Materials, Marketing and the Environment – An Interdisciplinary Approach for Students

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Abstract - **Presented in this paper is an interdisciplinary structure for mechanical and manufacturing students to incorporate marketing concepts into the selection of the proper material for a group of selected products while constrained only by environmental issues about the material. The outcomes for this course are greater student awareness for material selection, regardless of the student's discipline. In addition, the students, who are the future stewards of our global environment, will become knowledgeable of the impact of materials on our environment.**

Index Terms – Materials, Design, Environment, Marketing

INTRODUCTION

Using an introductory course in materials selection for a platform, the concepts of material design, industrial design and marketing can be combined to help select the appropriate material within the framework of the materials impact on the environment. Obviously, the whole semester was not focused on marketing and environmental aspects of materials selection but only when appropriate examples were presented.

This paper will present some results of a survey that was given towards the beginning and end of the semester. The purpose of the survey was to raise awareness of the impact of materials selection on the environment. Also, this survey instrument was used as one of the assessment tools for the course.

In addition, a series of questions was given to the students regarding the impact of a "Compact Fluorescent Light" bulb on the environment. Although most students understood the energy savings that could by realized by using this type of bulb, most were unaware of the negative environmental impact. They were also challenged to think about the marketing aspects of this bulb given the negative impact on the environment.

The results from these class activities have had a positive impact on the students with respect to their understanding of the relationship between materials selection, design and marketing. In addition, and just as important, how the relationship between technical and marketing aspects can impact the environment.

MECHANICAL AND INDUSTRIAL DESIGN

Product design consists of two distinct aspects, the first being mechanical design and the second is industrial design. The distinction between these two design philosophies is not necessarily divided by a sharp line! There exists a certain amount of interdependence between these two disciplines that needs to be explored with the development of each product.

The goal of mechanical design, or more generally technical design is to produce a useful product that is safe, economical, practical to manufacture and environmentally friendly. One way to accomplish this goal is by obtaining "off-the-shelf" components and arranging them in a manner that creates a useful product. At the other end of the mechanical design spectrum is a complete new design which involves material selection and manufacturing processes with a minimal amount of "off-the-shelf" components to produce the final product. Of course there are many points in between these approaches that may be chosen to produce a product that is safe, economical, practical to manufacture and environmentally friendly.

Simply put, industrial design focuses on consumer appeal. Industrial design addresses form, color, textures, sound, product ergonomics and material selection. A definition for industrial design which has been adopted by the International Council of Societies of Industrial Design states: "Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles.[1] Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange."

The intersection between mechanical design and industrial design exists primarily in two areas. The first is usability of the product and secondly, with material selection. This paper will focus on the effect material selection has on the mechanical and industrial design functions. More specifically, the role of material selection on the environment, that results from the mechanical and industrial design process.

MARKETING PHILOSOPHY

There are multiple definitions for marketing. However, let us begin with the "essence of marketing" as presented by Mercer. "The key aspect of marketing is an attitude of mind. It requires that, in taking marketing decisions, the manger looks at these from the viewpoint of the customer. These decisions will thus be driven by what the customer needs and wants."[2] Or perhaps the essence of marketing is an outside looking in approach.

Although there are many definitions of marketing Philip Kotler uses: "Marketing is human activity directed at satisfying needs and wants through exchange processes."[3] Subsequently, Kotler evolved this definition of marketing to: "Marketing is a social and managerial process by which individuals and groups obtain what they need and want through creating and exchanging products and value with others."[4] For our purpose, the important difference between these two definitions is the addition of the word "social" as this implies a responsibility to society.

A more direct definition of marketing as it relates to society is given by Bennett which states: "A societal marketing orientation adds an additional consideration to the marketing concept: the impact of a firm's activities on society."[5]

Specifically, for the purpose of this discussion, society can be equated with the word environment. Therefore, we could rewrite Bennett's definition to state: An environmental marketing orientation adds an additional consideration to the marketing concept: the impact of a firm's activities on the environment.

MATERIALS SELECTION THE RELATIONSHIP TO THE ENVIRONMENT

When selecting a material based upon environmental concerns, often recycling is the only consideration. This is incomplete as this does not consider the total life cycle of the material.

The material life cycle can be defined by four distinct processes.[6] These are:

1. Material Production
2. Product Manufacturing
3. Product Use
4. Product Disposal

Material production is the process of taking raw materials and producing a product that will be used in product manufacturing. Not only are raw materials required but energy inputs are required to process the raw materials. In addition, waste heat and waste materials are generated.

Product manufacturing is the process of generating a product for the consumer. This process uses inputs of materials and energy to produce the product. Waste heat and waste materials are also produced.

The portion of material life cycle focusing on product use requires energy inputs for the product to operate properly. During the products operation waste heat and waste products are generated.

The product disposal phase of a materials life cycle can take on a range of processes from total disposal in a landfill to complete recycling of the material. Energy and waste will be generated regardless of the product disposal method. However, if the product material is recycled an energy savings may be realized in the material production phase of the life cycle.

The waste materials that are generated at each step of a materials life cycle may consist of solids and gases. The solids may be immediately recycled for use in the material production phase of the life cycle or may be disposed of in a landfill. However, the gases that may be produced can be very harmful to the environment.

Gases such as carbon dioxide, nitrous oxide and sulfur dioxide are among some of the gases that are released into the atmosphere. These gases are usually the result of combustion.

METHODOLOGY, SURVEYS AND PROBLEM

The nature of our engineering technology students is that they are technically competent, somewhat knowledgeable about the environment, but certainly limited in their knowledge about the impact that marketing has on product development. In an effort to determine their baseline knowledge of materials, environment and marketing a survey along with a problem was developed for the students. The student's effort was rewarded by giving them an "A" for 10% of the course grade if they completed the survey and the problem.

The survey consisted of 27 questions and was given at a time in the semester where none of the information had been discussed in the class. The survey was also given towards the end of the semester after the lectures and reading assignments had been given on the material. The following 5 questions were used for evaluation:

1. What does "Design for the Environment" mean?
2. What does "Design for Sustainability" mean?
3. What does "Material Life Cycle" mean
4. What does an industrial designer do?
5. What is marketing?

The problem focused on the advantages and disadvantages of using a "Compact Fluorescent Light bulb (CFL)". The questions relating to materials, marketing and the environment were:

1. What is the most dangerous material in the CFL bulb?
2. Are there any negative aspects of emphasizing bulb materials as it relates to a CFL bulb?
3. From the point of view of bulb materials, what would you change to improve the marketing of a CFL bulb?

RESULTS

The qualitative nature of their responses to questions posed in the survey requires a subjective analysis. Therefore, the definition will be given and the student's answers compared with these definitions and "graded" on 1 to 5 scale. (5 being the best answer and 0 no response) In addition, the student's answers to the survey given earlier in the semester will be compared to the answers they gave at the end of the semester. This provides course assessment information for course improvement. The answers for the survey questions are:

1. What does "Design for the Environment" mean?

   "adjust our present design methods to correct known, measurable, environmental degradation; the time-scale of this thinking is 10 years or so, and average product's expected life"[5]

- 1st survey average score 2.48
- 2nd survey average score 2.92
- Was not statistically significant
- 11 students improved on this question from the 1st survey to the 2nd survey
- 5 students did worse on this question from the 1st survey to the 2nd survey
- 9 students stayed the same from the 1st survey to the 2nd survey

2. What does "Design for Sustainability" mean?

   "is the longer view: that of adaptation to a lifestyle that meets present needs without compromising the needs of future generations. The time-scale here is less clear – it is measured in decades or centuries"[5]

- 1st survey average score 0.96
- 2nd survey average score 1.28
- Was not statistically significant
- 7 students improved on this question from the 1st survey to the 2nd survey
- 2 students did worse on this question from the 1st survey to the 2nd survey
- 16 students stayed the same from the 1st survey to the 2nd survey

3. What does "Material Life Cycle" mean

   "Ore and feedstock, most of them nonrenewable, are processed to give materials; these are manufactured into products that are used, and, at the end of their lives, disposed, a fraction perhaps entering a recycling loop, the rest committed to incineration or landfill."[5]

- 1st survey average score 1.60
- 2nd survey average score 2.84
- Was statistically significant at the 0.02 level
- 11 students improved on this question from the 1st survey to the 2nd survey
- 2 students did worse on this question from the 1st survey to the 2nd survey
- 12 students stayed the same from the 1st survey to the 2nd survey

4. What does an industrial designer do?

   "speaks of pattern, color, texture and (above all) consumer appeal"[5]

- 1st survey average score 1.28
- 2nd survey average score 2.68
- Was statistically significant at the 0.01 level
- 11 students improved on this question from the 1st survey to the 2nd survey
- 1 students did worse on this question from the 1st survey to the 2nd survey
- 17 students stayed the same from the 1st survey to the 2nd survey

5. What is marketing?

   The rewritten version of Bennett's definition will be used:

   An environmental marketing orientation adds an additional consideration to the marketing concept: the impact of a firm's activities on the environment.

- 1st survey average score 1.84
- 2nd survey average score 1.88
- Was not statistically significant
- 5 students improved on this question from the 1st survey to the 2nd survey
- 3 students did worse on this question from the 1st survey to the 2nd survey
- 17 students stayed the same from the 1st survey to the 2nd survey

Typical answers for the three CFL questions were:

1. What is the most dangerous material in the CFL bulb?

- 23 students identified mercury as the problem material
- 2 students identified broken glass as the problem material

2. Are there any negative aspects of emphasizing bulb materials as it relates to a CFL bulb?

- 21 students identified mercury

- 1 student identified glass
- 1 student identified the cost of the bulb
- 1 identified that the bulb was not easily recycled
- 1 did not respond

3. From the point of view of bulb materials, what would you change to improve the marketing of a CFL bulb?

- 11 students suggested using something other than mercury
- 6 students suggested recycling centers
- 3 students indicated that the mercury warning should be removed from the box
- 2 students suggested to somehow trap the mercury vapor
- 2 students indicated the glass was really harmful
- 1 student indicated that the bulb should be made in different colors

DISCUSSION OF RESULTS

The students' response to survey question number 1 is fairly predictable. The 1st survey answer to this question scored quite high with an average of 2.48. This is due to their life experience for which they have daily exposure to environmental concerns. The increase score to 2.92 is the result of increasing awareness in the course to the definition for "design for the environment."

The response to survey question number 2 was the least understood concept with an average score of 0.96 on the 1st survey, increasing to only an average of 1.28 on the 2nd survey. The most common answer given by the students is "product longevity". Which is part is true, but lacks the understanding of the lifestyle adjustments that must be made now so that future generations are not compromised.

The change in response to survey question number 3 is significant. This can be explained by the understanding that engineering technology students understand how "systems" operate when the details of the system are explained while using real materials and products as examples.

The student showed a significant increase in understanding of the industrial design function as it relates to material selection and product design. The most common response to question 4 on the 1st survey related to mechanical design or factory layout which is expected because of their technical background. However, once they recognized that there had to be an "aesthetic" function that related to mechanical design and marketing a logical relationship was established within the context of the whole design process.

Survey question 5 relating to marketing and environment showed little improvement between the 1st and 2nd surveys. This emphasizes the need to include more about marketing with materials selection, the design process and the environment.

Unlike the surveys which were completed in the classroom, the questions concerning the CFL bulbs were assigned for homework. They were allowed to use any resources available to them to answer the questions.

The majority of the student correctly identified mercury as the most dangerous material in the CFL bulb. Although, 2 students indicated that broken glass was the biggest problem citing safety concerns. This indicates that an emphasis needs to be made to distinguish the differences/similarities between environmental and safety issues.

The majority of students (21 students) recognized that there is the potential that, by identifying that mercury is contained in the CFL bulb, the result may have a negative affect on marketing and sales of the bulb. However, when the students were asked from the point of view of CFL bulb materials what they would do to improve the marketing of the bulb the majority (11students) suggested using another material. On one hand this indicates they do not know how this bulb functions, but on a more positive note, they are indicating that they would try to find a replacement material.

Some responses to question 3 of CFL bulb raise a troubling ethical issue. Some students (3 students) indicated that the mercury warning should be removed from the label to improve the bulbs marketability! This provides an opportunity to incorporate ethics into the discussion about materials, marketing and the environment.

CONCLUSIONS

The results of the survey given to students in an introductory material selection course indicate that there is a significant amount work left to be done to develop the relationship between material selection, design, marketing and the environment. In addition, a clearer definition of what sustainability and aspects of marketing must be presented to the engineering technology students.

As a result of the students' efforts to learn more about the CFL bulb, 3 of the students indicated they would just remove the mercury warning from the box of the bulb to improve the bulbs marketability. This is a good example of why ethics discussions should be included in all of our courses taught in engineering technology.

PROPOSED CHANGES

Finally, as a class project for marketing students they should have to evaluate a product from a technical aspect and the engineering technology students should provide a marketing plan for the same product with both groups constrained to consider only the environmental aspects of the material and product. Then, these two groups should share their ideas with each other to increase each group's knowledge.

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