to achieve these goals. These learning processes, in turn, result in major reorientations that involve changed norms, values, world-views, or frames of reference (Argyris and Schön, 1978; Bateson, 1972; Shrivastava and Mitroff, 1982).

Similarly, changing business paradigms and fundamental shifts in philosophy occur when the firm's managers deal with the uncertain outcomes of incorporating environmental considerations into their decision processes. Besides consideration of the systemic impact of the natural environment on business (Shrivastava, 1995a), some fundamental philosophical changes in organizational thinking involve a shift to thinking toward closed systems and circular flows instead of linear processing systems, material conservation instead of efficiency in maximizing output and the use of

renewable energy sources. Thus, not only performance below aspirations, as the literature discusses at length, will trigger higher-order learning (Argyris and Schön, 1978; Cyert and March, 1963; Lant and Mezias, 1990; Milliken and Lant, 1991), but fundamental shifts in philosophy accompanying proactive environmental strategies can create an experiential base of activities that triggers the processes of higher-order learning within organizations. According to the environmental assessment manager of Buffalo:

> In our technologically mature industry, this is the one frontier open to fresh learning, innovations, and productivity improvements.

Managers of Buffalo and Sioux explained that in opening up communication channels to ideas from stakeholders such as local communities and environmental groups, they were able to look inwards and find ways of accomplishing the objectives of these groups while generating improvements within their organizations. This was seen as a circular process in which outside stakeholder influences sparked internal learning, which, in turn, triggered innovation leading to demonstrated actions for environmental protection. These actions, in turn, led to better relationships with external groups, feeding back as greater outside influence to reinforce organizational learning.

There are few benchmarks and a low level of existing knowledge in the industry regarding effective ways of reducing environmental impact. Thus, solutions for reducing these impacts were often left to the discretion of line managers. This discretion was accompanied by the integration of knowledge acquired from stakeholders, diffusion of knowledge within the organization, keeping up the momentum of learning, and feedback on knowledge application. In both companies, in order to encourage interaction, monthly meetings under the themes 'environmental leadership' (Buffalo) and 'alternative energy development' (Sioux) brought together a changing mix of managers from all of the company's facilities and operations. These groups formally and informally discussed advances in knowledge on the business/natural environment interface and actions taken to reduce environmental impact in each managers' operational domain.

This is a firm-specific capability since the same managers may not be able to adopt similar stances on experimentation, learning, and knowledge generation in organizations that do not provide a similar context. This capability is path dependent, involving a series of unique interactions and an experiential base of organizational activities over a long period of time. It must be noted here that proactive corporate environmental responsiveness is but one of the possible catalysts for building up an organization's capability for higher-order learning. It is possible that companies with reactive environmental strategies may build a similar capability as a result of other influences. However, the managers of the reactive companies did not associate environmental responsiveness with any capability or learning processes. Higher-order learning not only leads to capability development within companies, but is also a capability that leads to competitive benefits in terms of improved operations, increased efficiencies, cost reductions, higher productivity, as well as the triggering of a capability of continuous innovation.

Capability for continuous innovation

Higher-order learning processes, triggered by environmental responsiveness strategies, lead to a changing experiential base of organizational activities, routines, and goals. Changes in technologies, processes, specifications, inputs, and products can stimulate the building-up of internal capabilities and knowledge-based invisible assets (Itami, 1987). While environmental change provides an opportunity for a firm to be the first mover, the likelihood of a firm benefiting in a sustained manner from the first-mover status will depend upon the development of these capabilities. As the window for technological innovations gets shorter, even internal innovations in systems and management practices are rarely defensible against competitive actions. However, a capability of continuously generating a stream of innovations enables an organization to stay a step ahead of competitors who do not possess this capability. Hart (1995) calls this the capability of continuous improvement resulting from organizational efforts to reduce, minimize, and eliminate waste.

The managers of the reactive companies considered the industry as mature with 50–70 years of commercially viable oil stocks remaining. Hence, they saw no incentives for major technological improvements. In contrast, these factors

were not seen as constraints by the proactive companies. Table 4 provides numbers in different activity areas for the seven companies in respect to all innovations perceived to be related to environmental responsiveness.

The table provides numbers separately for innovations up to 1993 and during 1994. The latter indicate the continuing momentum of innovations for proactive companies. The numbers in parentheses indicate patents filed for, or obtained, for these innovations. The Appendix descriptively lists some of the major innovations attributed by these companies to their environmental responsiveness. As can be seen from Table 4 and the Appendix, Buffalo has a greater concentration of technological innovations in its upstream and manufacturing operations, while Sioux has concentrated on product-based innovations. At the same time, the reactive companies do not associate many innovations with their environmental strategies.

It may be noted here that the research study did not seek to understand and explore the emergence of innovations not perceived to be associated with environmental responsiveness by these companies. Thus, reactive companies may have an independent stream of innovations totally unrelated to environmental responsiveness. Moreover, the numbers of innovations do not reflect the visible excitement of dealing with a whole new area of continuing opportunity evidenced by the managers of Buffalo and Sioux. This excitement was missing among the reactive companies. The capability to innovate in the proactive companies was not confined to a specific operation or functional area, but appeared to be a pervasive part of the organizational culture.

The proactive companies provided an organizational context to support experimentation and the seeking of opportunities at the business/natural environment interface in an efficient and effective manner through employee compensation systems and by facilitating managerial discretion. This context encouraged employees to respond to these external influences, resulting in changing environmental philosophies and the emergence of unique organizational capabilities. Thus, new capabilities were developed in a period of perceived turbulence (Wernerfelt, 1984) and organizational change required to accommodate environmental strategies. This leads to the following hypotheses:

Table 4. Innovations (patents) related to environmental responsiveness (second phase of data collection)

	Buffalo (P)	Sioux (P)	Royal (R)	National (R)	U.S. Oil (R)	Farmers (R)	Northern (R)
Innovations (1980–93)							
Approx. total (patents filed)							
Drilling and exploration	23 (16)	–	2 (1)	5 (1)	5 (3)	None	None
Process	16 (7)	2 (2)	–	2	2		
Waste and emission control							
Products	33 (17)	5 (2)	2 (1)	2	2 (1)		
Others	9 (2)	25 (20)	2 (2)	2 (2)	2 (2)		
	8 (3)	–	–	1	2		
Innovations (1994)							
Approx. total (patents filed)							
Drilling and exploration	7 (5)	–	1 (1)	1	1		
Process	4 (2)	1 (1)	–	1	–	None	None
Waste and emission control	14 (8)	1 (1)	1 (1)	1 (1)	–		
Products	1 (1)	5 (5)	–	–	–		
Others	1 (1)	–	–	1	–		

Hypothesis 1: The greater the degree to which a company adopts proactive environmental responsiveness strategies, the greater the likelihood that firm-specific organizational capabilities will emerge.

Hypothesis 2: The greater the degree to which firm-specific organizational capabilities emerge within a company, the greater the likelihood of competitive benefits flowing from these capabilities.

The second hypothesis essentially is a test of the resource-based view of the firm; that is, organizational capabilities are competitively valuable. The first hypothesis does not rule out the emergence of organizational capabilities due to other types of organizational strategies as well as other organizational and environmental influences. The hypothesized relationships were tested through a mail survey in the Canadian oil and gas industry.

A SURVEY OF THE CANADIAN OIL AND GAS INDUSTRY: RESEARCH METHOD

The mail survey was conducted through a questionnaire-based research instrument. A 95-item, 7-point Likert-type, continuous scale was used to measure environmental strategies (ENVSTRGY). Due to unidimensionality of the items (as indicated by factor analysis), simple averages of the items were used to construct this scale. Perceptual measures using multiple respondents were used due to the unavailability of quantitative data bases that can reliably measure corporate environmental strategies in the Canadian oil and gas industry. The items constituting this scale, shown in Table 5, were based on the 11 dimensions used in the exploratory research. High scores indicate proactive strategies of environmental responsiveness. While this scale does not provide a discrete separation between reactive and proactive strategies, it is adequate to test Hypothesis 1 that companies which score higher on environmental responsiveness strategies will also score higher on the organizational capabilities scale.

Table 6(a) presents the items included in the organizational capabilities (CAPABLTY) measure. Since hypothesis testing was done within the larger context of the entire industry, it was considered necessary to supplement the three capabilities emerging from the exploratory study with a more general measure that could accommodate other capabilities that companies may associate with environmental responsiveness. Thus, the capabilities construct was based both on the exploratory study and concepts drawn from the resource-based view literature. The three capabilities emerging from the exploratory study—that is, stakeholder integration, continuous innovation, and organizational learning—were included in the measure. Characteristics of organizational capabilities drawn from the resource-based literature included causal ambiguity (Hart, 1995; Reed and DeFillippi, 1990; Rumelt, 1987; Teece, 1987), lack of an identifiable owner in an organization (Barney, 1991; Reed and DeFillipi, 1990), path dependency (Barney, 1991; Dierickx and Cool, 1989; Hart, 1995), and social complexity (Amit and Schoemaker, 1993; Barney, 1991), among others. Data collection was completed in spring 1995 and hence the survey did not include capabilities such as 'shared vision' predicted later by Hart (1995).

In order to test Hypothesis 2, a competitive benefits measure was developed. Table 6(b) presents the measure for competitive benefits (BENEFIT) intended to measure the competitive outcomes of the capabilities. The items constituting this measure were determined based on competitively beneficial outcomes of the capabilities perceived by managers during the exploratory study. These included cost reduction (Hart, 1995), improved operations and management practices, product quality, employee morale, corporate reputation and goodwill, faster regulatory approvals, product differentiation, improved ability to compete in the future (Hart, 1995), etc.

This research instrument was vetted by a group of university-based management researchers and industry experts, and then pretested among a group of 25 oil and gas industry managers. Reliability (Cronbach's coefficient alpha) checks were run for the constructs used. Most constructs exhibited high reliability in excess of 0.80. Tables 5, 6(a) and 6(b) include the Cronbach's coefficient alpha scores for the constructs. Data diagnostics tests for normality, homoscedasticity, and linearity indicated no violations of regression assumptions. Factor analysis using oblimin rotation revealed that each of the three constructs,

Table 5. List of items constituting the environmental strategies measure (overall construct reliability—Cronbach's coefficient alpha: 0.84)

1. To what extent has your company modified business practices in the following areas of operation, in order to reduce impact on animal species and natural habitats?
(Dimension Cronbach's coefficient alpha: 0.85)

- Exploration and prospecting sites
- Drilling sites and wellheads
- Oil and gas production
- Oil and gas gathering pipelines
- Refining facilities
- Transportation of petroleum products/chemicals

2. To what extent has your company undertaken the following voluntary actions (i.e., actions that are not required by regulations) for environmental restoration?
(Dimension Cronbach's coefficient alpha: 0.83)

- Clean-up of abandoned well sites
- Restoration of organic properties of contaminated soil
- Clean-up of abandoned retail gas station sites
- Protection of, and withdrawal from, ecologically sensitive habitats
- Disposal and treatment of hazardous/toxic wastes
- Compensation to local communities, employees, and other impacted parties for injury caused due to the company's environmental policies and accidents

3. To what extent has your company reduced wastes and emissions from operations as a result of the following actions?
(Dimension Cronbach's coefficient alpha: 0.81)

- Safe disposal of solid/hazardous wastes
- Investment in pollution/emission control equipment
- Recycling programs
- Closed-loop waste use within the organization
- Closed-loop waste use with other organizations
- Process modifications to reduce waste at source
- Changes in input material specifications
- Modifications of product specifications
- Implemented new technology to reduce wastes

4. To what extent has your company reduced purchases of nonrenewable materials, chemicals, and components, as a result of the following actions?
(Dimension Cronbach's coefficient alpha: 0.84)

- Reduction in total materials used
- Substitution by renewable materials
- Use of recycled/waste materials

5. To what extent has your company reduced the use of traditional fuels, by substitution of, and research into, the following energy sources?
(Dimension Cronbach's coefficient alpha: 0.83)

- Substitution by renewable energy sources
  (i) Photovoltaics/solar energy
  (ii) Wind power
- Substitution by alternative energy sources
  (i) Natural gas
  (ii) Geothermal energy
  (iii) Methane
  (iv) Biomass
  (v) Energy from wastes
- Increase in co-generation facilities
- Investment in research into alternative energy sources

Table 5. Continued

6. To what extent has your company reduced energy use, due to the following actions?
(Dimension Cronbach's coefficient alpha: 0.82)

- Better housekeeping/maintenance procedures
- Retrofitting/replacement of high-energy-consuming equipment
- Changes in process technology
- Changes in product specifications
- Changes in specifications of input materials

7. To what extent has your company undertaken the following actions to reduce the environmental impact of its products?
(Dimension Cronbach's coefficient alpha: 0.97)

- Introduced gasoline blends with lower emissions
- Introduced chemicals with lower environmental impact
- Made changes in packaging for engine oils/chemicals sold:
  (i) Reduced packaging
  (ii) Introduced packaging made from recycled materials
  (iii) Introduced biodegradable/recyclable packaging
  (iv) Eliminated packaging that damages the ozone layer
- Introduced used engine oil collection facilities
- Adopted comprehensive product life cycle analysis
- Obtained ecological certification of a product or service
- Reduced production of, eliminated, or replaced a product harmful to the environment
- Changed product specifications in order to make production processes less environmentally damaging
- Combined the functions of more than one product

8. To what extent has your company undertaken the following actions to reduce the risk of environmental accidents, spills, and releases?
(Dimension Cronbach's coefficient alpha: 0.82)

- Investments in equipment and control/alarm systems
- Rigorous emergency response procedures
- Employee training in emergency response procedures
- Employee involvement and responsibility for emergency response
- Training of local communities in emergency response procedures
- Fundamental changes in design of processes and products to reduce/eliminate environmental accidents, spills, releases, and hazardous waste
- Reduce/eliminate storage and use of hazardous chemicals/wastes

9. To what extent has your company established partnerships to reduce environmental impact?
(Dimension Cronbach's coefficient alpha: 0.80)

- Technology and research alliances with other companies:
  (i) Within the oil and gas industry
  (ii) Outside the oil and gas industry
- Agreements with other companies to process wastes
- Partnerships to establish environmental standards for products, processes, operations, and materials with:
  (i) Other companies
  (ii) Environmental groups
  (iii) Suppliers
  (iv) Distributors or retailers
  (v) Industry associations
- Establishment of consultative councils with local communities/governments, and environmental groups
- Education programs for reduction of wasteful consumption
- Partnerships in developing countries for environmental preservation

Table 5. Continued

10. Indicate the extent to which your company undertakes the following actions for environmental audit, public disclosure, employee training and immunity? (Dimension Cronbach's coefficient alpha 0.84)
• Detailed assessment of the environmental impact of operations (every _____ years)
• Comprehensive environmental audit (every _____ years)
• Release of a public environmental stewardship report (every _____ years)
• Employee training programs on environmental issues
• Provide immunity and protection to employees who report environmental accidents to management or authorities
• Inform in a timely manner everyone who may be affected by conditions that might endanger health, safety, or the environment
• Follow environmental practices according to North American regulations in developing countries where environmental regulations are less stringent
• Invest in research for environmental preservation: (i) Within company (ii) With industry associations (iii) With universities and other research agencies

ENVSTRGY, CAPABLTY, and BENEFITS were measures of a single variable.

Data collection and analysis

The questionnaire was administered to the total population of Canadian oil and gas companies in the Compact Disclosures data base with annual sales revenues in excess of $20 million. This population definition was intended to exclude the smallest companies which were hypothesized to lack the resources and motivation both to go beyond minimum regulatory compliance and to respond to a 13-page questionnaire. Each company was contacted by telephone to obtain names of potential respondent managers knowledgeable about the phenomena to be measured. The telephone contact also helped eliminate companies that had merged with other companies or were otherwise ineligible for the study. These telephone contacts identified the names of the CEO or a member of the top management team more likely to respond, the manager responsible for environmental affairs, a crude oil production and/or refinery manager, divisional supervisors, a drilling supervisor, and a marketing manager. The 110 companies thus included in the survey accounted for approximately 80 percent of the total annual sales revenues in the Canadian oil and gas sector.

Based on the names obtained during initial telephone contacts, questionnaires were mailed to between three to five persons for each company. The first mailings elicited a return of around 60 percent within 2 weeks. Follow-up faxes and telephone calls after two weeks resulted in a total response rate of 90 percent (99 out of 110 companies). The high response rate is largely attributable to the follow-up by telephone and fax, a mention of the funding support by CAPP (which agreed to undertake all mailing) in the cover letter, and the fact that the institution with which the researchers were affiliated is well known among Canadian managers.

Sixty-four companies (65%) provided multiple respondents. Of these, 40 companies provided two responses (usually from a manager in charge of environmental affairs and a member of the senior management team), 16 companies provided three responses (including a line manager such as exploration manager/refinery manager/drilling supervisor), 6 companies provided four responses, and 2 companies provided five responses. Obtaining multiple responses in strategy research provides perspectives from different levels and functional areas within a company. Strategy may be emergent and the top management viewpoint need not necessarily reflect the pattern of actions that constitutes strategy within an organization (Mintzberg, 1978, 1994). A 65 percent multiple response from top and middle managers was considered a healthy measure for triangulating different viewpoints within the companies for measuring strategy. The data indicated an interrespondent reliability greater than 0.80 on most measures.

Table 6(a). Items constituting the measure for organizational capabilities

Capabilities (reliability—Cronbach's coefficient alpha: 0.93)
The following items list some characteristics associated with organizational capabilities. Please indicate the extent to which you perceive capabilities, with the following characteristics, emerging within your organization as a consequence of your environmental practices:
• They take a long period of time to build up
• Competitors can not build up these capabilities faster through a greater application of resources
• They can not be easily be identified or imitated by competitors
• They span (provide benefits) to several functional areas/departments
• They span (provide benefits) to different levels within the company
• They lack a clearly identified owner within the company, i.e. an employee cannot leave with organizational reputation, knowledge, relationships, etc.
• They act as triggers for collective learning within the company
• They act as triggers for innovation within the company
• They act as triggers for collaborative problem solving with stakeholders
• They combine with other assets to generate benefits for the company, e.g. improved reputation combines with an established retail network

Table 6(b) Items constituting the measure for organizational benefits

Benefits (reliability—Cronbach's coefficient alpha: 0.96)
Please indicate the extent to which the company's environmental practices have led to any of the following competitive benefits?
• Reduction in costs: (i) Material costs (ii) Process/production costs (iii) Costs of regulatory compliance
• Improved operations: (i) Increased process/production efficiency (ii) Increases in productivity (iii) Increased knowledge about effective ways of managing operations (iv) Process innovations
• Improved product quality
• Product innovations
• Organization-wide learning among employees
• Improved employee morale
• Overall improved company reputation or goodwill
• Better relationships with stakeholders such as local communities, regulators, and environmental groups

Thus, multiple responses were averaged in order to arrive at variable values representative of the company as a whole.

The response rate of 90 percent largely preempted a nonresponse bias risk in the data. Moreover, a scan of the 11 companies out of 110 which did not respond indicated 1 senior company, 2 intermediates, and 7 junior companies. This was roughly the same in demographic proportions to the company population surveyed, further minimizing the nonresponse risk. The hypotheses were tested using multivariate regression.

THE MAIL SURVEY: RESULTS

Two regression models were tested according to the hypotheses presented above. The first (1) predicted that companies which score higher on environmental responsiveness strategies (ENVSTRGY) will also score higher on the organizational capabilities (CAPABLTY) measure. The second (2) predicted that higher levels of competitive benefits (BENEFITS) will be associated with higher scores on the organizational capabilities (CAPABLTY) measure.

$$\text{CAPABLTY} = a + b\ \text{ENVSTRGY} + e \quad (1)$$

$$\text{BENEFITS} = a_1 + b_1\ \text{CAPABLTY} + e_1 \quad (2)$$

Table 7 presents the results of the regression analysis.

Both hypothesized relationships were found to be statistically significant at $p < 0.0001$. Environmental responsiveness strategies of the companies appear to explain around 20 percent of the variation in the emergence of organizational capabilities within these organizations. Further, organizational capabilities appear to explain around 51 percent of the variation in the competitive benefits emerging in these organizations. Thus, proactiveness in environmental responsiveness is perceived to be associated with the emergence of organizational capabilities, and does not appear to have a negative impact on corporate competitiveness.

DISCUSSION AND IMPLICATIONS

The study addresses the debate regarding the role of environmental strategy in firm competitiveness by exploring empirically the relationship between environmental strategy and the emergence of competitively valuable organizational capabilities.

Early advocates of the 'green is gold' school argued that cost savings due to increased efficiency and waste elimination more than compensated for the cost of such environmental strategies. When these arguments proved overly simplistic and sometimes erroneous (Hart and Ahuja, 1996; Walley and Whitehead, 1994), more elaborate theoretical arguments premised on the resource-based view of the firm were advanced (Hart, 1995). Empirical findings using stock prices as a firm performance measure and environmental awards and crises as proxy variables of environmental strategy suggested that a

Table 7. Results of regression analysis

Variables	Unstd. *b* (S.E.)	Beta (*B*)	t-value	*p* (one-tailed)
Dependent variable: CAPABLTY				
ENVSTRGY	0.0082 (0.0016)	0.4569	5.059	0.0000
Constant	1.8822 (0.4145)		0.454	0.0000
R^2	0.2088			
Adjusted R^2	0.2006			
F-statistic	25.5910			
Probability of *F*	0.0000			
N	99			
Dependent variable: BENEFIT				
CAPABLTY	0.7481 (0.0734)	0.7207	10.186	0.0000
Constant	0.6271 (0.2999)		2.091	0.0392
R^2	0.5194			
Adjusted R^2	0.5144			
F-statistic	103.7581			
Probability of *F*	0.0000			
N	99			

more complex intraorganizational relationship may exist (Klassen and McLaughlin, 1996). Our study provides some empirical evidence for the theoretical argument that proactive environmental strategy may lead to the development of unique competitively valuable organizational capabilities (Hart, 1995).

Using comparative case studies, we found evidence of the development of a capability for stakeholder integration, a capability for higher-order learning, and a capability for continuous innovation in firms which we labeled as having proactive environmental strategies, based on self-reported environmental activities and triangulated with external (regulators and environmental group) commentators.

Statistical tests showed that proactive environmental strategy explained more than 20 percent of the variance in the firms' reports of whether their environmental strategy can be associated with the the development of unique organizational capabilities as conceived by the resource-based view of the firm (that is, they are path dependent, inimitable, socially complex, etc.).

These unique organizational capabilities, resulting from proactive environmental strategies, appear to account for more than 50 percent of the firms' self-reported variance in competitive benefits (that is, process/product/operational innovations, cost reductions, improved corporate reputations, better employee morale, etc.). These findings suggest that, in fact, proactive environmental strategies may invoke the processes suggested by the resource-based view of the firm and lead to competitive advantage.

Limitations and future research

This study was focused on environmental strategy as a source for competitively valuable organizational capabilities, and it does not rule out the possibility that other organizational strategies may also lead to the development of competitively valuable organizational capabilities. It is also possible that the environmentally reactive firms in this study developed competitively valuable organizational capabilities from other corporate strategies. Future studies might explore what other types of strategies lead to the development of such capabilities.

Although attempts were made in this study to triangulate data by using independent observers of the oil and gas industry wherever possible, the study relies heavily on self-reported measures provided by company managers. This is a methodological weakness shared with much other research examining corporate strategies. Nevertheless, future studies could add to our confidence in the results reported here by replicating this study using more direct objective measures of the theoretical constructs.

This paper is an empirical exploration and test of the resource-based view of the firm perspective that companies can gain competitive advantage from proactive environmental strategy (Hart, 1995). Further ramifications and theoretical linkages are left to future research which could inform our understanding of the linkage between particular dimensions of each of the major constructs in our study. For example, does the capability of stakeholder integration lead to improved morale, goodwill and reputation while the capability of continuous learning leads to improved operations and cost reduction?

It is possible that the findings reported here are limited to the Canadian context where practices such as extensive public consultation processes are perhaps more prevalent and expected in the environmental domain than in other national contexts (Pasquero, 1991). The authors are currently engaged in replicating and extending the study in the United States and in Latin American countries. Future studies may replicate and extend the study in other industries where environmental concerns may present themselves differently than in the oil and gas industry. Future studies may also extend the study to dependent measures of firm financial performance, measured objectively as return on investment, return on equity or stock price changes, or through self-reported measures compared to industry average (e.g., Govindarajan, 1984; Gupta, 1987). Both types of measures have been used in other studies linking the corporate strategies to financial performance.

Implications

As opportunities for developing corporate competitive advantage diminish in a world of global competition, shortening product life cycles, and declining barriers to entry, the resource-based view of the firm may provide increasing guidance to the development of competitive strategies. As a theory of the firm predicated on developing

organizational capabilities that can provide sustained competitive advantage, complex and comprehensive environmental strategies may indeed, as Hart (1995) argues, be an important emergent competitive domain to which leading firms should pay heed.

Public policy makers might look to 'raising the bar' environmentally in a predictable and timely fashion leaving details of how to meet the requirements to firms' own technical and managerial innovativeness. This would favor firms who proactively develop environmentally based capabilities while 'pulling up' the rest of the industry's environmental performance.

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REFERENCES

Amit, R. and P. J. H. Schoemaker (1993). 'Strategic assets and organizational rent', *Strategic Management Journal*, **14**(1), pp. 33–46.

Argyris, C. and D. A. Schön (1978). *Organizational Learning.* Addison-Wesley, Reading, MA.

Barnett, W. P, H. R. Greve and D. Y. Park (1994). 'An evolutionary model of organizational performance', *Strategic Management Journal*, Winter Special Issue, **15**, pp. 11–28.

Barney, J.B. (1991). 'Firm resources and sustained competitive advantage', *Journal of Management*, **17**(1), pp. 99–120.

Barney, J.B. and M.H. Hansen (1994). 'Trustworthiness as a source of competitive advantage', *Strategic Management Journal*, Winter Special Issue, **15**, pp. 175–190.

Barney, J. B. and E. J. Zajac (1994). 'Competitive organizational behavior: Toward an organizationally-based theory of competitive advantage', *Strategic Management Journal*, Winter 1994, **15**, pp. 5–9.

Bateson, G. (1972). *Steps to an Ecology of Mind.* Ballantine, New York.

Cialdini, R. B. (1984). *Influence*. William Morrow, New York.

Clarkson, M. B. E. (1995). 'A stakeholder framework for analyzing and evaluating corporate social performance', *Academy of Management Journal*, **20**(1), pp. 92–117.

Coff, R. W. (1997). 'Human assets and management dilemmas: Coping with hazards on the road to the resource-based theory,' *Academy of Management Review*, **23**(2), pp. 374–402.

Cyert, R. M. and J. G. March (1963). *A Behavioral Theory of the Firm.* Prentice-Hall, Englewood Cliffs, NJ.

Daft, R. L. and K. E. Weick (1984). 'Toward a model of organizations as interpretation systems', *Academy of Management Review*, **9**, pp. 284–295.

Day, G. S. (1994). 'The capabilities of market driven organizations.' *Journal of Marketing*, **58**, pp. 37–52.

Dierickx, I. and K. Cool (1989). 'Asset stock accumulation and sustainability of competitive advantage.' *Management Science*, **35**, pp. 1504–1511.

Duncan, R. B. and A. Weiss (1979). 'Organizational learning: Implications for organizational design'. In B Staw (ed.), *Research in Organizational Behavior.* JAI Press, Greenwich, CT, pp. 75–123.

Fiol, C. M. (1994). 'Consensus, diversity, and learning in organizations', *Organization Science*, **5**(3), pp. 403–420.

Fiol, C. M. and M. A. Lyles (1985). 'Organizational learning', *Academy of Management Review*, **10**(4), pp. 803–816.

Ginsberg, A. (1994). 'Minding the competition: From mapping to mastery', *Strategic Management Journal*, Winter Special Issue, **15**, pp. 153–174.

Ginsberg, A. and N. Venkataraman (1992). 'Investing in new information technology: The role of competitive posture and issue diagnosis', *Strategic Management Journal*, Summer Special Issue, **13**, pp. 37–53.

Ginsberg, A. and N. Venkataraman (1995). 'Institutional initiatives for technological change: From issue interpretation to strategic choice', *Organization Studies*, **16**, pp. 425–448.

Gladwin, T. N., J. J. Kennelly, and T. S. Krause (1995). 'Shifting paradigms for sustainable development: Implications for management theory and research', *Academy of Management Review*, **20**(4), pp. 874–907.

Glaser, B. G. and A. L. Strauss (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research.* Aldine, Chicago, IL.

Govindarajan, V. (1984). 'Appropriateness of accounting data in performance evaluation: An empirical examination of environmental uncertainty as an intervening variable', *Accounting, Organizations, and Society*, **9**(2), pp. 125–135.

Gray, B. (1989). *Collaborating: Finding Common Ground for Multiparty Problems.* Jossey-Bass, San Francisco, CA.

Gupta, A. K. (1987). 'SBU strategies, corporate–SBU relations, and SBU effectiveness in strategy implementation', *Academy of Management Journal*, **30**(3), pp. 477–500.

Hart, S. L. (1995). 'A natural-resource based view of the firm', *Academy of Management Review*, **20**(4), pp. 986–1014.

Hart, S. L. (1997). 'Beyond greening: Strategies for a sustainable world', *Harvard Business Review*, **25**(1), pp. 66–76.

Hart, S. L. and G. Ahuja (1996). 'Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance,' *Business Strategy and the Environment*, **5**, pp. 30–37.

Hawken, P. (1993). *The Ecology of Commerce: A Declaration of Sustainability*. Harper, New York.

Hedberg, B. (1981). 'How organizations learn and unlearn?'. In P. C. Nystorm and W. H. Starbuck (eds.), *Handbook of Organizational Design*, Vol. 2. Oxford University Press, New York, pp. 8–27.

Itami, H. (1987). *Mobilizing Invisible Assets*. Harvard University Press, Cambridge, MA.

Jacobs, J. (1992). *Systems of Survival*, Vintage Books, New York.

Kinder, P., S. D. Lydenberg and A. L. Domini (1992). *Investing for Good: Making Money while Being Socially Responsible*. Harper Business, New York.

Klassen, R. D. and C. P. McLaughlin (1996). 'The impact of environmental management on firm performance', *Management Science*, **42**, pp. 1199–1213.

Lant, T. and S. J Mezias (1990). 'Managing discontinuous change: A simulation study of organizational learning and entrepreneurship', *Academy of Management Journal*, **11**, pp. 147–179.

Lant, T. K. and S. J. Mezias (1992). 'An organizational learning model of convergence and reorientation', *Organization Science*, **3**(1), pp. 47–71.

Levinthal, D. and J. Myatt (1994). 'Co-evolution of capabilities and industry: The evolution of mutual fund processing', *Strategic Management Journal*, Winter Special Issue, **15**, pp. 45–62.

March, J. G. (1988). 'Variable risk preferences and adaptive aspirations', *Journal of Economic Behavior and Organization*, **9**, pp. 5–24.

March, J. G. and J. P. Olsen (1976). *Ambiguity and Choice in Organizations*. Universitetsforlagt, Bergen, Norway.

Miles, M. B. and A. M. Huberman (1984). *Qualitative Data Analysis: A Sourcebook of New Methods*. Sage, Newbury Park, CA.

Miller, D. and P. H. Friesen (1980). 'Momentum and revolution in organization adaptation', *Academy of Management Journal*, **23**, pp. 591–614.

Milliken, F. and T. K. Lant (1991). 'The effect of an organization's recent performance history on strategic persistence and change: The role of managerial interpretations'. In P. Shrivastava, A. Huff and J. Dutton (eds.), *Advances in Strategic Management*, Vol. 7. JAI Press, Greenwich, CT, pp. 129–156.

Mintzberg, H. (1978). 'Patterns in strategy formation', *Management Science*, **24**(9), pp. 937–948.

Mintzberg, H. (1994). *The Rise and Fall of Strategic Planning*. Free Press, New York.

Pasquero, J. (1991). 'Supraorganizational collaboration: The Canadian environmental experiment', *Journal of Applied Behavioural Science*, **27**(1), pp. 38–64.

Pfeffer, J. and J. Salancik (1978). *The External Control of Organizations*. Harper & Row, New York.

Polanyi, M. (1962). *Personal Knowledge: Towards a Post-critical Philosophy*. University of Chicago Press, Chicago, IL.

Porter, M. E. (1991). 'America's green strategy', *Scientific American*, April, p. 168.

Porter, M. E. and C. van der Linde (1995). 'Green and competitive', *Harvard Business Review*, **73**(5), pp. 120–134, 196.

Post, J. E. (1978). *Corporate Behavior and Social Change*. Reston Publishing, Reston, VA.

Reed, R. and R. J. DeFillippi (1990). 'Causal ambiguity, barriers to imitation and sustainable competitive advantage', *Academy of Management Review*, **15**, pp. 88–102.

Rumelt, R. P. (1987). 'Theory, strategy, and entrepreneurship'. In D. Teece (ed.), *The Competitive Challenge: Strategies for Industrial Innovation and Renewal*. Ballinger Division, Harper & Row, Cambridge, MA, pp. 137–158.

Schmidheiny, S. (1992). *Changing Course: A Global Business Perspective on Development and the Environment*. MIT Press, Cambridge, MA.

Sethi, S. P. (1979). 'A conceptual framework for environmental analysis of social issues and evaluation of business response patterns', *Academy of Management Review*, **4**, pp. 63–74.

Sharma, S., H. Vredenburg and F. Westley (1994). 'Strategic bridging: A role for the multinational corporation in Third World development', *Journal of Applied Behavioral Science*, **30**(4), pp. 458–476.

Shrivastava, P. (1995a). 'The role of corporations in achieving ecological sustainability', *Academy of Management Review*, **20**(4), pp. 936–960.

Shrivastava, P. (1995b). 'Environmental technologies and competitive advantage', *Strategic Management Journal*, Summer Special Issue, **16**, pp. 183–200.

Shrivastava, P. and I. I. Mitroff (1982). 'Frames of reference managers use: A study in applied sociology of knowledge'. In R. Lamb (ed.), *Advances in Strategic Management*. JAI Press, Greenwich, CT, pp. 161–182.

Starbuck, W. H., A. Greve and B. Hedberg (1978). 'Responding to crisis', *Journal of Business Administration*, **9**(2), pp. 112–137.

Starik, M. and G. P. Rands (1995). 'Weaving and integrated web: Multilevel and multisystem perspectives of ecologically sustainable organizations,' *Academy of Management Review*, **20**(4), pp. 908–935.

Teece, D. (1987). 'Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy'. In D. Teece (ed.), *The Competitive Challenge*. Ballinger, Cambridge, MA, pp. 185–220.

Thomas, J. B. and R. R. McDaniel (1990). 'Interpreting strategic issues: Effects of strategy and the information-processing structure of top management teams', *Academy of Management Journal*, **33**, pp. 286–306.

Vredenburg, H. and F. Westley (1997). 'Fostering innovation toward sustainability in renewable resource industries: The effects of regulation on organizational response.' *Optimum: The Journal of Public Sector Management*, 27(2), pp. 32–40.

Walley, N. and B. Whitehead (1994). 'It's not easy being green,' *Harvard Business Review*, **72**(3), pp. 46–52.

Weick, K. E. (1979). *Social Psychology of Organizing*. Addison-Wesley, Reading, MA.

Wernerfelt, B. (1984). 'A resource-based view of the firm', *Strategic Management Journal*, **5**(2), pp. 171–180.

Westley, F. and H. Vredenburg (1991). 'Strategic bridging: The collaboration between environmentalists and business in the marketing of green products,' *Journal of Applied Behavioral Science*, **27**, pp. 65–91.
Westley, F. and H. Vredenburg (1996). 'Sustainability and the corporation: Criteria for aligning economic practice with environmental protection', *Journal of Management Inquiry*, **5**, pp. 104–119.
Winter, S. (1987). 'Knowledge and competence as strategic assets', In D. Teece (ed.), *The Competitive Challenge*. Ballinger, Cambridge, MA, pp. 159–184.
Yin, R. K. (1989). *Case Study Research: Design and Methods*. Sage, Newbury Park, CA.

APPENDIX: List of innovations in the oil and gas industry

Reactive companies

- Royal Petroleum: Advancements in soil restoration technology between 1991 and 1994.
- Royal Petroleum and National Oil: Joint development of emergency response guidelines and risk assessment procedures for the oil and gas industry during 1989–93.

Proactive companies

Buffalo Oil—Pre-1993

- Patented technology to recover oil by crushing used filters to reduce solid waste disposal space and costs. The recovered oil is collected and sent to Sioux's recovery plant.
- Patented process improvements to reduce wastes and improve recovery in oil refining by 5 percent. This innovation has been sold to over 30 oil refiners in six countries.
- Patented improvements in the technology of horizontal drilling of wells that reduce the requirement for number of wells that need to be drilled to access a pool of oil. This also reduces costs of oil production and improves efficiency.
- Patented improvements in remote-sensing technology for oil exploration from the air.
- Several innovations to reduce environmental impact during prospecting, exploration, and development, such as the use of backpacking and horses to study geological formations in ecologically sensitive areas. These changes resulted in better relationships with communities and environmental groups and exploration costs reductions.
- Development of the industry's first detailed environmental assessment procedure in 1985. The law requiring detailed environmental assessment was passed in 1986.
- Development of a unique detailed data base of migration patterns and habitat biodiversity covering over 200 species in ecologically sensitive areas. This data base is used as a common resource and is lent to regulators and smaller companies required to conduct environmental assessments.
- Patented innovations in refineries undertaken with low investment allow a 99 percent average rate of sulfur recovery, resulting in 40 percent less sulfur dioxide emissions than permitted under the license requirements of 98 percent recovery. In contrast, the managers of reactive companies stated that reduction of air emissions by 1 percent from 98 percent to 99 percent would involve an investment of $1 billion for the entire oil and gas industry.
- Patented waste management procedures at refineries to recycle oily waste.
- Patented development of innovative and low-cost asphalt reclaimers at refineries.
- The first oil company to set up high-altitude meteorological monitoring systems to assist all plants in meeting air quality standards and reduce carbon dioxide emissions.
- Pioneered the collection plan at service stations (with Sioux) to recover used engine oil from consumers.
- The first oil company to set up land-farms in 1983, at its refineries to biodegrade oily sludges.
- In 1982 it developed the use of steamers to clean oil from equipment instead of using chemical solvents. These innovations resulted from an ongoing process of thorough housekeeping analysis, replacement of components and high-energy use equipment, and analysis of waste patterns.

Buffalo Oil—1993–94

- Patented process for recovery of sulfur contaminated with soil.
- Development of higher-efficiency vapor recovery systems technology to capture gasoline vapor from storage tanks to reduce ground-level ozone buildup.

- Advances in ongoing research in photovoltaic cell-based batteries in collaboration with research institutes in the United States, Japan, and Europe.
- Ongoing expansion of the data base on species migration patterns and biodiversity by documentation of 11 more species of flora and fauna.
- Several new patents on innovations to reduce wastes and steam recovery in the refining process.
- Development of two new high oxygenated blends of petroleum with lower carbon emissions. Its fully owned subsidiary in the United States is a world leader in hydrogenation technology, specializing in the development and licensing of advanced technologies for producing environmentally clean fuels from various fossil fuels such as heavy crude oils and high-sulfur coals.

Sioux Oil—pre-1993

- Sioux pioneered the technology for large-scale cleaning of used engine oil to produce usable clean engine oil. The first plant was set up in 1980.
- Set up the first used engine oil collection program from gas stations in Canada in 1981.
- In 1985, it set up the first commercial plant in Canada to manufacture vegetable-based engine oils. Pioneered ethanol-blended gasoline in Canada in 1979.
- Patent on the development of a super-lightweight fuel tank for storage of compressed natural gas for automotive use.
- 1988: Set up a facility to convert trucks and automobile engines to natural gas.

Sioux: 1993–94

- Patents on 10 percent improvements in productivity at its ethanol distilleries while reducing wastes.
- Advancements in research in photovoltaic cell-based rechargeable automotive batteries.
- Development of a new ethanol blend: 10 percent ethanol and highly oxygenated and reformulated gasoline that has the lowest total emissions of particulates and carbon gases in the world.