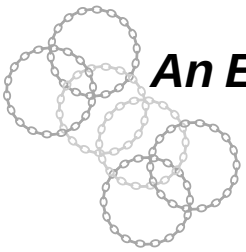

An Environmental Baldrige?

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Abstract

This study develops an integrated theory about how Total Quality Management (TQM) based capabilities can be leveraged for Environmentally Responsible Manufacturing (ERM). It suggests that efforts should be coordinated to take advantage of the potential synergies between TQM and ERM. The means for capturing these synergies might be accomplished by using the Malcolm Baldrige National Quality Award (MBNQA) framework. The MBNQA framework was adapted to address environmental issues and it was shown that the framework can be used as a basis for an integrative definition of ERM. This adaptation of the MBNQA framework suggests that there is an environmental version of the MBNQA framework and that quality principles can be seamlessly integrated into the practice of managing environmental issues. However, an empirical examination of the linkage between TQM and ERM remains untested. The findings of this study provide an important foundation for accomplishing this goal.

Keywords: Environmentally Responsible Manufacturing, Malcolm Baldrige National Quality Award, and Total Quality Management.

Introduction

Environmentally Responsible Manufacturing (ERM) is a relatively new concept which has received increasing attention by practitioners and academics alike in the last decade. ERM has been defined as an economically-driven, system-wide and integrated approach to the reduction and elimination of all waste streams associated with the design, manufacture, use and/or disposal of products and materials (Handfield, Walton, Seegers, and Melnyk 1997). Fundamental to ERM is the recognition that pollution, irrespective of its type and form, is waste. Strategies such as Just-In-Time (JIT), Total Quality Management (TQM), and Time Based Competition (TBC), have defined waste as any activity or product which consumes resources or creates costs without generating any form of offsetting stream of value (Porter 1991; Porter and Van der Linde 1995). By minimizing waste, the firm can reduce disposal costs and permit requirements, avoid environmental fines, boost profits, discover new business opportunities, rejuvenate employee morale, and protect and improve the state of the environment. When viewed in this light, it would be expected that more managers be interested in the development and use of ERM based systems. However, for most firms, ERM has not achieved the same degree of acceptance as have JIT, TQM, and TBC (Makower 1993, 1994; Epstein 1996).

By minimizing waste, (a) firm can reduce disposal costs… discover new business opportunities, rejuvenate employee morale, and protect and improve the state of the environment.

In general, a firm can assume a leadership position, in which case, management attempts to meet or exceed the level of performance demanded by regulations. Alternatively, the firm can aim for a compliance position. That is, the firm does only what is necessary to meet the letter of the law, as set down within the government regulations. The challenge of determining whether it is better for the firm to simply emphasize compliance or whether the firm wants to become recognized as an industrial leader in the development and application of ERM based systems describes the first of many obstacles and paradoxes surrounding ERM. In large part, the failure of management to become more environmentally responsible is really a reflection of its inability to address and resolve these paradoxes and problems. The following are some of the most important paradoxes and problems associated with the development and implementation of ERM systems:

- Top management must be willing to accept and champion corporate-wide developments if ERM is to become widespread (Hunt and Auster 1990; Schot 1991; Epstein 1996). However, when dealing with ERM, there is a strong bias in favor of ignorance at the highest levels of the firm (Handfield et al. 1997).

- In the short run, implementing ERM often causes costs to rise (Palmer, Oates, and Portney 1995). However, there is a real concern as to whether customers are willing to pay the added costs associated with having something that is environmentally friendly (Rosewicz 1990).
- It has been argued that being environmentally responsible ultimately makes a company more efficient and more competitive (Royston 1980; Bonifant 1994; Bonifant and Ratcliff 1994; Van der Linde 1995). However, there are many reported cases of ERM investments which have resulted in negative returns (Jaffe, Peterson, Portney, and Stavins 1994; Walley and Whitehead 1994).
- Ideally, the most appropriate place for considering ERM issues is in the design phase since the amount of waste generated is a direct consequence of decisions made during design (Bowman 1996; Fiskel 1993). However, there is a lack of appropriate measures and tools for capturing the environmental impact of designs (Van Weenen and Eeckles 1989; Allenby 1993; Graedel and Allenby 1995).
- Managers need frameworks or guidelines which they can use to better understand what ERM is and its components. However, a great deal of the information surrounding ERM is either legally based or derived from anecdotal stories and case studies (Piet 1994).
- Managers have difficulty assessing the impact of ERM measures and programs because of the lack of appropriate measures. In order for ERM to be given serious consideration by a firm, a process is required for evaluating ERM by appropriately including environmental costs and savings for each investment option (Sarkis and Rasheed 1995; Epstein 1996).

It is these paradoxes and problems which have encouraged research into ERM. Paradoxes are important because, in the case of ERM principles and practices, they have helped to limit the acceptance and use of these systems. From a research perspective, paradoxes form a foundation for identifying potential research problems (Davis 1971). However, in spite of this, research into ERM has been limited. Furthermore, ERM theory is far from being fully developed (Post and Altman 1992; Klassen 1995).

To move from anecdotes and case studies, the current focus of most ERM research, to testable models and hypotheses, it is critical that researchers develop an operational framework of ERM. At present, the ERM field lacks many of these theoretically derived frameworks for measuring ERM. Without such a framework, it is virtually impossible to encourage the development, construction, and continued refinement of theory (Bagozzi 1981). It is the primary objective of this paper to develop an operational framework of ERM that is theoretically grounded. To do this, we must begin by reviewing the appropriate body of literature.

A Review of the ERM Literature

Many different labels are used to describe companies' efforts to integrate environmental thinking into their decision-making processes. For example, Industrial Ecology, Environmental Operations Management, Total Quality Environmental Management (TQEM), Sustainable Development, and Environmentally Responsible Manufacturing are among the most popular labels used. However, a close examination of these terms highlights that they differ mostly by their labels and not in definition.

Arthur D. Little (1989) discussed the concept of Industrial Ecology which involves designing industrial infrastructures as if they were a series of interlocking man-made ecosystems interfacing with the natural global ecosystem. Industrial Ecology takes the pattern of the natural environment as a model for solving environmental problems, creating a new paradigm for the industrial system in the process.

Environmental Operations Management (EOM) has been defined as the integration of environmental management principles with the decision-making process for the conversion of resources into usable products (Gupta and Sharma 1996). EOM is viewed as a strategic level of operations management since it primarily concerns product and process design. EOM requires a thorough assessment of the operations of a firm, from the purchase of various inputs (e.g., raw materials and energy) through process control and changes (e.g., air and water pollution control, waste disposal operations, and new pollution control technology) to the output itself (e.g., green and clean products).

Sarkis and Rasheed (1995) defined Environmentally Conscious Manufacturing (ECM) as involving planning, developing, and implementing manufacturing processes and technologies that minimize or eliminate hazardous waste and reduce scrap. A major objective of ECM is to design products that are recyclable or can be remanufactured or reused. Compared to the other labels and definitions used to describe the integration of environmental issues into decision-making processes, Environmentally Responsible Manufacturing (ERM) is the most comprehensive and perhaps salient. Therefore, ERM and its definition described in the introduction will be used for the purposes of this paper.

Learning about ERM by reviewing the literature is a difficult task because of the diversity of sources contributing to its development and growth. The ERM field has been studied in areas such as political science, economics, marketing, biology, accounting, finance, strategy, and operations management. It has also been examined by academic and governmental agencies (e.g., the EPA). The literature reviewed for this article included refereed jour-

Table 1
Empirical Studies Characterizing ERM

Strategic Choice Perspective	***Stages*** ● ***or*** ■ ***or*** ▼ ***or*** ◆
Mahon, J.F. (1983)	1) avoid/neglect; 2) resistance; 3) accommodative; 4) compromise; and 5) collaborative
Logsdon, J.M. (1985)	1) resisting; and 2) accepting
Miles, R.H. (1987)	1) collaborative/problem-solving; and 2) individualistic/adversarial
Schot, J. (1991)	1) dependent; 2) defensive; 3) offensive; 4) aware; and 5) adapted
Arnfalk, P., and Thidell, A. (1992)	1) passive; 2) authority-controlled; 3) law-optimized; 4) aware; and 5) adapted
Dillon, P.S., and Fischer, K. (1992)	1) good environmental actors; and 2) bad environmental actors
Klassen, R.D. (1995)	1) reactive; 2) defensive; 3) accommodative; and 4) proactive
Vastag, G., Kerekes, S., and Rondinelli, D.A. (1996)	1) reactive; 2) proactive; 3) strategic; and 4) crisis preventive
Handfield, R.B., Walton, S.V., Seegers, L.K., and Melnyk, S.A. (1997)	1) resistance adaptation; 2) embracing w/o innovating; 3) reactive; 4) receptive; 5) constructive; and 6) proactive
Developmental Progression Perspective	***Stages*** ● → ■ → ▼ → ◆
Petulla, J.M. (1987)	1) crisis oriented; 2) cost oriented; and 3) enlightened
Arthur D. Little, Inc. (1989)	1) problem-solving; 2) managing; and 3) managing for assurance
Hunt, C.B., and Auster, E.R. (1990)	1) beginner; 2) fire-fighter; 3) concerned citizen; 4) pragmatist; and 5) proactivist
Clarkson, M. (1991)	1) reactive; 2) defensive; 3) accommodative; and 4) proactive
Marguglio, B.W. (1991)	1) insensitivity; 2) awareness; 3) enlightenment; and 4) certainty
Greening, D.W. (1992)	1) high involvement; and 2) low involvement
Post, J.E., and Altman, B.W. (1992)	1) adjustment; 2) adaptation; and 3) innovation
Flannery, B., and May, D.R. (1994)	1) individual; and 2) organizational
Greenberg, R., and Unger, C. (1994)	1) innocence; 2) awareness; 3) understanding; 4) competence; and 5) excellence
Epstein, M.J. (1996)	1) corporate environmental leader — 7) corporate environmental laggard

nals, general publications (e.g., Newsweek, The Economist), books, governmental and corporate reports, and monographs. Greater attention was given to articles appearing in refereed journals because of the rigorous reviewing process. Given that this is a relatively new field of study, the search was restricted to articles published primarily after 1980.

Based on this review, three categories of frameworks emerged: 1) anecdotal; 2) empirically based research; and, 3) formal assessment processes. The first category deals with corporate success stories and the personal experiences of people involved in the implementation and development of ERM systems and practices (e.g., Cairncross 1992; Schmidheiny 1992; Stead and Stead 1996; Makower 1993, 1994; Epstein 1996). While being the largest category in terms of the number of articles published, the anecdotal category is of limited importance since it is very difficult to generalize the resulting prescriptions.

The empirically based research category looks at applied studies that mostly chart a continuum of corporate approaches toward ERM. This research has suggested two perspectives on patterns of ERM: 1) a strategic perspective; and, 2) a developmental progression. The strategic perspective implies that distinct choices are made, while a developmental progression proposes managed growth over time (Klassen 1995). While few of these studies have attempted to determine causal relationships (e.g., with ERM performance and management methods), they have all helped identify positive traits of ERM firms. None of these studies, however, presented instruments for measuring the effectiveness of the underlying ERM constructs. A summary of the empirical ERM studies is presented in Table 1.

The third category examined popular formal assessment processes developed by such external organizations as the International Standards Organization (ISO), the Global Environmental Management Initiative (GEMI), and the Council of Great Lakes Industries (CGLI). While important to international and national assessment processes, this category does not lend itself to well-developed survey instruments.

These three categories of frameworks were used in an attempt to identify the various views of ERM. However, a review of the literature revealed the need for well-developed and theoretically based dimensions of ERM. The ERM literature is not at a level of development necessary for a more rigorous evaluation and formulation of ERM constructs. Therefore, it was necessary to look outside of the ERM field to develop an operational framework.

Developing an Operational Framework of ERM

After reviewing several other fields, it was decided to focus on the similarities between Total Quality Management (TQM) and ERM. This decision was based on the observed parallels between TQM and ERM based systems noted by numerous researchers (e.g., Habicht 1991; Shedroff and Bitters 1991; Alm 1992; Friedman 1992;

Welford 1992; Wheeler 1992; Green 1993; Makower 1993; Klassen and McLaughlin 1993; Neidart 1993; Thompson and Rauck 1993; Woods 1993; Sandelands 1994; Willig 1994; Hanna and Newman 1995; Hart 1995; May and Flannery 1995; McInerney and White 1995; Sarkis and Rasheed 1995; Shrivastava 1995; Epstein 1996; Puri 1996; Gorman and Krehbiel 1997; Rondinelli and Berry 1997; Berry and Rondinelli 1998). They all point out that TQM and ERM: 1) aim to improve a company's final output; 2) require some new definitions of leadership; 3) emphasize long-range planning over short-term considerations; 4) involve changing relationships between companies and their employees, suppliers, and, customers; 5) strive for a cultural change; 6) stress improved information, communication, training, and accountability; and 7) demand continual self-assessment and improvement.

What is implied … is that an operational framework of TQM can be adapted for ERM.

What is implied by these similarities is that an operational framework of TQM can be adapted for ERM. ERM systems are viewed as being TQM systems modified to deal with environmental issues. The evolution of quality to include the environment has been suggested by many authors (Mizuno 1988; Klassen and McLaughlin 1993, 1996; Sarkis and Rasheed 1995; Epstein 1996). The "no waste" aim of ERM based systems closely parallels the TQM goal of "zero defects." TQM focuses on waste as it applies to process inefficiencies, whereas ERM tends to focus on concrete outputs such as solid and hazardous waste. Because the two concepts share a similar focus, researchers note that it makes sense to use many of the tools, methods, and practices of TQM in implementing an ERM based system (Thompson and Rauck 1993; Epstein 1996; Gorman and Krehbiel 1997; Rodinelli and Berry 1997; Berry and Rondinelli 1998). Given this perspective, the structure of ERM systems is said to parallel or be very similar to that found in TQM systems. Therefore, developing an operational framework of ERM begins with identifying an operational framework that best fits the definition of TQM.

Total Quality Management – Defining the Concept

Based on the pioneering work of Deming, the term "Total Quality Management" (TQM) emerged over a decade ago in the U.S. and embodied a broad scope of activities within the framework of world class manufacturing (Deming 1981, 1982, and 1986). TQM itself is an integrated management philosophy and set of practices that establishes an organization-wide focus on quality, merging the development of a quality-oriented corporate culture with intensive use of management and statistical tools aimed at designing and delivering quality products to customers (Melnyk and Denzler 1996). TQM stresses three major principles: customer satisfaction, employee involvement, and continuous improvements in quality. TQM also involves benchmarking, product and service design, process design, long-range thinking, and problem-solving tools.

Logothetis (1992) describes TQM as "a culture; and inherent in this culture is a total commitment to quality and attitude expressed by everybody's involvement in the process of continuous improvement of products and services, through the use of innovative scientific methods." Perhaps one of the most salient definitions of TQM was provided by the *Report of the Total Quality Leadership Steering Committee and Working Councils* (Evans 1992). This council consists of a number of CEOs from major corporations, as well as a number of academic representatives from distinguished schools across the country. This council developed the following definition of TQM:

> a people-focused management system that aims at the continual increase of customer satisfaction at continually lower real cost. Total Quality is a total system approach (not a separate area or program), and an integral part of high-level strategy; it works horizontally across functions and departments, involves all employees, top to bottom, and extends backwards and forwards to include the supply chain and customer chain.

An Operational Framework of TQM

The beginning of this section offered several definitions of TQM (e.g., Evans 1992, Logothetis 1992, Melnyk and Denzler 1996). A series of associated traits were identified from these definitions of TQM: 1) continuous improvement; 2) meeting customers' requirements; 3) long-range planning; 4) increased employee involvement; 5) process management; 6) competitive benchmarking; 7) team-based problem-solving; 8) constant measurement of results; 9) closer relationships with customers; and 10) management commitment. Using these traits, the various constructs found in three categories of frameworks (anecdotal, empirically based research, and formal assessment processes) were reviewed to determine which framework best fits the definition of TQM (see Table 2).

Using the traits associated with TQM, and comparing these traits to the various constructs found in the literature, the Malcolm Baldrige National Quality Award (MBNQA) framework best satisfies the requirements of TQM. Since the MBNQA framework is most consistent with the definition of TQM, it will be used as the operational framework of TQM. Table 3 examines the MBNQA framework in detail.

Table 2
Definitions of TQM

Associated Traits of TQM	*Juran*	*Deming*	*Crosby*	*Saraph et al. (1989)*	*Flynn et al. (1994)*	*Powell (1995)*	*ISO 9000*	*MBNQA (Baldrige Award)*
Continuous Improvement	X	X	X	X	X			X
Meeting Customer's Requirements	X	X			X	X	X	X
Long-Range Planning	X			X				X
Employee Involvement	X	X	X	X		X		X
Process Management		X		X	X	X	X	X
Competitive Benchmarking				X		X		X
Team-Based Problem-Solving	X		X	X		X		X
Measurement of Results	X		X	X	X	X	X	X
Closer Relationships with Customers	X	X			X	X		X
Management Commitment	X	X	X	X	X	X	X	X
10 Traits Total:	8	6	5	8	6	8	4	10

The MBNQA criteria for performance excellence represent a comprehensive, integrated framework for the management of modern enterprises. The criteria have evolved based upon the accumulated knowledge of best management practices and the collective wisdom of practitioners and experts (Evans 1997a). However, the criteria have also been grounded in formal theory by design and validated via empirical research and analysis.

Several researchers have adopted the MBNQA framework as the basic operational model of TQM. For example, Dean and Bowen (1994) used it to explore the relationship between the principles of TQM and management theories. Black and Porter (1996) used it to develop their TQM survey questions, while Capon, Kaye, and Wood (1995) used it to identify measures of TQM success (also see, Choi and Eboch 1997; Dew 1994; George and Weimerskirch 1994). In cross-fertilization attempts, which is essentially the basis for using the TQM literature in this study, one is compelled to search for a framework that has been validated through generally accepted theoretical and empirical research methodologies. Such research, while preliminary, does generally exist with respect to the MBNQA criteria.

It also becomes important to recognize that the MBNQA criteria have evolved over the years and it has now become a model for major strategic initiatives that go beyond TQM. In fact, since 1997, the word "quality" does not appear in any of the headings for the categories. It is now broad enough to be used as a framework for quality and/or environmental issues. This framework can be adapted right away to develop ERM measures and constructs that are systemic in nature.

Eastman Kodak, a former recipient of the MBNQA, has started to apply the principle of TQM to its environmental management program using the MBNQA criteria. Also, some researchers (e.g., McGee and Bhushan 1993; Wever and Vorhauer 1993) describe how the implementation of ERM can be made more successful by integrating it into a TQM system embedded in the criteria associated with the MBNQA framework.

In 1994, the Council of Great Lakes Industries (CGLI) also developed a primer and self-assessment matrix for companies to develop and improve their ERM programs. The CGLI program is based on categories adapted from those used in the MBNQA framework. According to CGLI, although the MBNQA annually recognizes U.S. firms that excel in quality management and achievement, the process that underlies the award can be applied globally to measure and guide continuous improvement in all business areas, including ERM.

Drawing Parallels between TQM and ERM

There has been a great deal of discussion within the literature about TQM in environmental programs. It has been suggested by several researchers, through mostly conceptual analyses and case studies, that significant benefits arise from applying what has been learned about TQM to ERM. In these studies, the authors describe how the implementation of ERM can be made more successful by integrating it into a TQM system. In other words, the ability to reframe learnings from TQM is crucial to ERM.

For example, Klassen and McLaughlin (1993) suggested the need for an empirical investigation which examines whether firms that have advanced TQM programs in place also have more advanced environmental management programs in place than firms just initiating TQM. A case study analysis by Post and Altman (1992) identified that a firm's ability to reframe learnings

Table 3
The Malcolm Baldrige National Quality Award

1.0 Leadership *(110 points):* The *Leadership* category examines senior leaders' personal leadership and involvement in creating and sustaining values, company directions, performance expectations, customer focus, and a leadership system that promotes performance excellence. Also examined is how the values and expectations are integrated into the company's leadership system, including how the company continuously learns and improves, and addresses its societal responsibilities and community involvement.

1.1 Leadership System (80 points)
1.2 Company Responsibility and Citizenship (30 points)

2.0 Strategic Planning *(80 points):* The *Strategic Planning* category examines how the company sets strategic directions, and how it determines key action plans. Also examined is how the plans are translated into an effective performance management system.

2.1 Strategy Development Process (40 points)
2.2 Company Strategy (40 points)

3.0 Customer and Market Focus *(80 points):* The *Customer and Market Focus* category examines how the company determines requirements and expectations of customers and markets. Also examined is how the company enhances relationships with customers and determines their satisfaction.

3.1 Customer and Market Knowledge (40 points)
3.2 Customer Satisfaction and Relationship Enhancement (40 points)

4.0 Information and Analysis *(80 points):* The *Information and Analysis* category examines the management and effectiveness of the use of data and information to support key company processes and the company's performance management system.

4.1 Selection and Use of Information and Data (25 points)
4.2 Selection and Use of Comparative Information and Data (15 points)
4.3 Analysis and Review of Company Performance (40 points)

5.0 Human Resource Development and Management *(100 points):* The *Human Resource Development and Management* category examines how the work force is enabled to develop and utilize its full potential, aligned with the company's objectives. Also examined are the company's efforts to build and maintain an environment conducive to performance excellence, full participation, and personal and organizational growth.

5.1 Work Systems (40 points)
5.2 Employee Education, Training, and Development (30 points)
5.3 Employee Well-Being and Satisfaction (30 points)

6.0 Process Management *(100 points):* The *Process Management* category examines the key aspects of process management, including customer-focused design, product and service delivery processes, support processes, and supplier and partnering processes involving all work units. The category examines how key processes are designed, effectively managed, and improved to achieve better performance.

6.1 Management of Product and Service Processes (60 points)
6.2 Management of Support Processes (20 points)
6.3 Management of Supplier and Partnering Processes (20 points)

7.0 Business Results *(450 points):* The *Business Results* category examines the company's performance and improvement in key business areas - customer satisfaction, financial and marketplace performance, human resource, supplier and partner performance, and operational performance. Also examined are performance levels relative to competitors.

7.1 Customer Satisfaction Results (130 points)
7.2 Financial and Market Results (130 points)
7.3 Human Resource Results (35 points)
7.4 Supplier and Partner Results (25 points)
7.5 Company-Specific Results (130 points)

(For more details, see Curkovic & Handfield 1996 and *Malcolm Baldrige National Quality Award 1997 Award Criteria*).

from quality management programs is crucial to being environmentally responsible. Some researchers, such as Makower (1993) and Willig (1994), bring together first hand reports on how leading companies are going beyond meeting regulatory compliance to gaining a competitive advantage and improved profitability by applying TQM practices to ERM.

What is being argued is that TQM systems condition firms to be more interested in the need for an ERM system. When a TQM system precedes ERM, it increases the probability of an ERM system being present. The systemic view of TQM, encompassing both the finished product and all the activities to provide them, provides a strong rationale for an explicit focus on ERM (Klassen and McLaughlin 1993). Although originally applied to operations management for the purpose of improving product quality (i.e., reducing product waste in time, materials, and labor), the concept of TQM can be translated to the realm of ERM.

For example, companies can utilize TQM approaches to developing a system-wide and integrated approach to the reduction and elimination of all waste streams associated with the design, manufacture, use, and/or disposal of products and materials. Relevant TQM

principles which can be integrated into waste minimization programs include: 1) a systems analysis process orientation that aims to reduce inefficiencies and identify product problems; 2) data-driven tools, such as cause and effect diagrams, quality evolution charts, pareto analysis, and control charts; and, 3) a team orientation that uses the knowledge of employees to develop solutions for waste problems.

Although originally applied to operations management for the purpose of improving product quality … the concept of TQM can be translated to the realm of ERM.

3M and AT&T are also excellent examples of companies which were among the first to extend their TQM initiatives to ERM (Shedroff and Bitters 1991; Thompson and Rauck 1993). These companies utilized TQM approaches to work towards a goal of zero waste discharges. TQM principles which were integrated into their waste minimization programs included the use of pareto analysis and control charts to signal pollution problems with the manufacturing process. For example, control charts were used to determine the capability of a wastewater treatment system to operate within permit limits. Each company now reports aggregate savings and significant environmental benefits generated by using TQM concepts in environmental management.

Proctor & Gamble has used benchmarking techniques to assess conformance with elements of its own environmental management system (Sandelands 1994). The company regularly audits its facilities throughout the world in the areas of government and public relations, people capability, direct environmental impact, incident prevention, and continuous improvement. Standards in each of these areas are developed at the facility level ensuring business unit commitment and support, and a score is generated for each facility.

Sonoco's experience with materials reclamation illustrates how it used quality management principles to integrate environmental objectives (Rondinelli and Berry 1997). Sonoco's success with materials reclamation resulted mainly from the corporation's quality based culture. A strong and consistent vision from top leadership of the company was essential for environmental management. This was reflected by the chairman's "if we make it, we take it back" pronouncement. His clear environmental vision laid out an objective that each division and the corporation as a whole could strive to attain. The quality based principles also encouraged managers to seek solutions with multiple benefits. Division managers realized that interdivisional cooperation and cross-functional communication could lead to economies and opportunities both for them and for Sonoco.

By using TQM tools, methods, and practices to minimize waste, a firm can reduce disposal costs and permit requirements, avoid environmental fines, boost profits, discover new business opportunities, rejuvenate employee morale, and protect and improve the state of the environment. From an operations management perspective, simultaneous cost reduction and waste reduction can be demonstrated throughout processes in areas such as shipping and distribution costs, raw material costs, actual manufacturing and processing costs, packaging costs, costs of treatment or disposal of process emissions, landfill use costs, and customer disposal costs (Hanna and Newman 1995).

However, all of the examples assume there is a relationship between TQM and ERM. The normative literature and case studies which predominate the ERM field, suggests, but do not explicitly recognize, that in TQM there is an explainable, understandable, and documental path to ERM. Such postulated associations between TQM and ERM are based on deductive reasoning and case analysis. Unfortunately, while case studies and deductive arguments have emphasized the virtues of TQM's role in ERM, researchers have not supported these arguments with extensive systematic empirical analyses. Research directed at developing a rationally consistent theory of ERM which can be consistently related to management theories such as TQM represents an unexplored proposition.

The remaining portion of this section will review the links between the concepts of TQM and ERM in detail. Several concepts from the TQM literature will be reviewed, and parallels will be drawn with ERM. Having already identified the traits associated with TQM, and having compared these traits to the various constructs found in the literature, it was determined that the MBNQA framework best fits the definition of TQM. Since the MBNQA framework is the most consistent with the definition of TQM and is often used as the operational framework of TQM, the seven categories associated with the framework will be used to draw parallels between TQM and ERM. Parallels are drawn to further reinforce that the two concepts are so closely linked that an operational framework of TQM can be adapted for ERM. The results of this comparison are shown in Table 4.

The Operationalization of ERM

ERM will be conceptualized in terms of the basic factors described by the MBNQA framework. The 1997 MBNQA framework is described as three related subsystems (Evans 1997a, 1997b): 1) the "strategic" categories of *leadership*, *strategic planning*, and *customer/market focus*; 2) the "operational" categories of *human resource development* and *process management* (which lead to "results"); and 3) the "information" category that serves as the foundation for the other two subsystems. In

Table 4
Drawing Parallels Between TQM and ERM

Leadership

- Senior management acts as a driver for TQM implementation (Juran 1978, 1981; Tregoe 1983; Ham and Williams 1986; Kennedy 1989).
- The critical guide and motivator for the development and implementation of ERM must also come from senior management (Arthur D. Little, Inc. 1989; Hunt and Auster 1990; Bemowski 1991; Schot 1991; Makower 1993; Wever and Vorhauer 1993; Epstein 1996).

Strategic Planning

- TQM requires that product quality be defined from the customer's viewpoint and exceeding the customer's expectations can only be accomplished when organizations strategically plan and organize their resources (Juran 1978, 1981; Wheelwright 1981; Dale and Duncalf 1985; Garvin 1987).
- ERM requires that: 1) ERM issues will become an integral part of planning; and 2) a process will be in place to communicate with customers and stakeholders and include their input in planning (Herod 1989; Hunt and Auster 1990; Klassen and McLaughlin 1993, 1996; Wever and Vorhauer 1993; Epstein 1996)

Customer and Market Focus

- TQM is based on an organization's knowledge of its customers, overall customer service system, responsiveness, and ability to meet customer requirements and expectations (Ishikawa 1985; Juran and Gryna 1988; Lascelles and Dale 1989; Baum 1990; Feldman 1991).
- ERM also requires the adoption of response systems to handle the most basic of customer/stakeholder concerns or requirements (CGLI 1994; Johannson 1993; GEMI 1996).

Information and Analysis

- Fundamental to TQM is collecting relevant information from all phases of an organization's operations and using it to monitor and improve quality (Garvin 1983; Willborn 1986; Riehl 1988; Babbar 1992).
- ERM also requires extensive information collection and analysis and the latest technology for managing information resources (Bracken 1985; Johannson 1993; Orlin, Swalwell, and Fitzgerald 1993; Fitzgerald 1994; CGLI 1994).

Human Resource Management

- TQM demands that all aspects of human resource management (e.g., manpower planning, recruitment and staffing, training and development, performance appraisal, and reward systems) assume strategic roles (Cole 1980; Juran 1981; Ebrahimpour 1985; Lee and Ebrahimpour 1985; Oliver 1988; Harber, Burgess, and Barchy 1993; Longnecker and Scazzero 1993).
- The best results from ERM also can be only obtained when there is a high level of involvement and commitment from trained people (Enander and Pannullo 1990; Cook and Seith 1991, 1992; Gripman 1991; Marguglio 1991; Cramer and Roes 1993; Wever and Vorhaur 1993; May and Flannery 1995; Gupta and Sharma 1996).

Process Management

- The management of process quality examines how key processes are designed, effectively managed, and improved to achieve higher performance. The quality assurance and improvement efforts of an organization must not only include manufacturing, but also supporting functions which impact operations (Garvin 1984; Juran and Gryna 1988; Bhote 1989; Modaress and Ansari 1989; Taguchi and Clausing 1990; Benton 1991; Stein 1991).
- ERM also begins during initial product and process design. The goals of ERM can only be achieved when environmental issues and concerns are identified and resolved during the early stages of product and process design (Van Weenen and Eeckles 1989; Blacker and Fratoni 1990; Klassen and McLaughlin 1993, 1996; Wever and Vorhauer 1993; May and Flannery 1995).

Business Results

- TQM requires that companies monitor and improve their quality performance based on objective measures of quality and operational results (Reddy and Berger 1983; Fortuin 1988; Cole 1990; Fisher 1992; Curkovic, Vickery, and Forker 1999).
- Whenever ERM is implemented, measures should be identified to determine if the system is delivering the desired results (CGLI 1994; McGee and Bhushan 1993; GEMI 1996).

summary, ERM is hypothesized to consist of the following factors: 1) ERM Strategic Systems; 2) ERM Operational Systems; 3) ERM Information Systems; and, 4) ERM Results. These factors and their proposed measures span the entire range of activities deemed critical by the MBNQA framework and could be used by managers to assess their operations.

Operational Measures

Items were generated that represent manifestations of the four factors associated with ERM. Multi-item scales for each factor serve as parsimonious representations of unidimensional constructs, corresponding in similarity to each of the four factors associated with the MBNQA framework. Definitions for these factors and the selection

of items were developed from the MBNQA criteria, the ERM literature, and items from other questionnaires. Each manifestation is measured with an item in a scale. The references are shown in parentheses following each measure.

Preliminary scale development was conducted using interviews from managers. The primary objective was to provide an indication of content validity. Interviews with twelve managers in six North American manufacturing facilities were used to provide assistance in the identification and prima facie validation of the constructs and variables in the study. A lack of content validity reflects items in a measurement instrument which do not properly measure the constructs which they originally were purported to measure. Since items corresponding to the various constructs of the measurement instrument were derived from the MBNQA criteria, the ERM literature, and items from other questionnaires, content validity was more adequately assured (Bohrnstedt 1983). However, the framework was also validated for comprehensiveness and completeness in advance through interviews with these managers. Each manager provided feedback regarding the wording of items, their understandability, and the overall organization. The instrument was adjusted accordingly based on their feedback and is shown in Appendix A.

ERM Strategic Systems. An ERM Strategic System includes issues pertaining to leadership, strategic planning, and customer/stakeholder focus. More specifically, an ERM Strategic System collectively examines: 1) how senior leaders guide the company in setting directions and in developing and sustaining ERM values; 2) how the company sets strategic directions and how it determines key action plans for ERM issues; and 3) how the company determines the environmental requirements and expectations of customers and stakeholders (McGee and Bhushan 1993; CGLI 1994; GEMI 1994; MBNQA 1997). The index questions for the ERM Strategic Systems factor (questions 1–7) can be measured using a bipolar scale (e.g., strongly disagree, strongly agree).

ERM Operational Systems. An ERM Operational System includes issues pertaining to human resource development and process management. More specifically, an ERM Operational System examines: 1) how the work force is enabled to develop and utilize its full potential, aligned with the company's ERM objectives; and 2) how key processes are designed, effectively managed, and improved to achieve higher ERM performance (McGee and Bhushan 1993; CGLI 1994; MBNQA 1997). The index questions for the ERM Operational Systems factor (questions 8–13) can be measured using a bipolar scale (e.g., strongly disagree, strongly agree).

ERM Information Systems. An ERM Information System is defined as the effectiveness of an organization's collection, analysis, and use of information for environmental planning and improvement (McGee and Bhushan 1993; CGLI 1994). The index questions for the ERM Information Systems factor (questions 14-18) can be measured using a bipolar scale (e.g., strongly disagree, strongly agree).

ERM Results. ERM Results are defined as the organization's improvements in ERM (McGee and Bhushan 1993; CGLI 1994). The quantifiable measures for the ERM Results factor (questions 19–23) can be introduced by: "Please estimate the magnitude of change experienced in each environmental measure over the last three years:" These measures can be converted into a bipolar scale (e.g., ranging from 0 to 10), where 0= +100% or >, 1= +80%, 2= +60%, 3= +40%, 4= +20%, 5= no change, 6= -20%, 7= -40%, 8= -60%, 9= -80%, 10= -100% or >.

Concluding Comments

Often in the search for substantive relationships, an emerging field tends to overlook methodological issues such as measurement (Sethi and King 1994). This study has made a first attempt to preclude such a situation in the area of ERM. The ERM literature suffers from a lack of: 1) systematic scale development; 2) content validity; and 3) empirical validation. One of the primary contributions of this study has been the theoretically based development of an instrument for measuring ERM. Given that reliable and valid measures are needed for ERM constructs, which are in turn important for theory building, this study has made a first step by identifying an operational framework of ERM which is theoretically based. This study has helped to build ERM theory by identifying the major constructs, measures, and scales associated with an operational framework of ERM. However, it must still be determined if the measurement model has a satisfactory level of validity and reliability before using it to test for any substantive relationships such as the TQM-to-ERM linkage (Fornell and Larker 1981). The findings of this study provide an important foundation for accomplishing this goal. ■

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Appendix A
Environmentally Responsible Manufacturing Index

1. Environmental goals are clearly communicated to all plant personnel (GEMI 1994).
2. Environmental responsibility is emphasized through a well-defined set of environmental policies and procedures within your plant (McGee and Bhushan 1993; CGLI 1994).
3. Employees throughout your plant are evaluated on environmental performance results (McGee and Bhushan 1993; CGLI 1994).
4. Environmental requirements are used to establish a plant level environmental strategy (McGee and Bhushan 1993; CGLI 1994).
5. Adequate resources are provided to carry out environmental improvements within your plant (McGee and Bhushan 1993; CGLI 1994).
6. Processes have been developed to respond to customer/stakeholder (e.g., local community) questions and concerns regarding the environmental practices of your plant (Greening 1992).
7. Measures have been developed to determine the degree of customer/stakeholder satisfaction with the environmental performance of your plant (McGee and Bhushan 1993; CGLI 1994).
8. Human resources management within your plant is affected by environmental plans (McGee and Bhushan 1993; CGLI 1994).
9. An adequate amount of training in environmental awareness is provided to hourly/direct labor employees within your plant (McGee and Bhushan 1993; CGLI 1994).
10. An adequate amount of training in environmental awareness is provided to managers and supervisors within your plant (McGee and Bhushan 1993; CGLI 1994).
11. Environmental issues are included in the product design process (Calantone et al. 1997).
12. Environmental issues are included in the process design process (Calantone et al. 1997).
13. Performance on environmental dimensions is considered during supplier evaluations by plant and/or other company personnel (Calantone et al. 1997).
14. Environmentally-related information (e.g., changes in regulations) is used on an on-going basis by your plant (Calantone et al. 1997).
15. Information about best-in-class environmental performance is tracked and recorded by your plant (Calantone et al. 1997).
16. Environmental practices, procedures, and systems within your plant are compared with best-in-class on a regular basis (Calantone et al. 1997).
17. Environmental achievements of your plant are given prominent visibility within annual reports and other plant and/or company publications (Calantone et al. 1997).
18. Cost accounting has been used extensively by your plant for capturing and reporting environmental problems and costs (Calantone et al. 1997).
19. Pre/post consumer recyclable content of direct materials (reversed scale)
20. Volume of wastewater discharges
21. Tons of solid waste landfilled
22. Volume of hazardous waste
23. Tons of hazardous air emissions (CFCs, VOCs, carbon dioxide, methane, sulfur oxides, etc.)