

# **AC 2007-1019: THE PROMISE AND PERIL OF ISO 14000 AND THE ROLE OF ENGINEERING EDUCATORS**

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# **The Promise and Peril of ISO 14000 and the Role of Engineering Educators**

## **Abstract**

With increased pressures to make our curriculum relevant there are a number of crucial issues that need to be considered for inclusion in our courses. In an already overcrowded curriculum there is relentless tension about those student learning objectives that are desirable against those that are less relevant. The conceptual framework inherent in ISO 14000 is particularly relevant as the relentless pressures of pollution, climate change, and depletion of finite resource become more apparent with each passing day. These problems will require geopolitical, sociological, technological, and engineering solutions. Therefore, there is a pressing need to pursue inclusion of ISO 14000 concepts into our courses. Ideas such as the development of environmental management systems, environmentally benign manufacturing, life cycle assessment, and product take back should be included wherever appropriate. In this paper we will explore the educational opportunities that naturally emerge when addressing underlying concepts that are implicit in ISO 14000. Toward this end we will examine the positive aspects and limitations of this standard. Finally we will review some of the existing and emerging resources that can help faculty members either locate or create curriculum materials that are pertinent to ISO 14000.

## **Introduction**

The ISO 14000 standard was created to influence corporate policy with the ultimate goal of promoting environmental stewardship. Essentially ISO 14000 encourages the development of environmental management systems (EMS) with the central aim of pollution prevention.<sup>1</sup> Many stakeholders within a corporation are involved with ISO 14000 certification and performance assessment. As our collective consciousness is raised regarding ecological issues it is becoming apparent that many of these problems will require engineering and technological solutions. Corporate managers, policy makers, and society will turn increasingly to the engineers and technologist to solve an array of problems. Due to the service learning nature of these problems it may enable us to stem the tide of decreasing enrollments and also help with student retention. In addition, this standard supports a pedagogical model that encourages curriculum development efforts that are interdisciplinary and experiential. The development of suitable curricula around this standard will enable us to not only maintain relevancy but should enable us to strengthen our individual courses and programs.

The creation of modules appears to be the most realistic approach for curriculum development given the fact that faculty have limited time and resources as well as an already overcrowded curriculum. Given this situation we need to create easily integrated materials for our courses that can be shared with our colleagues. Fortunately there are public and private web-based resources to help faculty members develop and disseminate curriculum such as MERLOT and Rice

University's Connexions. There are also National Science Foundation (NSF) sponsored national resource centers that support curriculum development and act as clearinghouses.

One such center is the NSF's recently funded National Resource Center for Materials Technology Education (MatEd) at Edmonds Community College in Lynnwood Washington. The intent of this center is to locate, peer review, and post materials science curricula as well as support faculty members who wish to develop their own materials. In addition, MatEd's staff will provide workshops to help faculty development curriculum. The initial work for the MatED's team involved the identification, categorization, and prioritization of materials science core competencies needed by technologists. These core competencies will guide faculty in the development of classroom and laboratory exercises as well as assist in the development of curriculum that addresses ISO 14000. This standard is an attempt to influence how raw materials are handled during extraction, refining, processing, recycling and reuse. The intent of this standard is to encourage businesses to minimize pollution during each step of a product's life cycle and plan for its reuse, in other words, from "cradle to cradle."<sup>1,2,9</sup>

### **Pedagogical Framework**

An appropriate educational goal should be to make our students knowledgeable and sensitive to the importance of environmental stewardship through the engineering and technology assignments they are given. In order to achieve this goal the initial task must be to identify the desired student learning objectives and then either find or develop appropriate modules that address them. Since ISO 14000 typically involves a variety of stakeholders throughout the company as well as the community, it provides an opportunity for meaningful collaboration among our colleagues in other disciplines. It is not difficult to envision the synergistic effect that could evolve through such collaboration. As we all become more aware of pressing environmental issues there will be increased interest by students who will seek careers that sustain our environment. This might, in some cases, enable us to increase our enrollments if we can shape our curricula accordingly. Regardless, there have been prior research efforts that offer some perspective particularly with regard to applied research.

### **An Environmental Effort before ISO 14000**

Twenty years before ISO 14000 and the environment was only emerging as a major issue work was being done by farsighted engineers to solve recycling problems. An example of this is the research performed by Dr. Charley Shipley, then president of the Shipley Corporation, now Rohm & Hass Electronic Materials. Dr. Shipley was a visionary who tried to develop easily recyclable thermoplastic printed circuit board. Today's printed circuit boards are made up of thermosetting materials which are difficult to recycle. Thermoplastic materials by comparison can simply be cleaned, chopped up, and remolded and reused in new products, while thermosetting materials cannot be remolded but may be suitable as inert filler. Despite the fact that Dr. Shipley's project did not achieve its ultimate goal, his attempt was a worthwhile effort toward recycling electronics components or what is referred today as e-waste.<sup>5</sup> This example of applied research demonstrates that complex engineering problems will arise as companies seek ISO 14000 certification. It also point to one of the many vexing problems of environmental stewardship - product take-back. Product take-back is the idea that once a product has reached

the end of its useful life cycle the manufacturer is responsible, presumably, for its proper handling. This is the problem that Dr. Shipley tried to address over two decades ago for printed circuit board. Recent research indicates that thermoplastics or hybrid printed circuit boards are emerging for a variety of electronics applications. Regardless, an incident with Apple Computer that involved Steve Jobs' refusal to take back old I-Pods demonstrates that we have a long way to go. Fortunately, an outcry from his stockholders quickly altered his position. His attitude concerning product take back is not uncommon.<sup>5</sup> The basic idea is simple but difficult to execute in practice. It is unfortunate that some managers do not fully appreciate that raw materials constitute a significant portion of component unit cost. A concerted effort to conserve and recycle raw materials has a significant effect on stabilizing raw material prices which benefits producers and consumers at the same time conserving energy while mitigating pollution. Unfortunately, the problem is contentious and opinion among electronic manufacturers, for example, varies widely as to who is ultimately responsible for the handling of their products at the end of their life cycle.<sup>5</sup> The fundamental problem is that, in order to ensure product take back, products must be designed for disassembly and reuse from their inception.

Pedagogically, this is an excellent opportunity to introduce design for disassembly and reuse, benign manufacturing, as well as product life cycle assessment. The ISO 14000 standard provides the construct for faculty members and their students to actively participate in creating product components that are readily recyclable and or reused. It requires students to rethink material selection, processing, design and assembly decisions. If, as a community, we make a collectively efforts to encourage the design of such products it would have a significant impact on raw material availability and cost. The implication is that beyond the creation of relevant curricula we can foster the creation of interdisciplinary teams while creating a culture that is sensitive to environmental stewardship.

### **ISO 14000 The Standard**

The International Organization for Standardization (ISO) was founded in 1947 and "...is a federation of the national standards bodies of 157 countries, one per country, from all regions of the world, including developed, developing and transitional economies."<sup>1</sup> This body is responsible for creating numerous international standards for government and business organizations. ISO 9000 was released in 1987 and provides a framework for the creation of quality control systems.<sup>2</sup> An outgrowth of ISO 9000 was the development of ISO 14000 which provides companies of all sizes with a structure to create, codify, and refine environmental management systems.<sup>1</sup> ISO 14000 consists of a series of standards and guidelines that can be grouped into three categories: evaluating and auditing tools; managerial standards; and product-oriented support tools.<sup>16</sup> The ISO 14040 series for instance deals with life cycle assessment. Environmental labeling is covered under ISO 14020.

As companies seek certification it will fall to engineers and technologist working in collaboration with management and associated stakeholders to operationalize many aspects of ISO 14000. Therefore, as we develop our courses it is important that we understand the inherent benefits as well as the limitations of this specification. This is essential if we are to ensure that our students have a clear understanding of what issues, benefits and limitations, they will have to deal with while working in organizations guided by ISO 14000.

## **ISO 14000 – The Promise**

The implementation of ISO 14000 takes on increasing urgency as pollution, climate change, and depletion of finite resources become more apparent with each passing day. These problems will require geopolitical, technological, sociological, and managerial solutions.<sup>3</sup> The standard encompasses such areas as environmental management systems development, life cycle assessment, design for the environment, ethical issues, environmentally responsible manufacturing, as well as the implications of product take back.<sup>1,2,15</sup> In some countries this standard is being used to embrace a broader realm than originally intended to include new areas such as the work environment in life cycle assessment.<sup>4</sup> Continuous improvement is another inherent aspect of this standard. “It fosters self organization and self regulation, which represents the groundwork from which it is hoped that continuous improvement of environmental performance can be sustained. ISO 14000, in particular, tries to encourage a different and more effective environmental ethic to the design of product and processes from the selection of materials and the logistics of transportation.”<sup>15</sup>

These are promising beginnings and can clearly provide the needed framework for companies seeking certification under this standard. Direct benefit to companies include: assuring customers of their commitment to demonstrate environmental management; maintaining good public/community relations; satisfying investor criteria and improving access to capital; obtaining insurance at reasonable cost; enhancing image and market share; meeting vendor certification criteria; improving cost control; reducing incidents that result in liability; conserving input materials and energy; and fostering development and sharing of environmental solutions.<sup>15</sup> Engineering and technology courses have already been developed that are either stand alone or integrate aspects of ISO 14000 at both the community college and university level. For example Virginia Tech offers Introduction to Green Engineering and a course in Environmental Life Cycle Assessment. These courses are open to both engineering and non-engineering students as part of their new liberal arts offering. Athens State University offers an ISO 14000 course in their manufacturing program. However, there appears to be a lack of concerted involvement by the larger engineering and technology community. This may be due, in part, to the overall lack of certifications in the United States as compared to other developing nations.<sup>7</sup> Therefore, there may be less pressure for our graduates to have skills sets associated with ISO 14000. There are a number of issues that have been presented to explain the lack of certifications in the United States: lack of management support, overall expense, time required, limited perceived benefit to the company.<sup>6,7,13</sup> There is research that examines the number of ISO 14000 certifications in the United States as well as myths surrounding this standard. These myths include the difficulty of implementation, the cost of certification, and the perception of limited benefits.<sup>6,8</sup> Research indicates that United States companies lag well behind other developed nations.<sup>7</sup> Complicating these issues is the fact that there are some major concerns with the standard itself.

## **ISO 14000 - The Peril**

The ISO 14000 standard has been criticized because it is only a voluntary framework for the creation of environmental management systems. In addition, audits can be handled internally. Another criticism has been that there are no quantifiable levels or benchmarks that have to be

adhered to.<sup>6,8,13</sup> Although ISO 14000 certifications are on the rise in the United States they still lag behind, based on Gross Domestic Product (GDP), of other developed nations. This situation is ironic since many United States companies already have ISO 9000 certification and some consider ISO 14000 a natural extension of ISO 9000.<sup>7,8</sup>

The construction industry and the agricultural sector have a major impact on our environment and some feel that this standard is only reactive in nature. “Eco-labeling and ISO 14000 are important steps towards environmental management but, by definition, without restoration they are reactive to the situation of global environmental destabilization.”<sup>9</sup> Another criticism is that ISO 14000 documentation lack specificity, sufficient guidance, and appropriate levels of data integrity.<sup>14</sup> Some of this criticism is to be expected given that this is an international standard and cannot, in certain instances, be too prescriptive in nature. Regardless, as these issues come to light, future revisions of this standard can address these shortcomings. Despite these issues more United States companies are seeking certification and that increasingly multi-national corporations are requiring their suppliers to either obtain certification or conform to various aspects of this standard.<sup>5</sup>

## Conclusion

As an environmental framework we need to be realistic about ISO 14000, particularly its limitations. Our curriculum development efforts need to overcome these limitations where possible. We need to enable our students to not only find solutions to stop the deterioration of our environment but to reverse the damage before it becomes irreparable. We need to move our collective dialogue from reactive to proactive, from mitigation to elimination of pollution. Finally, we need to find solutions that promote the restoration of our environment and encourage the prudent use of our remaining man-made and natural resources. It will require the concerted effort of scientists, engineers, and technologists to identify and solve environmental problems while working closely with managers, community members, and policy makers.<sup>12</sup>

Pedagogically and programmatically there are advantages by embracing these concepts. The types of problems that need to be solved are complex and will require us to create interdisciplinary teams in order to provide holistic solutions. There is no lack of “real world” problems that need solutions. In addition, by cultivating an environmental theme in our respective disciplines we might be able to renew interest in engineering and technology, similar to that during the “Space Race.” These efforts may serve to counter declining interest and loss of enrollments in engineering and technology programs.

Our global environment is increasingly being stressed and in some regions pushed to and beyond their limits.<sup>19</sup> There are examples of this throughout history from the Easter Islands to the more recently Great Dust Bowl.<sup>17,18</sup> Therefore, we need to do more than develop curriculum that simply encourages an understanding of ISO 14000; our efforts must be more holistic and farsighted. We must advance our research, ideas, knowledge, while supporting a culture that fosters environmental stewardship among our students. This will not be an easy task given our present workloads and responsibilities. However, as pointed out previously there are a growing number of resources to help faculty. The National Center for Materials Technology MatEd is one of a number of resources that is being created to support faculty. Regardless, society will look to

the engineering and technology community to solve many of the problems associated with our environment. The question remains: will we be ready?

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