

What is the Relationship Among Cleaner Production, Pollution Prevention, Waste Minimization and ISO 14000?

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Introduction

In the last 15 years there has been a growing world wide movement among government and industry to change the way industry interacts with the environment. The focus of this movement has been to reduce environmental impacts from industry through changes in industrial behavior and technology. There are a number of terms that are used to describe both the movement and the approaches being used. All of them are based on what is commonly known as the “Precautionary Principle,” also known by the old saying, “an ounce of prevention is worth a pound of cure.” It is better, and usually much less expensive, to prevent environmental problems from happening than to fix them once they are created. And if we don’t know what effects our actions will have on the environment, we should proceed with caution and try to minimize any potential effects that might occur.

Debate has occurred around the world about just what to call this approach. Although this might seem trivial at first, it is actually quite important. The reason is that the right terminology is needed to communicate the concepts to the public and in particular to industry executives. Experience clearly shows that executives respond to words or phrases that imply profits or better business management, and do not respond well to words or phrases that imply actions motivated by anything other than business reasons. If we want to communicate to industry, we have to use words they are willing to hear.

The objective of this paper is to briefly define the most common concepts used for industrial environmental management and to show their relationships. These relationships are the real point of this paper. There are many actions industry can take, from the small to the very large, along a path or staircase that leads to increasingly broad impacts on and interactions with the environment and society. Many industries are working their way up this staircase using the operational concepts that located on the lower levels. No industry, and no society, is really at the top of the staircase; the top, which is sustainable development, is, like quality, a goal which is always elusive and for which we should never stop striving.

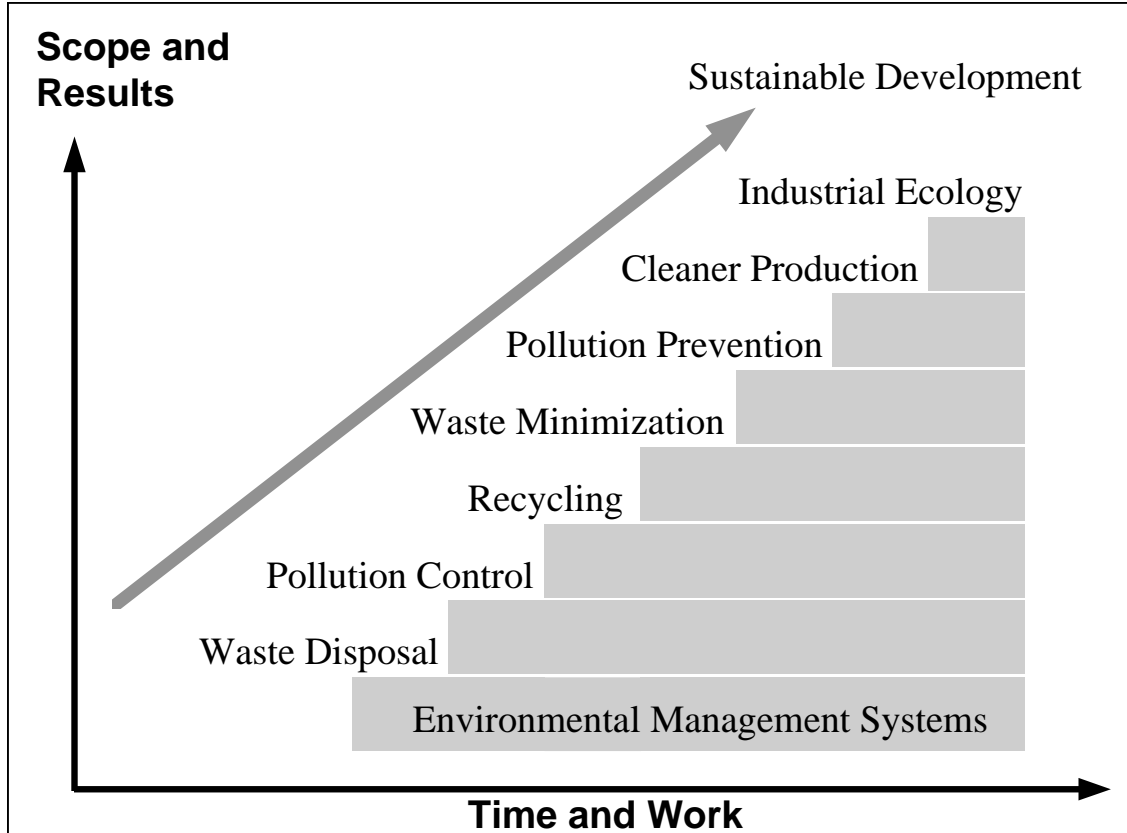
Another objective of this paper is to comment on the use of the definitions in the “real world”. Some of the terms are applicable in some places and not in others. Other terms should not be used when trying to interest industry in the concepts! It is hoped that the commentary will be useful in marketing the concepts to industry, and in particular to the Asian chemical industry.

It is not the objective of this paper to be authoritative about what all the terms mean. There has been enough debate already about this. Key definitions are cited for those who care about authority. The rest of us need to get on with explaining to the rest of the world just what we are talking about.

The Staircase of Concepts

The concepts of environmental management practice should be understood to be a kind of staircase. The various concepts make up the steps. Concepts higher up the staircase include the concepts below, and add additional elements of scope and complexity. The art and science of business management increases as one moves up the staircase (Fig. 1).

Figure 1. Staircase of Concepts in Industrial Environmental Management



The concepts on the staircase are, from highest to lowest,

- Sustainable Development
- Industrial Ecology
- Cleaner Production
- Pollution Prevention
- Waste Minimization
- Recycling
- Pollution Control
- Waste Disposal

The relationship between these terms is thus one of subsets and supersets. The lower terms are part of the higher terms. The highest term, sustainable development, includes other “staircases” of concepts such as population control, natural resource management, and economic development, as well as the staircase of industrial environmental management which is discussed here.

There are three types of concepts on the staircase. The macro-scale concepts of sustainable development and industrial ecology extend far beyond the firm and include relationships between companies, social institutions, the public and the environment in all its facets. The firm-wide concepts of environmental management systems and cleaner production address all aspects of the firm’s operations, from use of natural re-

sources to suppliers to production to product use to product disposal. The remaining operational concepts address specific functions of the business.

Environmental Management Systems are NOT on the staircase. EMS is simply a system for organization of environmental affairs and actions, not action itself. An EMS can address only one step on the staircase or the whole staircase, depending on the choices made by managers. The relationship of EMS and the ISO 14001 EMS standard to the other concepts is framework to action. One could say that EMS holds the staircase up; how high the staircase is depends on the vision and ambition of leaders.

Macro-Scale Concepts

Sustainable Development

Definitions:

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

Thus the goals of economic and social development must be defined in terms of sustainability in all countries -- developed or developing, market-oriented or centrally planned. Interpretations will vary, but must share certain general features and must flow from a consensus on the basic concept of sustainable development and on a broad strategic framework for achieving it.”¹

Relationship with Other Terms

Cleaner production, pollution prevention, etc. are all subsets of the concept of sustainable development, which states the basic problem that the other concepts attempt to address: There are limits to what the environment can tolerate, and society needs to ensure that development today does not cause environmental degradation that prevents development tomorrow. There are many issues here but the role of industry and industrial pollution is obvious. Industrial systems and individual companies will need to make changes in order to prevent future generations from being unable to meet their own needs. Sustainable development is thus the long-term goal of individual companies rather than a business practice.

Commentary

The definition above appears to be the most widely accepted, largely because of the large number of prominent people who participated in developing it. There are many other definitions of sustainable development. The discussion of which definition is best has been distracting and in some ways counterproductive, because sustainable development is a goal, not a thing. “Sustainable development” has become controversial in some circles, with some free-market advocates, conspiracy theorists and resource utopians (“there will always be enough for everyone”) claiming that it is a code phrase for global restrictions on individual and company freedoms, using the premise that in a limited world someone must make decisions about who gets what. Certainly, very few executives are interested in participating in discussions about sustainable development, which inevitably turn into arguments about politics and society. The real problem with the phrase is that it does not include or imply real actions in any particular dimension, so no one knows what to really do about it.

This term should generally not be used in promoting behavior changes to industry, for the reasons above. My experience is that including “sustainable development” in any promotional materials guarantees that almost no business executives will show up. It is best used as a frame for discussion. If there is agreement that, in fact, the world’s environmental resources really are limited, then the discussion can move directly into what are the practical strategies that firms can use.

The chemical industry is critical for sustainable development because of its primary role in the production processes of so many industries. Perhaps the greatest challenge to the industry is the design of chemical products that do not bioaccumulate or create long-term and subtle effects such as endocrine disruption that are only now starting to be recognized. The other great challenge is to achieve zero discharge of production wastes. Sustainable development also includes practices that enhance community welfare and protect natural resources such as forests, which in the long run lead to a better business environment.

Industrial Ecology

Definitions:

“Industrial ecology is the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a system view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to product, to waste product, and to ultimate disposal. Factors to be optimized include resources, energy and capital.”ⁱⁱ

“The aim of industrial ecology is to interpret and adapt an understanding of the natural system and apply it to the design of the manmade system, in order to achieve a pattern of industrialization that is not only more efficient, but that is intrinsically adjusted to the tolerances and characteristics of the natural system. The emphasis is on forms of technology that work *with* natural systems, not *against* them... Applied industrial ecology is an integrated management and technical program including:

1. The creation of industrial ecosystems
2. Balancing industrial input and output to natural ecosystem capacity
3. Dematerialization of industrial output
4. Improving the metabolic pathways of industrial processes and materials use.
5. Systemic patterns of energy use
6. Policy alignment with a long-term perspective of industrial ecosystem evolution.”ⁱⁱⁱ

Relationships

Industrial ecology can be considered the “production” component of sustainable development. The most important aspect of industrial ecology is the idea of industry as an system in which there is no waste at any step because all “waste” is a resource for another part of the industry network. Individual firms participate in industrial ecology by considering how their activities fit into the larger industrial system, for example, what other industries can use our company’s wastes as inputs, and how can we work with them? This concept is thus one of the relationship and dynamics between companies. To make industrial ecology work of course requires conscious application of the lower level concepts on the staircase as well as a motivation to sustainable development.

Industrial ecology is the most realizable macro-scale goal of the concerned executive. Sustainable development is a fuzzy concept, but partnering with other industries to turn wastes into profits, or using others' wastes as free resources, is not fuzzy at all. The concepts below industrial ecology are all fundamental to making industrial ecology successful.

Commentary

The two definitions above can be considered about the most authoritative ones available simply because there are not very many publications on the subject. Industrial ecology is still a very new concept and phrase, and is not recognized by most industry executives. It requires an understanding of the basic principle of ecology, which is dynamic feedback systems. Most executives (and most people) do not think that way, and will not intuitively understand what the phrase industrial ecology is trying to say. Other phrases that might be more easily understood yet mean somewhat of the same thing are cross-industry partnerships, vertical AND horizontal integration, or waste exchange. It is still too early for industrial ecology to be widely used in promoting behavior changes to industry or even in getting their attention, but the principles of zero waste and maximum efficiency through materials exchanges will interest any executives once we have their attention through other terms.

The chemical industry has tremendous opportunities for applied industrial ecology. The unavoidable wastes of many chemical companies could be turned into new chemical products by others if enough will-power is focused. Designing chemicals to do more with less increases the industrial system's metabolic efficiency, as does using inputs derived from natural renewable sources such as plant stocks instead of non-renewable petroleum. Increased vertical and horizontal integration can create significant competitive advantages as well as increasing management and product efficiencies.

Firm-Wide Concepts

These are concepts that affect the whole scope of the business enterprise, not just parts of it. They are essentially management philosophies and practices rather than technical practices and as such are best directed to the top levels of management.

Cleaner Production

Definitions

“Cleaner production means the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment. For production processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes before they leave a process. For products, the strategy focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product. Cleaner production is achieved by applying know-how, by improving technology, and by changing attitudes.”^{iv}

“The conceptual and procedural approach to production that demands that all phases of the life-cycle of products must be addressed with the objective of the prevention or minimization of short and long-term risks to humans and the environment.”^v

Relationships

Cleaner production is a broad concept that addresses all aspects of inputs, production and outputs. It is a firm-wide concept rather than an operational concept because it explicitly includes attitudes and manage-

ment philosophy as well as business practices. Cleaner production is what a good EMS is supposed to implement, and includes the other practices described below. It is broader in scope than pollution prevention in that it explicitly includes product design and use, which is not commonly associated with the pollution prevention concept.

Commentary

Cleaner production (CP) is a phrase that originated with the United Nations, so their official definition is used here. CP is used in most countries instead of pollution prevention, which is primarily used in the USA, although most people consider the two to mean basically the same thing. It is critical to note that the word is “cleaner”, not “clean.” There is no agreement on what constitutes “clean” production; even with zero discharge, toxic chemicals may be used and passed on to customers. The point is that, like quality, being cleaner is an endless journey, a management process.

Cleaner production is being increasingly accepted around the world, primarily due to its marketing by the UN, and also due to its “friendly” connotations to industry. The focus is on production, and on doing better, not on creating no pollution at all. In my experience, most executives like “CP” better than “pollution prevention” because of these reasons. Unfortunately, it is still hard to get management attention using the phrase cleaner production because it implies an environmental motivation rather than a purely profit motivation. Nonetheless, CP is being promoted globally by the UN and is likely to become the phrase of choice in conversation with industry.

Because it is a broad concept that specifically included product design, CP is the term of choice for the chemical industry. The industry’s technology evolves continuously, so being cleaner is often something that can be achieved by using the latest, most competitive technology. The industry’s Responsible Care Code of Conduct incorporates the concepts of CP very well, especially the concept of product stewardship.

Pollution Prevention

The USA Pollution Prevention Act of 1990 defines “pollution prevention” as a goal which is realized through source reduction.

“The term "source reduction" [or pollution prevention] means any practice which (i) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and (ii) reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. The term includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. The term "source reduction" does not include any practice which alters the physical, chemical, or biological characteristics or the volume of a hazardous substance, pollutant, or contaminant through a process or activity which itself is not integral to and necessary for the production of a product or the providing of a service.”^{vi}

“Pollution prevention is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. It includes practices that reduce the use of hazardous materials, energy, water, or other resources and practices that protect natural resources through conservation or more efficient use.”^{vii}

Relationships

Pollution Prevention (P2) is very similar to CP but is more focused on the manufacturing process. Product design is mentioned, but the priority is on using less toxic chemicals and reducing the generation of waste at the source. So P2 is a little less broad than CP and thus is a step lower on the staircase. P2 is one of the things that a good EMS should implement.

Commentary

P2 is a uniquely American term and is not widely used elsewhere. It has been subject to a tremendous amount of debate about definitions, with the more ideological environmentalists saying that it should not include recycling, which narrows its scope even more. When used in industry there is immediate confusion with pollution control. I have had many executives tell me, "I am preventing pollution, see my pollution control equipment!" In the normal way we talk about prevention and pollution, they are quite right, they are preventing pollutants from entering the environment in excessive amounts. Because it is commonly associated with pollution control, promotion of the phrase P2 generally ends up being directed to environmental engineers, not production staff or top management. I do not recommend it being used in promoting environmental management to industry; CP is a better phrase.

The US chemical industry has adopted P2 as one of the key elements of the Responsible Care code, but have expanded the definition to include recycling and re-use.

Operational Concepts

Waste Minimization

Definitions

"Waste Minimization (WM) is the reduction, to the extent feasible, of hazardous waste that is generated or subsequently treated, sorted or disposed. It includes any source reduction or recycling activity undertaken by a generator that results in either (1) the reduction of total volume or quantity of hazardous waste, or (2) the reduction of toxicity of hazardous waste, or both, so long as such reduction is consistent with the goal of minimizing recent and future threats to human health and the environment."^{viii}

Relationships

WM is a subset of pollution prevention and cleaner production that is primarily focused on the production process. Although some argue that it includes source reduction, most people understand WM to mean optimizing processes rather than changing inputs. This is a reasonable distinction because it provides more focus to the activity. Source reduction focused on reducing toxic inputs is more of a purchasing and design function, while waste minimization is more of a production function.

Commentary

There are a lot of definitions of WM because the concept has been part of business for many years. Synonyms include process efficiency, optimization, waste reduction, etc. The definition used here is the only "legal" definition of WM I know of although there may be others within the U.S. EPA regulations or regulations of various states.

WM is a phrase to which industry has no objection, since reducing waste is supposedly a primary objective of executives everywhere (even if they don't do a good job of it in practice). It is relatively easy to interest

executives in strategies for waste minimization, and once they are involved then additional elements such as source reduction and cleaner production can be introduced. In marketing, WM is a good phrase to use.

WM is a very practical issue for the chemical industry because the industry generates such large amounts of production process waste. The focus for the industry in this area is process control, batch scheduling, better operating practices, waste separation and reuse, and more efficient technology.

Recycling

Recycling is included here Recycling is a step on the staircase below waste minimization. There are almost always some wastes created by production processes, so they need to be recycled as much as possible. Recycling can be broken down into closed-loop recycling (which is really just a production process extension rather than recycling), on-site recycling and re-use, off-site recycling, and reclamation. Reclaiming wastes usually involves some kind of separation technologies such as distillation, filtration, etc., whereas straight recycling usually is understood to mean that the waste is simply reused somewhere else or back in the original process.

There is an important distinction to be made between on-site and off-site recycling. Asking others to recycle for you is risky. Many toxic waste sites in the U.S. were created by poorly managed firms recycling other companies' wastes, and now the companies are faced with cleanup costs. Off-site recycling is really a form of waste disposal for the company which creates the waste and so is a low priority for action compared to preventing the waste in the first place.

Pollution Control

Pollution control systems to reduce waste volume or toxicity are a necessity to manage wastes that cannot be prevented or exchanged. The relationship to the higher concepts is one of "last resort." Pollution control requires high capital and operating costs, and there are numerous risks associated with system failures and the use of treatment chemicals. Pollution control options should be considered only after all the higher level concepts have been thoroughly investigated. Compared to the cost of buying, installing and operating pollution control systems, improving production processes and other cleaner production strategies may be quite affordable and of course they also usually provide a return on investment. In contrast, pollution control always remains an operating cost with no payback.

Waste Disposal

The bottom of the staircase of industrial environmental management is waste disposal. Since some waste is an inevitable part of almost any operation, wastes need to be managed responsibly. This requires careful consideration of what will happen to the wastes once they have been disposed, and selection of the best disposal options to minimize risks to people and the environment.

ISO 14001: What Does It Really Mean?

Because ISO 14000 is attracting so much attention, it is very important to clarify the relationship between it and the other concepts discussed in this paper. First of all, it is critical to remember that most people are really focused on ISO 14001, Environmental Management Systems specification and guidance. This is only one of the standards in the ISO 14000 family. The other standards are not relevant to industry now because they are unfinished and most are likely to only be guidance and not certification standards.

Environmental Management Systems

Definitions

“An Environmental Management System (EMS) is that part of the overall management system which includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy... An EMS provides order and consistency for organizations to address environmental concerns through the allocation of resources, assignment of responsibilities, and ongoing evaluation of practices, procedures and processes.”^{ix}

Relationships

The EMS is the structure within which the other firm-wide and operational concepts on the staircase can be implemented. Of course this requires a management commitment to implement the other concepts in an organized fashion. An EMS can be limited to only one aspect of a firm's operations, such as pollution control systems, or it can be very comprehensive, even including external strategies to get involved in industrial ecology. This is the big problem with the relationship of EMS to all the other concepts; a management system only does what you want it to do. An EMS can address all of the concepts below and above, only one or two of them, or none of them. A firm can have an EMS that ensures it pollutes as much as possible. It is up to the management to decide in what direction the system is supposed to improve.

If the environmental management practices constitute the steps of a staircase, then the EMS is what holds the staircase up. Leaders have to decide how high they want to go up the staircase and then put an EMS in place that will hold them up on their journey.

Commentary

The definition of EMS used above is from the ISO 14001 EMS standard which is rapidly gaining worldwide recognition. The ISO definition is so broad that there seems little benefit in including other definitions.

EMS is widely misunderstood. Many consultants who hope to sell their EMS services claim that having an EMS will save companies money and improve the environment. This is not at all a necessary result. The system will create benefits only if its specific elements are designed to achieve them. Having an EMS is not a sign that a company is not a terrible polluter, or has better environmental performance than a similar company which has no organized EMS. Many companies are rushing to achieve ISO 14001 certification without understanding or implementing cleaner production, pollution prevention or even waste minimization. They are simply organizing their waste management systems better. As public awareness of this fact increases, companies will not be able to simply say that they are ISO-certified. They will have to explain just exactly what they are doing with their EMS.

The chemical industry is likely to be subject to significant pressure to implement ISO 14001. This pressure should be resisted. Instead, the industry should concentrate on moving steadily up the staircase to cleaner production and eventually industrial ecology. It is not necessary to have ISO 14001 certification to do this. It IS necessary to have a good management system in place, but the system does not have to follow the ISO specifications. However there is nothing wrong with the ISO management system elements and they certainly could be used by companies that do not already have comprehensive management in place.

The one element of the ISO 14001 standard that really makes a difference in certified firms is the management policy. To achieve third-party certification, companies will have to prove to auditors that they are

actually doing what they say in their policies. So if a chemical company's environmental management policy states that the company subscribes to the Responsible Care Code of Conduct, the company will have to prove to auditors that all elements of the code are really being implemented. If the policy says the company is committed to cleaner production, auditors will look for solid proof that cleaner production is happening. For this reason, third-party certification to ISO 14001 is the best way to ensure that the company is actually making its way up the staircase.

Discussion

In a capitalist society, industry is trying to make money. The steps on the staircase to sustainable development are a prescription of how to do this in the new environmental realities. Companies that do not move up the staircase will eventually be driven out of business by their competitors who are moving up past them. The realities will keep increasing environmental pressures on industry, particularly on the chemical industry, and will also keep changing. Good management systems that recognize and respond to the changes and continuously improve company environmental performance are a necessity.

What should we call this movement? All of the terms that are discussed in this paper have good and bad points. One point they all share in common is that they are focused on pollution. This is a serious drawback because top executives don't focus on pollution, they delegate that responsibility to subordinates. Top executives focus on strategies to make more money. So when we use terms such as cleaner production or pollution prevention, we tend to identify ourselves with middle management, not top management. This makes it harder for us to market the concepts to leaders, even though the concepts can make a lot more money for companies. Without awareness and understanding of the nature of the concepts and the staircase of progress at the very top, it is very hard for middle managers to get real support for changes. Perhaps the most common complaint heard by those who teach the concepts is, "I want to implement cleaner production but my boss won't support me."

Perhaps we need a new phrase that really shows the relationships that are discussed in this paper. I suggest the following: Sustainable Business.

All managers want their business to be sustainable, but this is increasingly going to require attention to environmental issues. The concepts on the staircase to sustainable development define the elements of strategy that companies can use, and the staircase shows clearly that the strategy is progressive and evolving. Environmental management systems, or other systems such as quality management or Responsible Care, hold the staircase up, and the higher the staircase goes, the more sophisticated the management system needs to be.

The relationship between Cleaner Production, Pollution Prevention, Waste Minimization, and ISO 14000 can be easily understood, and the concepts can be marketed to industry, if they are presented as business strategies to make more money in the environmental era. The relationships between them are ones of evolution and support, which are critical to any successful long-term strategy. Now, in the environmental era, we are starting to see what "long-term" is really all about.

ⁱ "Our Common Future." World Commission on Environment and Development (the Brundtland Commission), Oxford : Oxford University Press, 1987. Web site: <http://iisd1.iisd.ca/sd/default.htm>

ⁱⁱ Industrial Ecology. T.E. Graedel and B.R. Allenby. Prentice Hall, New Jersey, 1995.

ⁱⁱⁱ "Industrial Ecology: An Environmental Agenda for Industry." Hardin B.C. Tibbs. In: The Whole Earth Review, Winter 1992.

^{iv} Cleaner Production (pamphlet). United Nations Environment Program, Industry and Environment Programme, Paris, France 1995. Website: http://www.unepie.org/Cp2/what_is/general_info.html.

^v UNEP, Paris, 1989, as quoted in “Cleaner Production: The most effective approach to achieving improved water quality.” D. Huisingsh and L.W. Baas. *Journal of European Water Pollution Control*, Vol. 1 No.1, 1991.

^{vi} 42 US Code of Federal Regulations § 13102(5)(A) (01/24/94).

^{vii} “Pollution Prevention Directive.” U.S. Environmental Protection Agency, May 13, 1990.

^{viii} “Waste Minimization-Issues and Options.” Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, EPA/530/SW/86/041, BP87-114351, Washington DC, October 1986.

^{ix} Environmental Management Systems - Specification with Guidance for Use. International Standard Organization, ISO/DIS 14001, 1995.