Integrating DFE as Core Course for Engineering Technology Programs

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ABSTRACT

Design for the environment (DFE) is an essential tool for manufacturing companies to become competitive in today’s global market. In the past, economic and technological decisions were solely based on market and profit outcomes, and little consideration was given to environmental and social impacts. With the increase in public awareness, pollution and health concerns become an important factor in today’s engineering practices. Engineers and technologists familiar with DFE tools can positively impact company’s market share and profitability without sacrificing sustainable development.

The ISO-14,000 standard will soon become the common standard among international corporations as a result of the world’s market rapidly moving towards globalization. Companies will embrace this standard similarly to ISO-9,000, which has gained broad acceptance among US and international companies. The DFE principles and practices are necessary tools for achieving major components of the ISO-14,000 objectives. Presently a large number of engineers are not trained in DFE practices. This situation creates some resistance to the implementation of DFE tools in product, equipment, facility and process design. Introducing DFE as a core course for all engineering and technology majors is central to the solution of this problem.

We propose a core course that incorporates topics such as life cycle analysis; environmental impact assessment, just in time (JIT) concepts, concurrent engineering, and application of DFE tools as the design solution for efficiency, profitability, sustainability and lean manufacturing of environmental friendly products.

Introduction

With market globalization presently at a fast pace, employers require engineering and technology professionals who are knowledgeable in environmentally safe design and processes. Authors such as McCright and Bergmiller (1), Wells (2), believe that there is a need for engineers trained
in environmental protection, material conservation, and product quality. Consumers and manufacturers are accepting the concept of green products as modus operandi with the advent of the new millenium.

Minimizing environmental impact of manufacturing and promoting sustainable development around the globe require the implementation of ISO 14000 standards. The environmental analog of the quality management standards (ISO 9000 series) now widely accepted and implemented by most manufacturers is the environmental management standards (ISO 14000 standards). Design for the Environment (DFE) and affiliated tools offer an excellent approach to achieving the environmental portion of the ISO 14000 standards. These standards are a series of voluntary management or process standards developed by ISO, an international organization responsible for standardization. They are aimed at establishing organizational environmental ethics, and enhancing an organization’s ability to measure and attain standards of environmental performance. Presently, an organization chooses how much of the standards it would commit to and measure its performance against its commitment. They provide an Environmental Management System (EMS) that explains how adhering to the standards can help consumers, governments, and companies monitor ways to reduce their environmental impact and increase the "long run" sustainability, thus creating "Strategic Sustainability," according to Ostler (3). The core of the series is ISO 14001 with the specific goal of reducing wastes and inefficiencies--factors necessary for sustainability. The major elements of ISO 14001 standard include the setting of environmental policy planning, implementation and operation, checking (auditing) and corrective action, and management review. Soon firms will have to show that they have environmental control programs to be accepted in (international) commerce. Recently, an American firm was prevented from carrying out commerce in Europe. It may be argued that there is an upfront cost for implementing ISO 14000 Standards. However, according to Ostler (3) this added cost could easily be made up, possibly with a few cycles of production.

Goals of DFE as a core course

It is expected that the number of major companies applying for ISO 14000 certification would rise in the future. The drive for certification necessitates the need for DFE as a core course in the engineering and technology curriculum. Thus, graduating future engineers will have the knowledge to design and build environmentally benign, cost effective, and efficient products and processes that optimizes quality and promotes sustainable development. Henry and Heinke (4) attested to the fact that these are necessary skills of the future engineer or technologist.

Appropriate year to teach course

DFE should be taught in the sophomore year prior to capstone design courses and projects or it should be taught in the junior year. All engineering majors should take the same course with examples and case studies drawn from the many disciplines. Senior capstone design courses and projects should emphasize DFE knowledge acquired earlier by the students.
Design for the Environment (DFE)

DFE is the systematic consideration of design performance in which the environmental impact, sustainable development, health, safety, and waste are optimized over the full product and process life cycle.

Course content

1) Definitions including that of DFE and affiliated tools.

2) Brief history of federal regulations. Some ethical and legal considerations contrasted.

3) Emphasis on how DFE can help determine significant amount (75%) of the cost of a product throughout the product life (include potential consequences, tolerances, safety features, risk assessment, residual risk, the disposal cost).

4) Raw material selection (less hazardous alternative material) considered right at the design stage.

5) Hazard analysis of: mechanical, chemical, electrical, noise, ergonomics (human factors) at the design stage. Including potential consequences, tolerances, safety features residual risk. Hazard analysis is viewed here as an affiliated tool.

6) Risk management: environmental aspect characterization. Inputs (processes chemicals, materials, energy), system or process (equipment, site), outputs (wastes, energy, process material, product decommission, excess material inventory).

7) Case studies of equipment, process, facility design, etcetera. Discussion of ethical and legal considerations in these case studies.

8) Use of the Internet for more information and supporting documentation.

9) Outline of ISO 14000 elements.

10) Outline of those elements of ISO 14000 that are achievable with DFE and affiliated tools. Affiliated tools includes just in time (JIT) manufacturing and concurrent engineering (CE)

11) Interdisciplinary design project. The design must meet federal waste and hazardous standards with supporting cost analysis and documentation.

Conclusion

The professor who find the above course content too ambitious may teach emphasizing certain topics, while taking a cursory look at the other topics. The following are additional testimonials that the time to incorporate DFE as a core course into the engineering or technology curriculum is now:
• EPA’s programs such as the Green Lights Program for companies installing energy efficient lighting.

• Energy Star Program allowing display of logo for companies encouraging energy conservation in electronic devices.

• 33/50 Program encouraging companies to reduce thirty three percent of the seventeen (17) selected Toxic Release Inventory (TRI) substances by 1993 and fifty percent by 1995 for which four hundred companies had already signed up.

• According to Ostler (3), President Clinton’s issued an executive order in 1993 directing federal agencies to purchase environmentally friendly products.

• 1994 EPA’s procurement guidelines for purchasing recycled products.

• "Take back" legislation.

Incorporating DFE as a core course into the engineering curriculum is a necessary tool that future engineers and technologist must have in order to help their companies obtained ISO 14000 certification and become more competitive. In addition, these engineers will more readily accept and not hinder environmentally benign design and manufacturing with sustainable development. They will view DFE and ISO 14000 implementation as cost effective in the long run. Finally, the students must be taught that practical DFE and ISO 14000 implementation in industry is top down and must be embraced by management.

References


(2) Wells, W. E., 1996 Environmental Education for All Engineers. ASEE: Session 3151.


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Dr. Charles U. Okonkwo graduated with bachelors and master’s degrees in chemical engineering from Iowa State University, and a Ph.D. in chemical engineering from the University of Florida. He has worked as senior process engineers for both the chemical and semiconductor industries. Since joining the College of Technology and Applied Sciences as a lecturer, he has taught graduate courses in hazardous waste management program, and undergraduate and graduate courses including thermodynamics, fluid dynamics, heat transfer, statistical process control and design of experiments in the Department of Manufacturing and Aerospace Engineering Technology. His emphasis has now changed from waste management to waste minimization and pollution prevention, and design concepts for environmentally safe manufacturing.
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