Environmental and Sustainability Ethics in Supply Chain Management

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ABSTRACT: *Environmentally Conscious Supply Chain Management (ECSCM) refers to the control exerted over all immediate and eventual environmental effects of products and processes associated with converting raw materials into final products. While much work has been done in this area, the focus has traditionally been on either: product recovery (recycling, remanufacturing, or re-use) or the product design function only (e.g., design for environment). Environmental considerations in manufacturing are often viewed as separate from traditional, value-added considerations. However, the case can be made that professional engineers have an ethical responsibility to consider the immediate and eventual environmental impacts of products and processes that they design and/or manage. This paper describes ECSCM as a component of engineering ethics, and highlights the major issues associated with ethical decision-making in supply chain management.*

1. Introduction

"Ethical responsibility…involves more than leading a decent, honest, truthful life, as important as such lives certainly remain. And it involves something much more than making wise choices when such choices suddenly, unexpectedly present themselves. Our moral obligations…must include a willingness to engage others in the difficult work of defining what the crucial choices are that confront technological society and how intelligently to confront them,"[1 (p.404)] as quoted from Langdon Winner.[2 (p.62)]

The purpose of a supply chain is to supply. Ethical supply refers to the practice of providing goods and services to customers while subscribing to an ethical code. Woodhouse relates the concept of "oversupply" to ethically responsible engineering design and the proliferation of products into the waste stream.[3] The issue of ethical supply may be broadened to include all aspects of the supply chain, beyond product

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design: its goal (to supply) as well as its means (supply chain management activities). The objective of Environmentally-Conscious Supply Chain Management (ECSCM) is to consider the total immediate and eventual environmental effects of all products and processes, in order to protect the natural environment.[4] Engineering ethics is concerned with moral decision-making that arises in the practice of engineering.[5] The questions that arise when applying engineering ethics to environmentally-conscious supply chain management and design are: (1) to what extent are engineers ethically required to consider the natural environment when making design or management decisions, (2) given that there is a vast array of decisions to be made on all levels (strategic, tactical, and operational), how does engineering ethics govern and apply to those decisions, and (3) what are the potential conflicts that arise from ethical decision-making in supply chain management and design?

2. Background: Environmental Consciousness

With the objective of considering all product and process effects, the extent of environmental consideration and the scope of those effects are open to interpretation. Minimally, ECSCM is aligned with the safety, health, and welfare of the public. It may also be interpreted to imply sustainability, which requires consideration of the interests of current and future human generations. ECSCM may be even more broadly interpreted to imply environmental stewardship, defined as "the responsible use of natural resources in a way that takes full and balanced account of the interests of society, future generations, and other species, as well as private needs, and accepts significant answerability to society."[6] Under its broadest definition, ECSCM could also be aligned with contemporary environmentalism, which views nature as a "biotic community" with the following moral standard, as expressed by environmentalist Aldo Leopold: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise".[7] For the purposes of this discussion, ECSCM will refer to the control exerted over all immediate and eventual effects of products and processes associated with translating raw materials into final products, with the objective of effectively balancing the interests of today with those of future generations.

3. Ethical Requirement

Engineering ethics, like professional ethics in any domain, are created to govern the conduct of its practicing professionals. Professional ethics are therefore separate from personal ethics (an individual's own morality that guides his or her own conduct) or common morality (a set of commitments that guide the conduct of cultures or societies).[8] Indeed, professional ethics are designed to set moral standards beyond those set by law, the market, and common morality.[9] For the purposes of this discussion, engineering ethics will refer to the set of ethics that guide the conduct of engineers. Here, we focus on engineering ethics as applied to supply chain design and management, as these ethics are invoked within the functional areas of management, often by practicing engineers. It is important to note that engineering ethics is typically divided into two categories: engineering macroethics (collective social responsibility of the engineering profession) and engineering microethics (responsibility of an individual engineer to his or her clients).[1] This discussion will primarily focus on macroethics, as it relates to environmental protection.

3.1 Engineering Codes

The first step in identifying the ethical environmental responsibility for practicing engineers is to understand what the engineering codes have to say about professional responsibility to the environment. We will focus on the general engineering codes, which are designed to guide engineering conduct across all engineering disciplines. In this section, we examine the Codes of Ethics for Engineers set forth by the Accreditation Board for Engineering and Technology (ABET) and the National Society of Professional Engineers (NSPE).[10] Each of these Codes is organized differently. The ABET Codes are divided into Fundamental Principles (basic laws) and Fundamental Canons (standards or criterion for action). The NSPE Codes are divided into Fundamental Canons and Rules of Practice. The environment-related responsibilities set forth by these two general codes fall into two basic categories: (1) those related to public safety, health, and welfare and (2) disclosure responsibilities.

Public Safety, Health and Welfare:

- "Engineers shall hold paramount the safety, health, and welfare of the public." (NSPE)
- "Engineers shall at all times strive to serve the public interest…and work for the advancement of the safety, health, and well-being of their community." (NSPE)
- "Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties" (ABET).
- "Engineers should…work for the advancement of the safety, health, and well-being of their communities." (ABET)
- "Engineers should be committed to improving the environment to enhance the quality of life." (ABET)

Disclosure:

- "Engineers having knowledge of any alleged violation of this Code shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required." (NSPE)
- "Should Engineers observe conditions which they believe will endanger public safety or health, they shall inform the proper authority of the situation in writing and shall cooperate with the proper authority in furnishing such further information or assistance as may be required." (ABET)

In addition to the general codes described above, there are also engineering codes that are specific to particular engineering disciplines, typically set forth by individual professional engineering societies. The three predominant discipline-specific engineering codes are from the American Society of Civil Engineers (ASCE), the Institute of Electrical and Electronics Engineers (IEEE), and the American Society of Mechanical Engineers (ASME). While there are many similarities across the discipline-specific codes, they do contain important differences. The ASME codes are very similar to those set forth by ABET, the IEEE codes focus primarily on responsible decision-making and disclosure, and the ASCE code places more emphasis on sustainable development.

As observed by Harris, Pritchard, and Rabins,[8] the strength of the collective responsibilities set forth by all of these codes may be identified by their use of the words "shall" and "should"; whereas "shall" implies a requirement, "should" implies a recommendation. This distinction can be applied to the NSPE and ABET Codes to summarize an engineer's ethical responsibility as it pertains to the environment.

Requirements. Engineers <u>must</u>:

- Hold most important the safety, health, and welfare of the public.
- Report code violations to the proper authorities.
- Cooperate with and provide assistance to those authorities, as needed.

Recommendations. Engineers <u>should</u>:

- Work towards advancing the safety, health, and welfare of the public.
- Commit to protecting the environment and enhancing the public's quality of life.

3.2 Levels of Ethical Responsibility

The following commonly used frame of reference will be helpful in understanding the different levels of ethical responsibility.

- Minimalist: Engineers must follow the standard operating procedures of their profession, as bound by their employment. The objective of the minimalist is to avoid blame and liability. This is the most common philosophy of engineering practice for most companies worldwide.[3]
- Reasonable Care: Engineers must consider those at risk of harm from any given activity. The engineer practicing reasonable care will evaluate the risk associated with a technology and/or action and provide proportional protection to society.
- Good Works: Engineers will act "above and beyond the call of duty" – beyond what can be reasonably expected. The good works engineer will often devote his or her own time to examine potential hazards and take extraordinary steps to safeguard against those hazards.

Thus, the answer to our first question is: the engineering code requirements as applied to environmentally ethical behavior (discussed in Section 3.1) mandates conduct in the range of "reasonable care", but recommends "good works" conduct. That is, engineers are required to protect the environment, inasmuch as it affects public safety, health, and welfare (reasonable care), but should seek out ways to protect the environment and the quality of life, safety, health, and welfare of the public (good works). It is important to notice here that the engineering codes are completely anthropocentric. That is, the codes imply that only humans have intrinsic value ("safety, health, and welfare of the (implied: human) public"), which thereby imply that the non-human environment has value only insofar as it is useful or appreciated by human beings (instrumental value), in contrast to non-anthropocentric ethics that hold that some natural objects other than human beings have intrinsic value.[8]

4. Supply Chain Management and Design Decisions

ECSCM may be placed underneath the umbrella of corporate social responsibility (CSR). The framework suggested by Carroll[11,12] categorizes CSR into four groups:[11-13]

(1) Economic responsibilities: supply products and services.
(2) Legal responsibilities: obey laws.
(3) Ethical responsibilities: conduct business in a way that is morally consistent with the beliefs of society; not required by law.
(4) Philanthropic responsibilities: engage in activities beyond responsibility and expectation.

While much of the CSR literature focuses on the economic, legal, and ethical responsibilities of the firm, the vast majority of the work in ethical responsibilities centers on buyer-supplier relationships and safety. However, this paper focuses on ethical responsibilities in supply chain management and design, specifically as they relate to environmental protection. The focus of this discussion is on specific environmental supply chain management and design decisions within the control of the enterprise and does not cover the ethics of buyer-supplier relationships. The ethics of buyer-supplier relationships are examined elsewhere.[14-17]

Moreover, the ethical discussion here focuses on the major environment-affecting decisions faced by decision-makers operating within an open-loop, enterprise-controlled supply chain.

Therefore, thorough treatments of reverse logistics and product recovery, as well as safety (secure logistics), are beyond the scope of this discussion. However, we would be remiss if we did not briefly address the issue of product disposal. As noted by Beamon,[4] product and process stewardship refer to the practice of considering all immediate and eventual environmental effects of all supply chain products and processes. The classical implementation of stewardship is life cycle analysis, or life cycle assessment (LCA). LCA is defined as "a method to evaluate the environmental burdens associated with a set of business processes, assess the impacts on the environment, and evaluate opportunities for improvement".[18] More specifically, LCA considers the effects of all process inputs (e.g., energy, raw materials) and outputs (e.g., the product itself, solid wastes, airborne emissions) on the environment and identifies methods for reducing those impacts. From the ethical perspective, the LCA "consideration" could be evaluated based on any of the three levels of ethical responsibility discussed in Section 3.2. For example, if during the LCA, an engineer were considering the airborne emissions resulting from a particular process, the level of consideration is the ethical issue: whether this consideration is "minimalist" (ensure the emissions are lawful), exhibiting "reasonable care" (consider risks to society with proportional safeguards), or exhibiting "good works" (consider all possible risks to society with extraordinary safeguards), the level of consideration would determine the level of ethical responsibility demonstrated by the analysis. (Readers who are interested in LCA are referred to Fiksel,[18] Masters,[19] and Cattanach et al.[20])).

The first step to understanding the second question, how engineering ethics governs and applies to supply chain management and design decisions that affect the environment, is identifying those decisions. Table 1 below illustrates the major decisions made on the three levels of decision-making (strategic, tactical, and operational). These decisions are grouped by decision type (facility location, material flow, information, and customer service).

Table 1. Supply Chain Management and Design Decisions (modified from[21-22])

Type of Decision	Strategic	Tactical	Operational
Facility Location	Number of Facilities Number of Echelons Facility Locations	Facility Design	
Material Flow	Transportation Mode Selection Supplier Selection Distribution Center-Retailer Assignments Plant-Product Assignments Inventory Positioning Strategies Distribution Strategies	Inventory Control Policies Stock Rotation Policies	Production Scheduling Replenishment Quantities Replenishment Intervals Carrier Routing and Scheduling Order Expediency Mechanisms
Information	Information System Design Information Protocol Selection Information Policies	Demand Forecasting Methods Periodic Statistics Reporting	Real-time Information Control
Customer Service	Standards and Objectives	Order Priority Rules	

The decisions in Table 1 have varying magnitudes of effect on the natural environment. Table 2 focuses only on those decisions that have a comparatively substantial effect on the natural environment.

Table 2. Supply Chain Decisions and their Effects on the Environment

Type of Decision	Potential Environmental Effects
Strategic Facility Location	Strategic decisions pertaining to facilities affect the natural environment by affecting natural habitats (ecosystems), humans, and animals, primarily through habitat destruction, increased air, water, and noise pollution and energy consumption.
Material Flow (all levels)	Decisions pertaining to transportation modes and material movement have significant effects on energy consumption and motor vehicle congestion (and subsequently air and noise pollution).

Therefore, in terms of internal supply chain management and design, the decisions most substantially affecting the environment are strategic facility location and material flow. These decisions are most substantial since they are both likely to disturb the external environment through emitted pollutants (noise, air, water) and energy consumption. The environmental effects of the remaining decisions that were not selected for Table 2 are either relatively small or secondary.

5. Practicing Ethics in Supply Chain Management and Design

Engineers should apply ethical decision-making to supply chain management and design decisions, and identify the potential barriers that exist to such decisions.

5.1 Applying Ethical Decision-Making

In practicing ethical supply chain decision-making, one can adapt the steps of ethical decision analysis (modified from Harris, Pritchard, and Rabins):[8]

1. Identify the facts associated with the decision.
2. Identify the ethical considerations (environmental concepts or principles) that affect the safety, health, and welfare of the public.
3. Take necessary action to ensure that the resulting decision holds as most important the safety, health, and welfare of the public.

The type of resulting ethical decision in step three will be referred to as either a Proper Engineering Decision (PED) or a Proper Management Decision (PMD). A PED is a decision based on engineering expertise that follows the engineering codes of ethics and a PMD is a decision relating to the overall well-being of the organization that does not force engineers to compromise ethical standards.[8] The actions described in the examples below are PEDs that must be supported by PMDs.

<u>Example 1:</u> New Facility Location.

- *Step 1:* Facts associated with the decision. Given a set of objectives and constraints, determine the best location for a new facility.
- *Step 2:* Ethical considerations. The construction and operation of the new facility affects the natural environment by affecting natural habitats (ecosystems), primarily through habitat destruction and increased air, water, and noise pollution. As the engineering codes do not provide for broad protection of ecosystems, the ethical consideration in this case is to the public in terms of the effect of increased energy use, as well as increased air, water, and noise pollution.
- *Step 3:* Necessary action. In determining the location and construction plans for the new facility, take action to reduce the effects of increased air, noise, and water pollution on the public. Actions: take steps to minimize total material and personnel travel distances to and from the facility, make provisions to avoid run-off from construction activity and new pavement, consider noise-abatement strategies, and take steps to reduce the air pollution effects of the new facility, particularly with respect to population centers.

<u>Example 2:</u> Inventory Control Policy.

- *Step 1:* Facts associated with the decision. Given a set of objectives and constraints, determine the best inventory control policy.
- *Step 2:* Ethical considerations. The selected inventory control policy has significant effects on ecosystems and the public, primarily through noise pollution, increased energy use, and increased motor vehicle congestion (and subsequently air pollution). As the engineering codes do not provide for broad protection of ecosystems, the ethical consideration in this case is to the public in terms of the effects of increased motor vehicle congestion and air pollution.
- *Step 3:* Necessary action. In designing the inventory control policy, take action to reduce motor vehicle congestion and air pollution. Actions: take steps to minimize total material movement to and from the facility by: order/delivery consolidation, accepting larger inventories by lengthening or shortening shipment intervals to avoid rush hours, reducing the number of shipments, or scheduling truck traffic density patterns to be acyclic to passenger car traffic.[23] Other actions include considering noise-abatement strategies and taking steps to reduce the air pollution effects of the new facility, particularly with respect to population centers.

Therefore, the answer to the second question is given in Table 1 and illustrated by the above examples. The examples highlight the need to extend traditional analysis to include an assessment of public environmental risks and actions to mitigate or eliminate those risks.

5.2 Barriers to Ethical Decision-Making

The final question to address is what types of potential conflicts arise from ethical decision-making in supply chain management and design. The first step is to recognize that there is pervasive industry reluctance to care for the environment. This reluctance follows from two different, but related, commonly-held anti-environment paradigms:

1. Crisis-Oriented Environmental Management: Environmental management hampers business performance.[23] Businesses should not cooperate with the government or anyone else who detracts from the purpose of business: to make money.[8]

2. Cost-Oriented Environmental Management: Environmental regulations are a cost of doing business, nothing more.[8]

These two paradigms pose substantial barriers to ethical engineering and management decision-making, as they pertain to the environment.

Additionally, as observed by Brumsen and van de Poel,[9] it is important to differentiate between the ethical scope and responsibility of engineering professionals and what those professionals can be reasonably expected to do, given their role within the organization, technical expertise, and level of autonomy. That is, in order to act ethically, engineers may risk their job, their career, and possibly their freedom, as in the case of the Aberdeen Three.[a] So, while the engineering codes clearly require that engineers protect human safety, health, and welfare, in some situations it may be practically impossible, or at least very costly.

These risks can present a special conflict if the consequences of a decision are scientifically uncertain. But, as pointed out by Manion,[24] the ethics of this situation is governed by the "precautionary principle" as "When an activity raises threats of harm to human health and the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."[24 (p.40)] The author goes on to interpret the principle to mean that scientific uncertainty about whether a technological process or system poses a threat does not allow decision-makers to ignore potential negative consequences and do nothing to prevent them.[24]

The ongoing conflict between ethical concerns and job security highlights a need for effective legal protections. Existing laws that would protect engineers in this situation fall under the umbrella of the so-called whistle-blower laws. In the United States, these laws are a combination of industry-specific federal legislation that contain some whistle-blower protections (e.g., The False Claims Act, the Civil Service Reform

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a. "The Aberdeen Three" refers to three chemical engineers (Carl Gepp, William Dee, and Robert Lentz) who, in 1988, were charged and convicted of illegally handling, storing, and disposing of hazardous chemicals at the United States Army's Aberdeen Proving Ground, in violation of the U.S. Resource Conservation and Recovery Act (RCRA). Even though they did not directly handle the chemicals, they managed those who did and therefore bore the responsibility. Although the maximum sentence for each defendant was 15 years and $750,000 in fines, they were able to escape with relatively light sentences of community service and probation.[8]

Act), state statutes (that vary dramatically from state to state), and judicial precedent.[25] The limitations of these existing protections are:[25]

- At the federal level, there is no unified body of whistle-blower laws. The protections that do exist are across seven separate pieces of legislation, and depend on the type and location of the employer, the status of the employee, the type of offense that the employee reported, and the steps the employee took before he or she blew the whistle.
- The state whistle-blower statutes vary widely across states, but in many cases may not be invoked, since many state laws provide for employers to fire non-contract employees for any reason (or none at all). Non-contract employees are called “at will employees”. While most states recognize an exception to the at will law when an employee refuses to act in a way that public policy would condemn, there is no legal consensus for what actions invoke the public policy exception.

Moreover, the legal job protection offered to an engineer engaged in ethical decision-making varies greatly, and depends on the specific circumstances. This suggests a need for strong, clear, and unifying legislation to protect engineers across industries and circumstances.

6. An Environmental Engineering Ethic

The general and discipline-specific engineering codes mandate a limited (protect today’s human interests only) reasonable care (consider risks and provide proportional protection) level of environmental consideration. However, there seems to be room for an ethic that moves closer to sustainability, particularly as a means of being consistent with the principles of ECSCM described earlier. The World Federation of Engineering Organizations (WFEO) Model Code of Ethics, consistent with ECSCM, provides a more environmentally comprehensive ethic that requires sustainability through good works engineering practice.

The WFEO is a non-governmental international organization comprised of members from national engineering organizations representing over 80 nations (including the United States).[26] In 2001, the WFEO adopted a Model Code of Ethics, which consists of: Broad Principles, Practice Provision Ethics, Environmental Engineering Ethics, and Conclusion. The Environmental Engineering Ethics, in Part III of the Code, specifies that engineers *shall*:[27]

- “…Promote a healthy and agreeable surrounding for all people, in open spaces as well as indoors.”
- “…Strive to accomplish the beneficial objectives of their work with the lowest possible consumption of raw materials and energy and the lowest production of wastes and any kind of pollution.”
- “Discuss…the consequences of their proposals and actions, direct or indirect, immediate or long term, upon the health of people, social equity and the local system of values.”

- "…Assess all the impacts that might arise in the structure, dynamics and aesthetics of the ecosystems involved, urbanized or natural, as well as in the pertinent socio-economic systems, and select the best alternative for development that is both environmentally sound and sustainable."
- "Promote a clear understanding of the actions required to restore and, if possible, to improve the environment that may be disturbed, and include them in their proposals."
- "Reject any kind of commitment that involves unfair damages for human surroundings and nature, and aim for the best possible technical, social, and political solution."
- "Be aware that the principles of eco-systemic interdependence, diversity maintenance, resource recovery and inter-relational harmony form the basis of humankind's continued existence and that each of these bases poses a threshold of sustainability that should not be exceeded."

The preceding principles are requirements, as implied by the words "engineers *shall*". These principles go well beyond the ethical responsibilities set forth by ABET, NSPE, ASCE, IEEE, and ASME in that they specifically *require* sustainability, and gives a clear mandate to extend environmental protection beyond the interests of humans, to include the entire ecosystem.

If we revisit our two examples from Section 5, we will notice that the ethical considerations (step 2) and actions (step 3) would differ, if we were to apply the WFEO Model Code of Ethics instead of the general engineering codes. For Example 1 (New Facility Location), in addition to the ethical considerations of increased air, water, and noise pollution, the WFEO Model Code would require consideration of habitat destruction. The resulting actions would be amended to include protection of the habitats disturbed by the new construction and material flow activities. Example 2 (Inventory Control Policy) would change similarly, now mandating consideration of and protection of ecosystems. Additionally, for both examples, the WFEO Model Code would require additional effort in seeking to minimize (not simply mitigate) energy consumption and wastes, considering long-term effects on habitats and socio-economic human systems (under the principles of sustainability), and seeking to restore and improve any areas disturbed by the new activity.

Clearly, implementing the WFEO Model Code of Ethics would require a fundamental paradigm shift in supply chain management. The WFEO Codes suggest a need for what Woodhouse[3] referred to as "preventive engineering", which would require engineers to integrate sustainability into their traditional engineering practice. They also imply a mandate for supply chain modeling (engineering research). In addition to revenue or cost-based aspects, new models must integrate environmental aspects (performance measures and decision variables) as well, as a means of studying the possibilities of achieving simultaneous high-performance supply and environmental protection.

7. Summary and Concluding Remarks

The primary objectives of this paper were to answer the following questions:

1. *To what extent are engineers ethically required to consider the natural environment when making supply chain design or management decisions?* According to the general and discipline-specific engineering codes, engineers are required to protect the environment, inasmuch as it affects public safety, health, and welfare, but are encouraged to seek out ways to protect the environment and the quality of life, safety, health, and welfare of the public. However, according to the WFEO codes, engineering responsibility extends beyond the boundaries of the safety, health, and welfare of the public, to require environmentally sustainable conduct that protects the entire ecosystem.
2. *How does engineering ethics govern and apply to decisions in supply chain management and design?* Engineering ethics primarily applies to decisions involving strategic-level facility location and material flow. The potential environmental effects resulting from these decisions include increased air, noise (and sometimes water) pollution. These potential effects can be reduced or sometimes eliminated by taking appropriate actions.
3. *What are the potential conflicts that arise from ethical decision-making in supply chain management and design?* The potential conflicts include the two pervasive anti-environment paradigms (crisis-oriented and cost-oriented environmental management) and the difficulty that arises when comparing the ethical scope and responsibility of engineering professionals and what those professionals can be reasonably expected to do. Existing whistleblower legislation is inadequate in resolving the conflicts between an individual's ethical concerns and his or her need for job security.

It is clear that there is a gap in the body of supply chain research (and likely research in other fields of engineering, management and business). That is, there are many decisions to be made on the strategic, tactical and operational level of technological systems that may significantly affect present and future ecosystems. The conclusion to be drawn, as observed by Woodhouse,[3] is that engineers must "figure out what constitutes an appropriate balance among our individual tastes, the rights of others [today and in the future]…and the larger collective good."[3 (p.25)] A research agenda in this area would include the study of ethical issues as they relate to other fields involving the development and management of technological systems, techniques to minimize barriers to ethical decision-making (including guidelines for reasonable expectations for practicing engineers and legislation to protect engineers making ethical decisions), and approaches to integrate ethical principles into traditional research and practice.

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