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Strategically Informed, Environmentally Conscious Information Requirements for Accounting Information Systems

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ABSTRACT: Accounting information systems (AIS) should provide the information firms need to manage organizational activities. Environmental considerations are increasingly important in the business world, so firms are attending more to environmental risks and activities. AIS must respond to these emerging environmental requirements. We develop an information matrix for identifying alternative management strategies for framing and responding to environmental issues. The proposed matrix provides a tool for identifying the information collected, stored, analyzed, and reported in environmentally attuned accounting information systems.

Keywords: accounting information systems; environmental reporting; environmental strategy; sustainability.

> [A]n accounting system that cannot recognize social or environmental issues is very unlikely to encourage that organization to take serious account of such matters. (Gray and Bebbington 2002, 160)

I. INTRODUCTION

Environmental issues are increasingly important to businesses (Clarkson et al. 2004; KPMG 2002; Joshi et al. 2001; Blacconiere and Northcut 1997). This importance was recently underscored when a United States congressional hearing addressed issues of corporate environmental disclosures (Corporate Sunshine Working Group [CSWG] 2004). A committee of the Senate commissioned the U.S. Government Accounting Office (GAO) to report on environmental disclosures in corporate reports (GAO 2004). The report emphasized the need for greater transparency in reporting environmental data and recognized that current environmental reporting provides little useful information for investors. Around the globe, reporting demands are changing For example, France requires publicly listed companies to report environmental data[1] and other countries are contemplating similar legislation (Corporate Social Responsibility [CSR] 2004). Investors evidence a growing

[1] These disclosures go well beyond the FAS No. 5 contingent liability disclosures required by U.S. GAAP.

interest in the environmental components of corporate reports (Triple Bottom Line Investing [TBLI] 2005; also see KPMG 2002; Joshi et al. 2001).

Environmentally related business issues have expanded from the initial threats associated with the regulatory requirements of the 1960s and 1970s. Contemporary businesses confront an increasingly complex set of environmental risks, including changing market opportunities, shifting societal expectations for corporate environmental responsibility, and exogenous factors such as global warming, all of which may impact on business (Hoffman 2000; Murray 2004). Furthermore, environmentally proactive management—management that attempts to address environmental issues before regulation or crisis—moves beyond business risk and profit implications and considers the environmental impact of business operations and actions. This environmentally proactive perspective incorporates sustainability[2] criteria in addition to, and at times in opposition with, maximizing shareholder wealth (see Hoffman 2000; Reinhardt 2000). Contemporary business decision makers confront an expanding range of environmental decisions for which they are held responsible. To support environmentally related managerial decisions, accounting information systems (AIS)[3] must capture and report relevant information.

AIS rarely provide adequate support for managing or assessing these concerns (Gray and Bebbington 2002).[4] The designers, configurers, and purchasers of AIS generally ignore environmental information needs, so businesses seldom capture sufficient environmental information. Schaltegger and Burritt (2000) found few examples of comprehensive accounting systems that incorporate environmental information. Joshi et al. (2001) found that accounting systems were unlikely to capture even the actual, direct cost of environmental *regulation*, which is but a small part of the total impact of environmental issues. Captured information tends to be highly aggregated, inhibiting informed decision making (Reinhardt 2002). Furthermore, information systems that capture regulatory and other environmental information are generally kept separate from the systems used to manage the organization (Epstein 1996; Schaltegger and Burritt 2000).

The ultimate goal of our research is to connect organizations with their decision makers (i.e., social systems[5]) and the natural systems they act upon and within. This paper is a pragmatic step toward helping organizations identify relevant environmental information. Specifically, we develop a general framework for identifying the information a business

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[2] Sustainability is often defined as "the ability of current generations to meet their needs without compromising the ability of future generations to meet theirs" (World Commission on Environment and Development [WCED] 1987). Sustainability, as defined, implies both social and environmental aspects. We identify any initiatives that move a firm toward the goal, even if that movement is merely a reduction in the rate of divergence from the goal, as sustainability initiatives. So "incorporates sustainability criteria" implies that the organization is explicitly considering social and environmental criteria. Our discussion is designed to assist in achieving this objective. We restrict ourselves to discussions of environmental sustainability, while acknowledging the vital importance of social sustainability. The general approach of the framework we develop may have implications for information systems that would support social sustainability, but we make no such claims at this time.

[3] We use the terms information systems and accounting information systems interchangeably in this paper.

[4] Both internal and external decision makers require environmental information. In the following discussion, we refer primarily to management's information needs because we see this as the most inclusive set, with other stakeholders' information needs generally being a subset of that which is needed by management.

[5] Social systems are groups of people and their institutions that interact to create a shared set of understandings, norms or routines (Westley et al. 2002). Social systems are self-referential, based on meaningful communication to constitute and interconnect the events that build up the systems (Luhmann 1982). Social systems, in this paper, include organizations and their artifacts such as information systems and decision processes, which represent technology created from the purposeful and reflexive actions of humans within the context of their institutions.

needs to effectively manage in environmentally responsible directions.[6] Consistent with our objective of motivating awareness and incremental change, we do not argue that the design of all systems must be drastically altered. Instead, we argue for expansion of the relevant environmental information in systems.

We next frame our argument by briefly discussing the relationship between organizations (social systems) and the environment (natural systems). We argue that organizations can develop and maintain the body of knowledge necessary to purposefully make environmentally responsible decisions only when formal information systems explicitly indicate natural system attributes. Next, we develop a matrix that specifies needed management information for progressively more environmentally responsible, strategic decisions. The matrix provides the framework for specifying the components of a more environmentally conscious accounting information system.[7] We identify information components associated with each cell in the matrix and provide examples of the associated environmental actions. We conclude with a brief summary, recognition of the limitations of the proposed processes, and future research implications.

II. PRIOR RESEARCH

AIS must explicitly indicate the dimensions of natural systems so that organizations can develop and maintain the body of knowledge they need to make environmentally responsible decisions. We briefly consider the relationship between natural and social systems and then review relevant previous accounting literature.

An Ecological View of Natural and Social Systems

Businesses (social systems) traditionally ignore or exploit goods that society owns in common, including the environment (natural systems) (Hardin 1968; Gladwin et al. 1995). Business-oriented environmentalists such as Hawken et al. (1999) suggest that if management is to provide environmental stewardship it must acknowledge that the organization is the primary environment-transforming entity of society. As such, management must accept its responsibility for natural systems.[8]

Westley et al. (2002) articulate the degree of compatibility between natural and social systems. The researchers argue that it is false to claim a dichotomy between natural and social systems: social systems and the natural world cannot exist independently; rather, social systems act within and upon natural systems. Following Westley et al. (2002), we hold that natural and social systems are interrelated, and that the relationships must be represented in AIS.

Social systems can communicate and administer rewards and sanctions based on shared norms and values, and they can accomplish goals through their control over physical and human resources. Multiple agents, such as business owners, governmental agencies, and

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[6] We recognize that not all managers choose to lead their organizations in an environmentally responsible manner. We also recognize that the framework we present will not be considered relevant unless management believes that the environmental impacts of their decisions are important. If managers do not believe that the environmental impacts of their decisions are important, then they will not use or support the development of environmental information. We believe that environmental impacts are important to most decision makers since (1) most organizations fall under some environmental regulation, (2) many organizations are beginning to see environmentalism as beneficial (at least at the margin) to their bottom line, and (3) some few organizations see environmental sustainability as an imperative for long-term survival.

[7] We use the term "environmentally conscious accounting information system" to convey that an accounting information system has, by virtue of the specific information that it holds, an ability to address a set of decisions. When an AIS contains the information necessary to address environmental decisions, it is an "environmentally conscious" AIS.

[8] As noted earlier, we recognize that this is not universally accepted in business organizations.

laborers, interact to construct increasingly complex social systems, such as business organizations. These purposeful and reflexive actions produce and reproduce social systems. Agents can, then, act purposefully to change social systems.

Natural systems have always constrained the actions of social systems through scarcity, degradation, or loss of absorptive capacities. Until recently, however, organizations have focused primarily on economic requirements, in particular creating profit and increasing wealth for owners. Previously, organizations perceived that they needed information related to economic transactions only. Thus, this discussion turns to social system representations—the AIS—that do not adequately recognize or meaningfully connect to natural systems and therefore limit management's decision alternatives.

Information System Representations

Information systems symbolically represent a reality bounded by the subset of all the possible attributes of the related natural, physical, and social world that the system captures. For example, traditional AIS symbolically represent the world in terms of the attributes of economic exchange transactions. Alternatively, enterprise resource planning (ERP) systems integrate production processes with the functions of purchasing, inventory management, receiving, accounting, and marketing. The traditional accounting system, in effect, defines activities as relevant if they directly affect assets, liabilities, and/or owners' equity. The ERP system, on the other hand, defines the relevant reality as any of the processes that impact the production of products. Each system limits its view of reality by its design choices when it identifies which data it will capture and, consequently, how that data will enable and constrain the decision maker.

A simple example is illustrative. For a typical sales transaction, the information system may capture the data attributes of inventory item, sales price, date, customer, and salesperson. These attributes are, of course, a subset of all possible attributes. Among the virtually infinite possible transaction attributes, the system could also capture time of the sale, duration of the sales event, ambient room temperature, and number of companions with the customer. Information system designers make explicit and implicit decisions about what attributes to capture—limiting the scope of the information captured from each transaction. The design scope limits how much information is available to decision makers who use the information system to understand the transaction. In the above example, the system enables a decision maker to track sales by date, but it does not allow the decision maker to determine whether a sale occurred in the morning or the afternoon.

As an organization's decision scope broadens, whether through changes in production technology, marketplace influences, or a growing awareness of environmental responsibilities, information systems must adapt to reflect the organization's changing world. We do not see this process as linear but as recursive and dynamic, where changes in the organizational context occur as the organization becomes more aware of alternative representations and, likewise, changes in the organization are motivated by changes in the context.

To summarize, agents choose which attributes to capture in information systems, and those choices give significance and salience to the chosen attributes. What is actually a reduced or restricted representation of reality becomes, in the view of the user, the context from which reality emerges. Information systems designers, who see no need to include attributes of natural systems, omit them. What has become the "reality" to organizations

ignores natural systems. The economics literature is replete with discussions of "externalities"[9] that may happen because the relevant attributes were omitted in the information set and consequently were omitted from the decision process (see, for example, Goodstein 2004 or Daly and Farley 2004).

This understanding has several implications for information systems and their ability to influence organizational decision making. First, symbolic capabilities can close off and exploit natural systems to the point of destroying them (ultimately destroying social systems as well), but those same capabilities can also be used to understand and sustain natural systems (Hoffman 2000; Allenby et al. 2001; Epstein 1996). Although our information systems can and do drive behaviors that exploit natural systems,[10] we can modify information systems to incorporate information about impacts on natural systems, enabling decision makers to nurture natural systems instead. Second, to better understand and sustain natural systems, managers must recognize the need for change and grasp the means for undertaking it. Managers must revise norms and values to supplement, complement, or replace economic criteria with criteria directly connecting to sustaining dimensions of natural systems. Third, change requires that resources are directed by the new norms, values, and richer representation structures. We must modify information sets and decision models to reflect enlightened appreciations of natural systems and the processes necessary to regenerate, sustain, and enrich them. We add specificity to these rather abstract ideas by identifying the information needs associated with alternative management approaches to environmental stewardship. First, however, we consider the accounting literature relating to the design of environmentally oriented information systems.

Prior Accounting Research

Natural environmental issues are a growing concern in the accounting field. Accounting research has begun to examine corporate social responsibility, including both social and environmental issues. Socially responsible investing research focuses on the efficacy of investing with environmental considerations as one of several screens to be included in an investment portfolio (Stone 2001; Richardson and Welker 2001; Richardson et al. 1999). Studies consider the extent and impacts of environmental disclosure (European Environment Agency [EEA] 2001; KPMG 2002; White and Zinkl 1998; Li et al. 1997; Warsame et al. 2002), the relationship between corporate characteristics and environmental disclosures (Gamble et al. 1995; Gray et al. 2001; O'Donovan 2002; Marshall and Brown 2003a), the impacts of environmental accounting information on capital markets (Blacconiere and Patten 1994; Blacconiere and Northcut 1997; Li et al. 1997), and the efficacy of accounting for environmental costs (Joshi et al. 2001). Several recent studies have shown that accounting systems poorly identify environmental costs. Clarkson et al. (2004) suggested that high-polluting firms have significant unrecorded liabilities, while Joshi et al. (2001) found that expenses recognized as environmentally related were a small fraction of the true environmentally related amount.[11] Virtually all accounting research in this area looks at impacts

[9] Externalities exist when an activity by one party causes an unintended and uncompensated loss or gain by another party. An example of an environmental externality is the fouling of a public good without compensating the public for the damage done, such as an aluminum plant's air pollution that destroys a public forest. The cost of the destroyed forest is "externalized" to the public—not paid for by the aluminum plant.

[10] And, of course, managerial and financial accounting examples abound to demonstrate that our information systems cause a wide range of other dysfunctional behaviors as well. Enron debacles, budget game playing, and teaching-to-the-test can all be somewhat explained by deficiencies in our information systems.

[11] For overviews of environmental accounting and research in environmental accounting and reporting, see Mathews (1997, 2001), Epstein (1996), Gray and Bebbington (2002) and Schaltegger and Burritt (2000).

of environmental reporting, at some level. Our work relates the accounting system to environmental activities, adding to the literature by addressing accounting as an input to the decision process, rather than merely measuring outputs from the process.

In the information systems literature, Shaft et al. (2002) showed that information systems can help an organization move toward environmentally responsive business practices. They identified a range of organizational information systems and discussed how these systems may support environmentally oriented decision making. Rikhardsson (1998) identified information technology as a possible tool to improve environmental accounting. He identified a subset of natural resource inputs and pollution and worklife related outputs capable of being kept in a pseudo chart of accounts, and even directly related to financial amounts. In a series of interviews with chemical and process industries, Kleindorfer and Snir (2001) examined the role of information systems in an environmentally responsive supply chain. They suggested ways to improve business performance and reduce risk by capturing and attending to natural system information. Allenby et al. (2001) provided a thoughtful overview of the integration of information systems, organizations, and environmental initiatives, and argued that meeting the environmental imperatives of the future requires better and richer information.[12] While the information system literature provides some general notion that information technology can improve decision making, we add to this literature by providing a framework for understanding and prescribing the AIS specifics based on organizational motivation.

We are unaware of research specifically dealing with environmental issues as a dimension of AIS development. The environmentally oriented information available in most accounting systems primarily addresses the needs of regulatory decisions (Schaltegger and Burritt 2000). The needs of decision makers interested in the issues of business opportunities, business risk, and social responsibility are left unmet. We address this lacuna by considering the information requirements associated with environmentally focused AIS. The following section initiates the first phase of an ongoing, iterative process whereby these information needs are more fully articulated with an eye toward developing environmentally conscious AIS.

III. ENVIRONMENTAL INFORMATION MATRIX

In this section, we develop an environmental information matrix (EIM), presented in Table 1. To develop this matrix we first identify three representative strategic environmental orientations from the strategy literature. Next, we discuss the decision scope over which these orientations are applied. The decision scope circumscribes the constituent set considered with respect to a particular activity in order to specify associated environmentally related information. As we discuss the decision scope, we specify information sets relevant to each strategic information/decision scope pair, ultimately discussing each of the nine cells in the EIM. These information sets provide examples of the particular data objects that are useful in making decisions relating to a specific strategic environmental orientation and decision scope.

Our matrix identifies organizational strategic orientations similar to ones identified by Bansal and Roth (2000) on the vertical dimension (see also Hoffman 2000). The horizontal dimension identifies discrete decision scopes, representing a degree of constituent stakeholder inclusivity. AT&T used a similar matrix to relate life-cycle stages of product development with environmental concerns (Allenby 2000). Similar to our framework, it associated certain motivations for activities with the intensity of environmental impact inherent

[12] See Richards et al. (2001) for an overview of information systems and the environment.

in those purposes. While the AT&T matrix provided a quantitative assessment of the scope of impact based on the life-cycle stage and environmental concern, we concentrate on the information attributes important in managerial decision making. We articulate specific information requirements based on the strategic orientation/decision scope pair.

Environmental Strategies

The environmental management and corporate social responsibility literatures classify firms along a response continuum ranging from firms that merely react to environmental regulations to visionary, proactive organizations for which environmental issues are of paramount importance (Hunt and Auster 1990; Roome 1992; Henriques and Sadorsky 1999). Bansal and Roth (2000) use grounded theory to identify three basic motivators for corporate

TABLE 1
Some Selected Information Items for Strategic Orientation/Decision Scope Cells

	Decision Scope of Environmental Decision		
	Operations	**Market**	**Society**
Strategic Orientation of Environmental Decision	**Cell 1**	**Cell 2**	**Cell 3**

Legitimation	• Cost of violations of environmental regulations
	• Number of violations of environmental regulations
	• Cost of reclamation and/or remediation efforts
	• Number of reclamation and/or remediation efforts
	• Cost of pollution control technologies
	• Cost of maintaining pollution control equipment
	• Cost of emergency supplies for material spills
	• Cost of permits for use of regulated materials
	• Cost of negotiations with regulators
	• Aggregate output of regulated emissions and effluents
	• Aggregate consumption of regulated materials
	• Cost of hazardous materials employee training
		• Cost of obtaining and maintaining product and process certifications
		• Reputation of product and process certifications
		• Number and kind of certified products produced by competitors
		• Costs of meeting demands of consumer advocacy groups
		• Market share of products attributable to certifications
			• Cost of meetings with nongovernmental, political and community activist groups
			  • Personnel costs
			  • Travel costs
			  • Legal costs
			  • Seminar costs
			• Reduction in compliance-related penalties due to interaction with stakeholders
			• Reduction in cost of stakeholder issue-related data reporting due to obtaining "green permits"
			• Cost of stakeholder issue-related data collection
			  • Personnel costs
			  • Travel costs
			  • Supply costs
			  • Equipment costs

(*continued on next page*)

TABLE 1 (continued)

	Decision Scope of Environmental Decision		
	Operations	**Market**	**Society**
Strategic Orientation of Environmental Decision Competitiveness	**Cell 4** • Cost of environmental management system administration • Quantity of regulated and nonregulated emissions and effluents—in aggregate and per unit of output • Cost of disposing of wastes • Consumption of regulated and nonregulated material—aggregate and per unit of output • Cost of substitutes for regulated materials • Availability of substitutes for regulated materials • Cost of green portion of process engineering • Cost of employee training green process engineering • Costs of nonrenewable and renewable energy usable for production	**Cell 5** • Cost of market analysis for green products • Price elasticity of consumers for green products • Sales volume, price points, and market share for green products • Gross margin on green products • Competitors' green product attributes, sales volumes, and market share • Obsolescence rates for green products and technologies • Salaries for and availability of green product engineers • Reputation and costs of available product and process certification programs • Sources and costs of recycled materials and components • Expected sales volumes for green products	**Cell 6** • Costs of identifying stakeholders • Cost of stakeholder collaborations • Number of stakeholder collaborations • Incremental cost reductions from stakeholder collaborations • Incremental revenue generation due to stakeholder collaborations • Cost of supplier audits and procurement guidelines enforcement • Cost of industrial customer audits and procurement guidelines • Cost of using trading permits • Volume of trading permits available • Cost of re-engineering polluting processes

(*continued on next page*)

environmental behavior: legitimation, competitiveness, and ecological responsibility. Hart (1995), in his articulation of a natural-resource-based view of the firm, identified three similar strategic orientations of a firm's relationship to natural systems: pollution prevention, product stewardship, and sustainable development. These environmental perspectives inform

TABLE 1 (continued)

	Decision Scope of Environmental Decision		
	Operations	**Market**	**Society**
Strategic Orientation of Environmental Decision			
Enlightened Management	**Cell 7** • Cost of environmental management system administration • Volume of emissions and effluents outputs, by unit of production, point source, and in aggregate • Toxicity rating of effluents and emissions • Amount of renewable energy used for production • Percentage of energy usage from renewable sources • Availability of renewable energy • Employee commuting and business travel energy usage and environmental impact • Incremental costs of improving facility and buildings energy efficiency • Incremental costs of facility design and construction using renewable and/or recycled materials	**Cell 8** • Cost of renewable energy for product in-use • Availability of renewable energy for product in-use • Cost of renewable and/or recyclable materials and components for product • Availability of renewable and/or recyclable materials and components for product • Amount of required energy for life cycle of products • Percentage of products recyclable and/or reusable • Cost of take-back systems • Availability of take-back systems	**Cell 9** • Cost of identifying stakeholders • Cost of evaluating stakeholder involvement schemes • Identify of potential partners for co-locating • Identify of potential uses for waste outputs • Cost of measuring environmental conditions—local, regional, and global • Status of relevant local, regional, and global environmental conditions • Cost of measuring environmental impacts—local, regional, and global—including bioaccumulative and transboundary impacts • Cost of carbon offsets • Cost of performing life cycle analyses • Life cycle database

the strategic orientation within the organization that circumscribes the activity set and represent management's response to business and environmental risks. The three strategic orientations we identify—legitimation, competitiveness, and enlightened management[13]—are consistent with the prior strategy research.[14]

[13] We adopt the term "enlightened management" rather than Bansal and Roth's (2000) "ecological responsibility" because enlightened management is more generalizable than ecological responsibility, and therefore more consistent with the strategic foci of legitimation and competitiveness, the other two strategic orientations. The strategic orientations are focused, not specifically on environmental issues, but rather on a broader view of strategy as a whole. In the context of this paper we focus on environmental considerations.

[14] We discuss these three alternatives as though they were separate characterizations. As discussed in Bansal and Roth (2000), we recognized that these lie on a continuum and that the boundaries are not clear-cut.

Legitimation

Legitimation attempts to meet the cultural and social norms of the industry and society in which the organization operates (Hoffman 2000; Bansal and Roth 2000). In our matrix, a firm with a legitimation orientation maintains its standing in the industry and society and preserves its social license to practice by engaging in environmentally sufficient behaviors. The firm seeks parity, not advantage, in the environmental arena, and social license, not social preference, from its environmental behaviors. A legitimation strategy situates the organization so that it will not be negatively affected by its environmentally related actions. For example, when the relevant cultural and social norms dictate that an organization must install wastewater treatment, the firm will obtain such technologies. Likewise, a retail grocer, operating in a social climate where organic foods are typically available, will stock some organics simply to support the prevailing social norms of the locale, even if not choosing to compete actively in the organic food market.

Competitiveness

The second strategic orientation considers environmental issues in light of enhancing competitiveness through improving market position relative to competitors (Hart 1995). Under this strategy, environmentally desirable behaviors improve long-term profitability by creating new products and processes, or by creating new benefits in old products (Bansal and Roth 2000). Environmentally conscious actions lead to greater efficiencies or higher product quality (Klassen and Whybark 1999; Lovins et al. 1999; Porter and van der Linde 1995b). For example, an organization might introduce an aggressive waste-reduction policy through employee training and process redesign, providing substantial cost savings that result in above-average financial performance.

An organization may also attempt to establish new markets, gain market share, and/or increase market size through environmentally related product development, product improvement, and customer loyalty (Porter and van der Linde 1995a). An organization might establish or exploit a niche market, or make its products more desirable in the marketplace by attaining "green" certification—perhaps by providing organically grown vegetables, or by making the component parts of its computer printers reclaimable, or by using recycled, post-consumer materials. In these examples, the firm uses environmentally conscious behaviors to create competitive advantage.

Enlightened Management

In the third strategic orientation, management conceives of the firm as a force for social good (Bansal and Roth 2000). Organizational leadership determines that the organization must operate in an environmentally sound way in order to preserve itself in perpetuity (Starik and Rands 1995) and embraces the perspective that a prosperous economy can exist only within a healthy natural system (Gladwin et al. 1995). The firm considers that maintaining environmental sustainability is equal or superior to maintaining financial viability, so enlightened management evaluates actions in light of environmental sustainability. The organization creates products and services based on the long-term regenerative capacities of renewable resources, in keeping with the values of environmentally desirable behavior (Gladwin 1993; McDonough and Braungart 2002; Kiuchi and Shireman 2002). For example, an organization may harvest only as much timber as its forests replenish during a given harvest cycle, or may require that all fabrics be sustainably grown and colored with nontoxic, nonpetroleum-based dyes. In these activities, the organization advances environmental sustainability while meeting marketplace demands.

In summary, we identify three strategic positions along a continuous gradient. *Legitimation* is a strategy used by organizations that see environmentally oriented activities as necessary to maintain the social license to continue operations. Firms focused on *competitiveness* use environmentally oriented activities as tools for improving their market position. *Enlightened management* firms see an imperative to preserve and secure natural systems for their (and others') long-term survival. Next, we discuss the decision scopes over which each of these strategic orientations can be implemented and specify information sets relevant to each strategic orientation/decision scope pair.

Decision Scope

Management also chooses a decision scope that circumscribes its vision with respect to the impacts of its actions. The decision scope emerges from the values, norms, and goals of the organization and its management. Managers must specify the scope it considers relevant for its decisions before identifying essential items of information. The scope's articulation, maintenance, and potential alteration depend on how management conceptualizes its risks and responsibilities.

In our information matrix, the decision scope specifies the parties and contexts that affect or are affected by anticipated actions. Decision makers in organizations implicitly or explicitly choose the parties and contexts. The affected parties might be internal or external: customers, suppliers, or any of a broad set of potential stakeholders. When management implements any environmental strategy, management presumes or chooses a context that may vary along time and space dimensions. For example, the firm could either reduce waste from its internal processes or influence its suppliers to adopt a zero-waste policy. If the firm chooses the first alternative, the firm does not directly depend on resources outside of the firm to implement the waste reduction, so the time scope would be relatively short (the firm can begin immediately), and the space scope would be relatively narrow (restricted to the firm). If the firm chooses the second alternative, the time scope is longer and the space scope broader, as the firm engages, encourages, and supports its suppliers to adopt a new policy.[15]

We choose three distinct scopes as exemplars: (1) operations—i.e., relationships inside the firm, (2) customer/market—i.e., relationships inside the firm's competitive marketplace, and (3) stakeholder/society—i.e., relationships within society-at-large. The operations scope focuses on the organizational domain and is not predicated on the direct involvement of business partners or other stakeholders. Such a perspective is generally associated with improving input to output relationships. The market scope focuses on the organization's markets and related constituencies, and is generally associated with improving the firm's economic position. Finally, the society decision scope impacts a wide range of possible partners, competitors, and other stakeholders. Generally, the primary objective is seen as impacting the ecosystems within which the organization operates. These decision scopes, as described, are ideal types. They are rarely discrete, and the activities of an organization can rarely impact only one scope, but an organization can identify one scope on which it wishes to focus, thus circumscribing its decision making context. We discuss each of these decision scopes and their relevant information sets in turn. Cell numbers refer to cells in

[15] Allenby (2000) presents a matrix to quantify the impacts of development activities on a variety of environmental attributes. His matrix recognizes that different activities have a different impact scope, as does ours. He, however, identifies scope as different environmental attributes, while we identify our scope as the primary stakeholder groups with whom the firm anticipates interacting and the associated time-space implications.

Table 1. We also present examples of environmental actions taken by actual organizations (see Table 2).[16] The following discussion is illustrative and does not purport to represent a complete decision set or to cover all possible information sets, which are situation dependent.

Decision Scope 1—Operations

The operations decision scope focuses on relationships and processes within the firm. In this perspective, consumers or other external stakeholders are beyond the organization's decision scope. Operational activities can immediately impact both the environment and the organization. Generally, the time needed to initiate action is short and the impact limited, inasmuch as the focal activities reside within the organization and rely upon the concurrence of internal stakeholders.[17]

TABLE 2
Examples of Environmental Actions for Strategic Orientation/Decision Scope Cells

	Decision Scope of Environmental Decision		
	Operations	**Market**	**Society**
Strategic Orientation of Environmental Decision Legitimation	**Cell 1** • Merck audited all operations to determine conformance with environmental regulatory requirements. (Merck 2003). • SGI, a maker of supercomputers, conducts a regulatory compliance evaluation every odd fiscal year (SGI 2003). • Potlatch directs each line operation to establish polices assuring that employees comply with all environmental laws that are applicable to its operations (Potlatch 2005).	**Cell 2** • Agilent Technologies certified its manufacturing facilities to the International Organization for Standards ISO 14001 guidelines for environmental management systems (Agilent 2004). • General Mills certifies its Hearty Morning Cereal to U.S. Department of Agriculture's Organic standards (General Mills 2005). • Maytag received Energy Star designation for a line of clothes washers and dryers (Maytag 2003).	**Cell 3** • Ashland, Inc. published on its website the number of environment-related inspections and fines, comparing fiscal 2001 and 2002 (Ashland 2003). • Ford Motor Company states on its website that it received 22 notices of violations (NOV) from government agencies in 2003. Eighteen of the NOVs received were in the United States, three in India and one in Mexico (Ford 2004).

(*continued on next page*)

[16] These examples are drawn from publicly available information about the companies mentioned. Whereas a company may engage in an activity that fits into one of the cells in the matrix, that does not mean that the company, as a whole, would be categorized in that cell. The overall strategic orientations or decision scopes of individual companies may differ from the examples used herein.

[17] We are not saying that there are not long-term consequences from the decision, but that the firm only considers the short-term, internal implications in framing the decision.

TABLE 2 (continued)

	Decision Scope of Environmental Decision		
	Operations	**Market**	**Society**
Strategic Orientation of Environmental Decision Competitiveness	**Cell 4** • Roche redesigned its process for making cough medicine, reducing phosphate emissions by 90% and volatile organic compound emissions by 80% per pound of product (Hoffman-La Roche 2001). • Fuji Xerox incorporates nine types of recycled plastic parts (ABS plastics), jointly developed with UMG ABS, Ltd., in its desktop office laser printers, the DocuPrint 211 and the DocuPrint 181 (FujiXerox 2004).	**Cell 5** • S. C. Johnson reformulated RAID ant and roach baits to use a biodegradable bait (S. C. Johnson 2004). • Ricoh developed quick start-up technology, which enables machines to save energy and recover quickly from energy-saving (off/sleep) mode when needed (Ricoh 2000).	**Cell 6** • Ricoh published goals for reducing CO_2 emissions for 2004 and 2010 in its Japan manufacturing and nonmanufacturing facilities as well as non-Japan manufacturing facilities (Ricoh 2004). • Ricoh established Green Procurement Guidelines for all its suppliers, including specifications regarding implementation of environmental management systems (Ricoh 2000). • Electrolux provides a policy statement on its efforts to mitigate contributions, due to its activities, to climate change (Electrolux 2005).
Strategic Orientation of Environmental Decision Enlightened Management	**Cell 7** • Norm Thompson built bio-swale to collect and drain storm-water from its corporate buildings and parking areas (Norm Thompson 2005). • Ricoh has achieved nearly 99% resource recovery of waste from production facilities, based on zero waste to landfill targets (Ricoh 2004).	**Cell 8** • Collins-Pine timber harvesting is based on long-term sustainable yield practices (Collins 2002). • Interface Corporation introduced biodegradable fabrics made with bio-based polymers. It also offers office panel and upholstery fabrics that are 100% recycled or 100% compostable (Interface 2005).	**Cell 9** • Toyota is partnering with Universities of California-Davis and -Irvine in designing and testing hydrogen fuel cell cars. Works with municipalities, infrastructure providers, and product suppliers to create test communities for use of fuel cell vehicles (Toyota 2005).

Given the internal focus, there is at least an implicit assumption it is unnecessary to consider the relationships across inter-organizational boundaries. Consider, for example, decisions to invest in pollution-prevention equipment, to implement recycling programs, or

to modify production processes. These decisions, in most cases, require only initiative and implementation within the organization. Operations-related decisions may consider variables with a short time horizon, such as the immediate cost of obtaining recycling containers and employing labor to implement an office-wide recycling program. Likewise, the economic costs and benefits generally occur locally and may dissipate quickly if the activities are discontinued. The implementation of the decision involves a relatively narrow social space, encompassing only the people within the organization directly involved in the activity. We now examine the three environmental impact matrix (EIM) cells relevant to the operations decision scope.

Cell 1—Legitimation/Operations

Firms maintain legitimacy through environmental actions focused on their operations. The legitimation orientation typifies organizations using environmentally conscious actions to maintain their ability to continue operations and to maintain parity with competitors. For example, if an organization must manage hazardous and toxic materials and meet emissions requirements, the managers must concentrate on the environmental issues associated with operations. Management engages process engineers and environmental staff within the firm to implement pollution prevention technologies to ensure compliance with regulations. Merck's auditing activities (Merck 2003), Silicon Graphics Incorporated's cycle of regulatory compliance evaluations (SGI 2003), and Potlatch's policies for compliance are examples of legitimation/operations environmental actions (Potlatch 2005).

The information sets in this cell include predominantly cost-related items. Currently, costs relating to environmental regulation are often hidden in aggregated and unidentified accounts (Joshi et al. 2001). These costs must be separately identified and segregated in the AIS to accurately understand the true costs of environmental actions. For example, the cost of negotiating with regulators must be separated from other legal costs. The cost of maintaining pollution control equipment must be separated from general maintenance costs. The cost of using hazardous materials includes, in addition to the materials themselves, the required costs of hazardous materials training, monthly updates to the training, keeping and replenishing safety supplies, and obtaining permits for use of the materials. AIS must provide these data as they are needed.

Cell 4—Competitiveness/Operations

In this cell, firms focus on gaining competitive advantage by improving environmental performance within their operations. Meeting consumer needs better than competitors is at the core of long-term competitiveness. Many eco-efficiency methods (DeSimone and Popoff 2000) fall within this cell, including reducing the material per unit of product, decreasing emissions, and eliminating hazardous and toxic materials. Roche's redesign of its manufacturing processes (Hoffman-La Roche 2001) and Fuji Xerox's incorporation of recycled plastics into its laser printers illustrate competitiveness/operations environmental actions (FujiXerox 2004).

Examples of the data items captured and reported in this cell include the quantity and cost of waste, the relative costs of energy from renewable and nonrenewable sources, and the cost and availability of substitutes for regulated input materials. The cost of substitutes not already used in the business must be captured. This means that possible substitute materials and their costs must also be identified and captured. An example of this is the Chemical Assessment and Ranking System database prepared by the Zero Waste Alliance (ZWA), which facilitates substituting less hazardous chemicals for more hazardous ones (ZWA 2003).

Cell 7—Enlightened Management/Operations

This cell deals with management decisions to carry out an environmentally enlightened strategy focused on internal operations. For example, firms strive for zero-waste in their facilities and find opportunities for upcycling (using components and materials from one product to create a new product of greater value). They identify hazardous chemicals and reduce or replace them with more benign substitutes. Based on a natural-systems perspective, firms in this cell view any process byproduct as a potential input to another process, rather than as a waste stream. Ricoh's achievement of nearly 99 percent resource recovery in its facilities (Ricoh 2004) and Norm Thompson's use of bio-swale to protect watersheds are examples of behaviors in this cell (Norm Thompson 2005).

Information requirements relate to the costs and capabilities of internal changes to benefit the natural system. Collecting information about employee travel, such as numbers of miles driven, emissions from the transport sources used, and the greenhouse gasses produced are relevant here. The availability and cost of renewable energy sources, and the percentage and absolute amounts of renewable energy used provide a basis for improving operations. This information can then be used to implement conservation measures, which have costs that will, in turn, be captured by the system. An enlightened perspective places great emphasis on internalizing costs that have traditionally been externalized. Information for firms will include many data items that have not been captured in traditional AIS.

Decision Scope 2—Market

Whereas the operational decision scope focuses the firm internally, the market decision scope expands to relationships within the boundaries of the firm's market and suggests that management considers and chooses its environmental actions based on the nature of its marketplace relationships. The impact of the activities goes beyond the organization itself, reaching the organization's customers, suppliers, regulators, and competitors. Activities in the market decision scope involve processes internal and external to the organization, involving relationships across inter-organizational boundaries.

For example, one market decision activity would be to acquire third-party certification of the environmental characteristics of consumer electronics products. This activity creates a new attribute for the firm's products, one that is important to potential consumers. By acquiring certification, the firm modifies its products, modifies its image, and, potentially, modifies the consumer electronics marketplace. Relative to the operations scope, the social space is broader, extending beyond the firm to include customers, potential customers, competitors, suppliers, and certification agencies. The time to implement also expands because the firm must work with the certification agency as well as develop and implement marketing programs to communicate the new product attributes to customers. These relationships require time to develop and may need to be sustained, for example with periodic updates. We now examine the three EIM cells relevant to the market decision scope.

Cell 2—Legitimation/Market

Firms extend the boundary of their legitimacy-seeking relationships into the marketplace. Actions in this cell are geared to staying competitive in the market. For example, to remain viable, suppliers of auto manufacturers that require ISO 14000 certification must seek certification by accredited third-party organizations. Certifications require substantial investments in process and administrative technologies, and impact firm operations beyond the current period. Agilent Technologies' attainment of ISO 14001 certification for its manufacturing facilities (Agilent 2004), General Mills' organic certification of breakfast cereal

(General Mills 2005), and Maytag's Energy Star designation for appliances (Maytag 2003) provide examples of legitimation/market environmental actions.

In this cell, firms must add new items of information to their accounting information system. The systems must capture and inform about different types of certifications, to what products the certifications pertain, and the certifications obtained by their competitors. In order to meet the competition in the organic food marketplace, a company like General Mills must identify which competitors have obtained organic certification, track the relative market share obtained by organically certified products, and track the costs of obtaining the certifications.

Cell 5—Competitiveness/Market

In this cell, firms design and deliver products differentiated in the marketplace based on their environmental attributes. These firms anticipate, create, or respond to consumer markets. Firms design products with increased reliance on recycled components or renewable energy sources, or reduced reliance on nonrenewable energy sources and toxic materials. Examples of environmental actions in this cell include automakers' initiatives to produce hybrid vehicles, S. C. Johnson's reformulation of its pesticide for lower in-use emissions (S. C. Johnson 2004), and Ricoh's development of energy-saving quick-start technology (Ricoh 2000).

The Competitiveness/Market cell contains data necessary for making customer-based decisions relating to use of environmentally preferable products and services. Costs and prices of "green" products, competitive offerings, percent of sales, and sources and costs of recycled components would be captured in the AIS. When automakers consider producing hybrid vehicles, they need information about anticipated fuel costs, design costs, and production costs. Salary differentials between design engineers with and without environmentally aware design skills are important. The anticipated sales volumes for hybrid vehicles must be estimated and projected into the budgets for determining their anticipated contribution to net income. Systems to support these decisions must separate and identify incremental costs and benefits accruing from actions relating specifically to the environmental character of the products.

Cell 8—Enlightened Management/Market

Firms design and deliver unique products that maximize the environmentally sustainable character of the products and processes involved. Product design considers both environmental consequences and market opportunities, with the environmental considerations being the primary focus, contrasted with the competitiveness strategy where market opportunities would be the primary focus and the environmental considerations would be seen as supporting. The products emphasize the use of renewable sources of energy during production and/or consumption, or incorporate renewable and biodegradable materials and/or fully recyclable components. Collins Pine's sustainable-yield forestry practices (Collins 2002) and Interface Corporation's manufacturing of biodegradable and compostable fabrics (Interface 2005) are examples of environmental actions in this category.

Information requirements to support the environmentally enlightened decisions associated with this cell include such items as the energy consumption in the firm's products' service lives, material quantities required for creating products, the recyclable percentage of the finished products, and the cost of take-back systems for reclaiming and restoring the products after use by the primary consumer.

Decision Scope 3—Society

The society decision scope extends the boundaries of the impacts contemplated by the decision makers to include relationships with the members of society-at-large. This decision scope relates to the firm's environmental actions as a member of a larger society, with a wide range of traditional and nontraditional stakeholders. The firm considers activities impacting society as a whole, both currently and into the future. The time horizons for these decisions tend to be long-term. While some society decision scope activities may have an immediate impact, such as changing from chlorofluorocarbons (CFCs) to a benign compound, the overall impact of the activity can extend well into the future. Likewise, the spatial scope of these activities extends well beyond the firm and its marketplace partners. For example, eliminating CFCs benefits society as a whole, not just the marketplace in which the firm operates.[18] Activities in the society decision scope involve both internal and external processes, and may require relationships across organizational and institutional boundaries as well. For example, to eliminate CFCs in all of the operations of an organization, it may be necessary to find alternatives, to convince suppliers to change their processes, to educate consumers on product redesigns, and to get approval from regulatory organizations. Carrying out these requirements may require considerable time and effort and have a time and space scope that exceeds those associated with the operations or market decision scopes.

Activities in the society decision scope depend upon relationships that last well into the future and often require long-term investments of resources to ensure their successful implementation. For example, addressing the issues of environmentally sustainable housing development requires continuing relationships with suppliers, regulators, environmental activists, planners, and housing-dwellers. To be effective, this engagement must be a continuous process. The costs, in time and money, occur throughout the process. The benefits, in environmental, social, and monetary terms are long term, accruing throughout the life of the community. An environmentally sustainable housing development involves the firm and its customers, the community surrounding the development, and, more broadly, the social institutions that interact with the development. The nature of these activities involves engagement in relationships well beyond the boundaries of the activities themselves. We now examine the three EIM cells relevant to the society decision scope.

Cell 3—Legitimation/Society

Firms in this cell maintain social license to operate across a range of stakeholder interests. Communicating environmental liabilities, discussing pending litigation, and supporting environmentally friendly causes allow a firm to maintain a required level of legitimacy with societal groups beyond marketplace participants. For example, to address the expectations of environmentally concerned stakeholders, Ashland, Inc. published the number of environment-related inspections and fines for fiscal 2001 and 2002 on its website, increasing the environmental transparency and enhancing the legitimacy of Ashland in the eyes of various stakeholders (Ashland 2003).

When companies are motivated solely by legitimation strategies in addressing society issues, they must accurately track the costs of dealing with stakeholders. The costs of public meetings could include personnel costs, travel costs, legal fees, and seminar costs. In order

[18] Individuals differ over whether the elimination of CFCs is worth the elimination of jobs creating the CFCs. While there will rarely be unanimity regarding these events, we assume that there are benefits to society that individuals generally agree upon.

to assess the efficacy of engaging in these activities, the information system must be able to segregate the overall personnel, travel, legal, and seminar costs. AIS are seldom organized to capture data in this fashion (Joshi et al. 2001; Schaltegger and Burritt 2000). A firm may contemplate applying for permits to reduce the number of inspections required or the frequency of required reporting, and so the firm must capture the costs of collecting environmental data: the specific personnel, equipment, supplies, and travel costs. In such case, the information system must specify the types of data collected when a technician runs a lab test or the purpose for travel when a field assistant drives to gather water samples.

Cell 6—Competitiveness/Society

Organizations seeking competitive advantages in the marketplace by involving stakeholders other than just internal actors and customers move to the Competitiveness/Society cell. These firms engage select stakeholders in product and process design and integrate value chain members in innovation efforts focused on their products, processes, and business models. Motivated by competitiveness, firms build relationships with societal stakeholders, including regulators, suppliers, nongovernmental organizations, and communities. Examples of companies engaging in relationships with key stakeholders in respect to environmental actions are Ricoh's commitment to use green procurement guidelines (Ricoh 2000), as well as electric utilities' purchases of renewable energy from windmill companies. These relationships with societal members improve operational efficiencies, uniquely position the firm's products, build environmental reputations, and meet consumer demands for environmentally sensitive products.

The information items specifically identified in this cell relate to the costs and benefits of environmentally related activities to gain competitive advantage through engagement with external parties. Organizations that pollute may need to collect and report information relating to the availability and cost of trading permits,[19] which would then be compared with the costs of re-engineering polluting processes. The organization would then use these information items to determine whether they were better off purchasing trading permits or modifying their processes. A firm producing clothes from organically grown textiles must capture the costs of auditing its suppliers, the incremental costs of negotiating with and educating suppliers about environmentally relevant product characteristics, and the costs of additional training for its buyers (see Marshall and Brown [2003b] for a case discussion of such an activity). These costs must be collected and available for decision makers interested in making environmentally aware decisions.

Cell 9—Enlightened Management/Society

In this cell, firms' actions are based on a thorough understanding, or at least recognition, of the relationship between a firm's activities and local and global environmental conditions. Firms taking these actions seek to eliminate negative environmental impacts, and in some cases, enhance ecosystem health. Firms that choose to co-locate facilities with complementary operations provide the most prominent example of this cell (see Allenby 1999). They need information such as quantities of waste created, potential uses for the waste, other companies that can use the waste as productive input, and regulatory issues relevant to eco-park implementation. The cost of engaging in cooperative discussions among partners to

[19] In an emission scheme, governments would set a cap for their nation's greenhouse emissions. Governments would issue permits to pollute and polluters would be free to trade their permits. Companies that find it expensive to reduce emissions can instead buy permits from companies that can reduce their emissions more cheaply.

plan and implement developments for co-locating must be estimated and ultimately captured by the system.

The broad view of firms in this cell implies that they would need an AIS that captured data regarding the local, regional, and perhaps global state of salient environmental factors. Enlightened Management/Society actions require comprehensive assessments of environmental impacts along the entire value chain through life-cycle analyses and cooperation with other groups based on the complementary nature of process byproducts. The cost of performing life-cycle analyses, the resultant rich databases, and processes for using the data to analyze new products and procedures must all be kept in the AIS.

In summary, we have presented an environmental information matrix (EIM), using strategic orientation of the organization and the decision scope over which the organization's impacts will occur. The information items identified in the matrix may be well understood, such as the cost of training employees to handle toxic chemicals, or unknowable, such as the rate of change in greenhouse gasses that the atmosphere can absorb. Many of the items have been previously identified. The United States Environmental Protection Agency (U.S. EPA 1995) identified over sixty individual environmental costs that could be incurred by firms, including hidden upfront costs, image and relationship costs, and voluntary costs. Epstein and Wisner (2001) recognize that the scope of environmental impacts goes beyond costs to include such items as green products, numbers of spills, and percentage of environmentally certified facilities. The Global Reporting Initiative (GRI 2002) identify 35 general environmental performance indicators. There are many sources for identifying these specific information items, although there is a lack of consensus about which items should be identified. The benefit of the EIM is that it allows an AIS designer to identify the information items relevant to the subject firm, dependent upon the firm's strategic orientation as regards environmental behavior, and the temporal and stakeholder scope over which it wishes to affect its impact. We recognize that items within the cells of the matrix may overlap. One decision may affect multiple decision scopes; several strategic orientations may result in a similar activity. Identifying specific strategic orientation/decision scope pairs, however, facilitates understanding the information needs for an organization.

IV. CONCLUDING REMARKS

This paper began with a quote cautioning that organizations are unlikely to take environmental issues seriously if such matters are unrecognized in their formal information systems. Environmental issues affect many business decisions, and the saliency of these issues continues to grow. Current accounting systems are designed to provide a narrow set of economically oriented attributes. To provide management with the environmental information needed to manage in the current business circumstances, AIS designers must explicitly consider environmental issues. We propose a process for creating and implementing AIS that explicitly considers environmental attributes as integral components. We develop a matrix that provides a means for identifying environmental attributes. This paper presents an initial step in designing AIS that respond to the needs of organizations attempting to be environmentally conscious.

So, what is the benefit of the EIM to a business or manager? The EIM, based on strategic motivations from the business strategy literature, provides guidance in designing AIS that support environmentally responsible decision making. Environmentally conscious AIS benefit firms in two ways: first, management becomes more aware of environmentally related business opportunities and risks and is, therefore, better able to manage them, and

second, the AIS provides information a company needs to implement a specific environmental strategy. In addition, the EIM can be used to assess the extent to which environmental considerations inform management's decisions. Finally, the EIM is useful in guiding a firm that is attempting to enhance its level of environmental responsibility.

From a broader perspective, however, what are the potential benefits of the EIM? The proposed EIM links management decision sets with information sets to more clearly articulate requirements for an environmentally conscious AIS. However, it does not link management's actions, translated into administrative and scientific technologies, to natural systems. Future research must specifically articulate the links between social and natural systems. When established, these links can implement proactive programs that account for the systemic interrelationships. Next, we consider how businesses and their managements might employ the ideas developed here in undertaking desired change.

First, social actors can change social systems through purposeful actions over time and space constructs. Corporate entities that have exploited natural systems can also be harnessed to enhance or protect the natural systems. The cells of our information matrix reflect information sets that would be associated with these alternative objectives.

Second, for organizations to make systemic decisions that include both natural and social systems as decision parameters, both systems must be represented within the AIS, where the impacts of perturbations in one system can be shown on the interrelated systems. Failure to consider the wider implications of a decision leads to imbalances in the social systems, the natural systems, or both, that can ultimately result in their collapse. Our matrix provides a step toward integrating these systems.

Third, social systems that focus predominately on wealth accumulation and economic growth are likely to produce technologies that create contradictions and conflicts within and among the natural and social system relationships. As organizations contemplate expanding the decision set to include longer time horizons, broader spatial horizons, and expanded stakeholder sets, they encounter the inherent constraints that exist due to a gap in their identification of relevant information. The EIM provides a tool to close that gap.

Fourth, enlightened agents, managers in this case, have the option to act. As such, they can choose to modify their options to include environmental issues as they gain a better understanding of the short-term and long-term implications of these issues. The information matrix can identify information sets that support such actions.

AIS delineate the relationships and objects we consider in our decision models, linking our social systems to natural systems by including the appropriate relationships and objects in the information system. Establishing these linkages connotes a necessary condition for representing the effects of alternative environmental strategies on natural systems, leading to higher levels of accountability. In the preceding discussion, we only nod toward these linkages. The EIM represents a preliminary step in articulating and, hopefully, inculcating the realities of natural systems into the operational, market, and societal representations of business organizations.

What is the benefit of the EIM for research? The framework we propose facilitates integrating new and nontraditional types of information into AIS. This opens a wide range of research questions and opportunities. To implement the EIM, to integrate new and nontraditional types of information, we must identify, capture, process, and report in new and nontraditional ways. For example, environmental information often comes in units, frequencies, and formats unfamiliar to accountants and managers. Similarly, environmental information may be "denominated" as relationships—how do we account for such characteristics in AIS? Research can help determine how best to incorporate the information into existing or modified AIS.

Some other potential research questions are:

- How can we design accounting processes that capture the required information? How can the necessary information be identified and input into our existing or future systems?
- What should we ask of information system designers and vendors in terms of integrating environmental information capabilities?
- How can we practically integrate the complex and often unstructured environmental data into a traditional AIS?
- What types of *environmental* information would be transaction-based and what would be periodic or episodic? Will the information be generated internally, externally, or both? How can accounting and information systems be adapted to handle exogenous data?
- What is the impact of including these data in an AIS—on decision makers, investors, auditors, supply chain partners, and external stakeholders, among others? What is the impact of reporting this information externally versus only using it internally?
- What reporting issues arise due to the special characteristics of the environmental data?

Some of these issues are evident when observing the struggle to determine a standardized method for identifying and reporting environmental performance (Global Reporting Initiative [GRI] 2002) or when comparing environmental reporting across organizations (Marshall and Brown 2003a).

The EIM benefits education by providing a tool for incorporating strategic orientation, time horizon, and stakeholder consideration in the design of AIS. Recognizing that the AIS creates the abstraction of reality as seen by managers, the EIM, as a generalizable framework, illuminates the issue of managerial "blind spots" due to omission of potentially relevant information sets. Certainly the EIM provides a context-specific tool to inform about environmentally conscious information sets, but its value is greater as an exemplar of a tool for a multitude of nontraditional, but relevant, information needs.

In summary, Gladwin et al. (1995) pose the possibility that humans and their organizations have been programmed by evolutionary forces to instinctively discount over time and space. This tendency to discount portends that it will be difficult for businesses to obtain the extended mental and moral embrace required for environmental sustainability. Businesses often make decisions that ignore their long term impacts over space and time. This makes it critical that the business sector create environmentally responsible information systems if they are going to meet the growing environmental requirements imposed by society and by natural systems. We argue that integrating the environmental information matrix within AIS design increases management awareness that alternative strategies are available. By linking environmental strategies and decision scopes with information sets, we take an incremental step in helping management understand how to conserve and sustain natural systems and in helping society hold companies accountable for environmental stewardship.

This incremental approach will not solve the fundamental problems of unbridled growth and accumulation, such as bio-diversity losses, ozone depletion, deforestation, and fish population collapses. These problems require deep-seated political and social change. However, this approach is a beginning toward helping businesses address environmental problems. If businesses can incorporate data that are environmentally pertinent and decision-relevant into their information systems, then our proposed method has the potential to

inform and encourage important and progressive changes. Further, the environmental information matrix provides guidance for designing AIS that raises awareness of the impact of businesses on natural systems.

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