

AC 2009-2103: CURRICULUM DEVELOPMENT ON A "SUSTAINABILITY" MAJOR USING QUALITY FUNCTION DEPLOYMENT (QFD) TECHNIQUES

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Curriculum Development on a ‘Sustainability’ Minor Using Quality Function Deployment (QFD) Techniques

Abstract

This paper presents a methodology for curriculum development for a proposed minor on ‘Sustainability’ at a public university in the southeast United States. The minor is intended to reach across different disciplines such as Biology, Chemistry, Geology, Business, Engineering and the Visual Arts. The case is made for a standalone minor in sustainability that encompasses factors such as carbon footprint, limited resources, renewable energy, and the business case for sustainability. It also stresses on the importance of a capstone course that emphasizes hands experience in designing sustainable systems (products or services).

Different aspects of a multifaceted issue such as sustainability are addressed using a QFD approach to ensure objectivity and quality of course material as well as instruction.

Introduction

There has been considerable amount of interest in the general area of ‘sustainability’ of late. Given the government’s resolve to try and find a remedy for the ongoing financial crisis by investment in ‘green’ infrastructure, the time is opportune to delve deeper into environment consciousness at all levels.

In view of the aforementioned facts, it is becoming increasingly obvious that there will be quite a substantial number of employment opportunities for individuals that are trained in ‘green’ technologies. It is not surprising therefore that universities and colleges across the United States are increasingly trying to incorporate sustainability into their curricula. This has been somewhat of a new phenomenon in the United States unlike in Europe. In the case of the latter, this is nothing new. In Europe, government regulations mandate environment conscious decisions by individuals as well as corporations. The US is increasingly turning its attention to this expanding field of education.

There are two principal ways of introducing the topic of sustainability into a curriculum. It can be done by means of a singular course or a series of courses offered to students at the university or college. Students get credit for the courses, but only within their major. This appears of individual transcripts and any potential employer can observe the same. The other method is by introducing a minor and prospectively a major in sustainability at the university level. This way students are free to specialize in this field if they so wish.

There has been considerable interest expressed in just such a project being put into action at a public university in the southeast United States This paper strives to present a methodology by means of which a minor in sustainability will potentially be offered.

Methodology

Introducing a minor in sustainability at the university level is a very different matter than introducing a course in the same topic. A minor emphasizes some degree of specialization in the subject matter. Similarly, given the myriad employment opportunities that are likely to open up in the near future, minor needs to prepare students to take advantage of the same.

Sustainability is a cross disciplinary topic. This means that it draws equally from various disciplines such as Chemistry, Biology, Geology, Botany etc. However, any effort to introduce a proposed minor at any institution in a topic such as sustainability is bound to fail in the absence of a practical viewpoint built into the curriculum structure. Another important point to be borne in mind is the fact that all activities intended to improve sustainability need to be cost effective. A third and most important facet related to curriculum design pivots on design. This is not the aesthetic kind of design that we are talking about. By design, we mean that factors such as product assembly, disassembly, disposal, recycling etc need to be incorporated into the product design. Waste and environmental pollution is largely the result of human consumption. The problem of environmental degradation can be attacked at its root in only one way. The solution lies in tackling underlying design issues. If this issue is successfully addressed, there is not as much need for environmental regulation as one might think.

Another important issue is that of energy conservation and harnessing alternative sources of energy in such a way that they might one day be economically viable. Consequently, our effort has focused on imparting students basic skills in engineering. Examples of the same include skills pertaining to fluid mechanics (read windmill design), automation and control (read enhancing systems efficiency) and a variety of related topics.

The curriculum is developed using a Six Sigma based design philosophy by taking advantage of tools such as Quality Function Deployment (QFD). This is done in order to address the needs of various constituencies. It also achieves the streamlining of the process by taking advantage of the concept of the House of Quality¹.

For those readers that are not necessarily familiar with the concept of six sigma, the following paragraph seeks to present a brief elucidation. Most statistical data can be expressed in the form of some kind of normal distribution. The concept of six sigma is a concept that seeks to enhance quality²⁻⁴. This is achieved by ensuring that a substantially large number of the population as expressed by the normal distribution meets or exceeds desired quality levels. That way the number of rejections is minimized and waste is practically eliminated. Why do we use the quantity 6 Sigma? The answer lies in the simple fact that 99.7% of the normal distribution is contained within 3 standard deviations on either side of the mean of any normal distribution. That means that the total population falling within those bands corresponds to 6 times standard deviation (Sigma). In view of the success that has been enjoyed by this simple approach in industrial as well as management settings, it is only natural to try and extend it to academic purposes as well.

Salient Features of this approach (How this approach compares with other approaches):

The approach described in this paper is customer oriented. The objective of using an approach based on six sigma techniques is to find out the specific needs of the market place and try to address those needs effectively. A significant advantage of a curriculum that is based on this approach is that it significantly improves the employability of students. It imparts a set of marketable skills that can be used in an entrepreneurial sense. In order to accomplish this objective, the aforementioned approach places heavy emphasis on 'how-to' approach of problem solving pertaining to sustainability.

Obstacles to implementation:

Rapid change in marketplace demand constitutes one of the principal obstacles that could be encountered. However, this problem can be easily encountered by placing relative emphasis on fundamental concepts of sustainability. This will enable students to grasp concepts clearly thus facilitating their application irrespective of the kind of technology that is being used.

Curriculum Design

The curriculum design is still underway at said university. However, the following section offers a brief glimpse into the manner in which quality principles are used to build the curriculum from the ground up.

The voice of different stakeholders including employers, government organizations and regulatory agencies is incorporated into the curriculum. This is done through the extensive use of a tool referred to as Quality Function Deployment (QFD). This tool centers on the so called house of Quality. The House of Quality is a matrix that converts customer requirements into product design features.

Figure 1 illustrates the structure of a typical house of quality.

It is evident from the figure that customer requirements can easily be translated into product features using this approach. Simultaneously, it is also useful in ensuring that the product stays ahead of any competition that may exist or might crop up in the future. .

In order to use the QFD systematically, one needs to adopt a four step approach to curriculum design which is detailed as follows.

1. **Curriculum Planning:** This is the first step in the process. It seeks to incorporate the voice of the customer into curriculum design. This is important if students minoring in sustainability are to have any future in terms of employability at all. Incorporation of this step in the design process ensures proactive design decisions. It is akin to asking the question: 'What outcome do you expect out of this course?' Opinions expressed are then gathered together and arranged from highest priority to lowest priority. This is accomplished by assigning numeric scores ranging from 1-10 to each.

2. **Component Deployment:** Once customer needs have been ascertained, it is essential to break them down into manageable portions. Each portion represents a characteristic of the curriculum. For instance, a customer requirement such as ‘understand economics of sustainability’ could be translated into components such as ‘knowledge of engineering economy’, ‘knowledge of finance’ etc. This step identifies which courses from each college on campus need to be incorporated into the proposed minor. It also tries to find out how many credit hours need to be assigned to each course.
3. **Instruction Planning:** This step identifies the resources and methods needed to impart education and training conforming to customer requirements.
4. **Quality Control:** This is the final step in the design of the curriculum. It tries to identify the minimum level of knowledge every student minoring in sustainability is expected to have. It is crucial at this juncture to clearly identify between knowledge and information. We seek to impart knowledge to students and not just information.

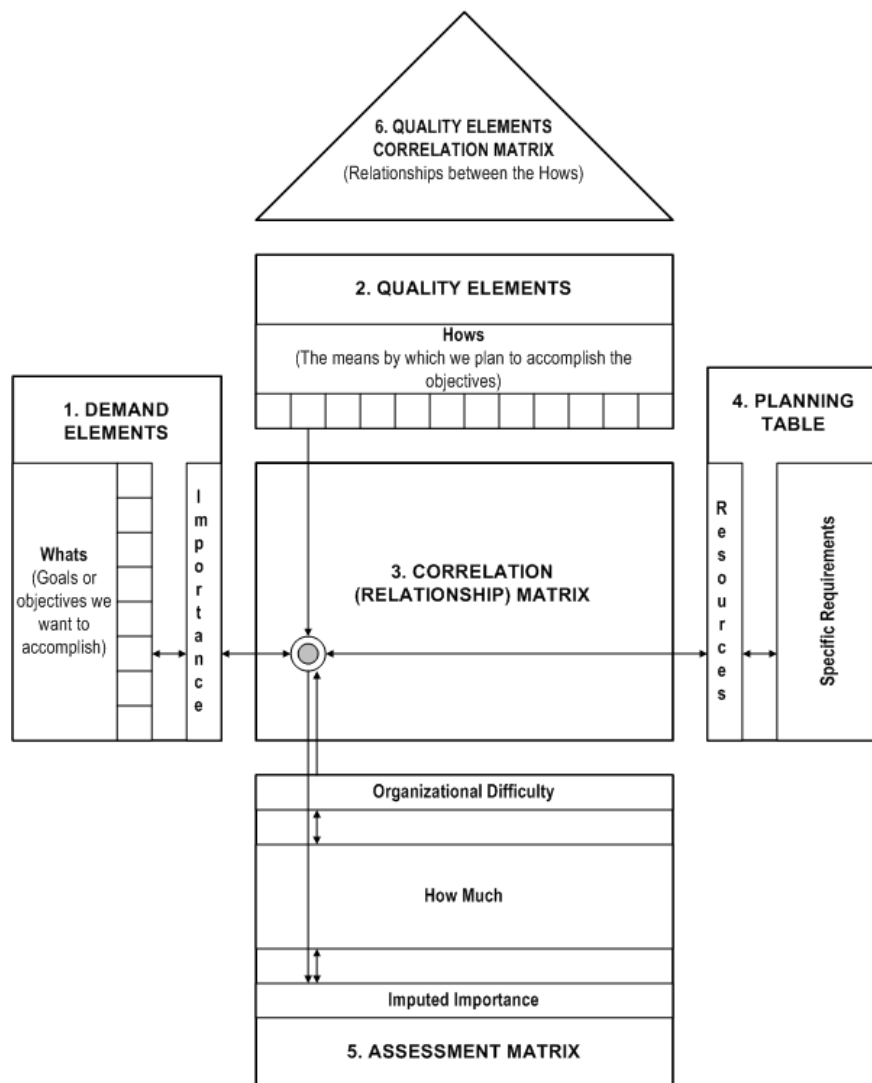


Figure 1: Structure of the House of Quality

Since the design of the curriculum is still underway, the authors are unable to present more specific information about this minor at this juncture. However, we plan on presenting the results of this project at an identical forum in the future. Readers need to make a note of the fact that the curriculum design process does not follow the norm. What we mean by this is that we have not sought to find out what other institutions are doing and follow their lead. Rather, we have chosen to be more proactive in our approach and address specific needs as might be expressed by our own stakeholders. To be sure, there are bound to be certain overlapping aspects that might be common with other curricula. However, this can only be owed to the need to add a certain universal appeal to the entire curriculum.

Given the early stages of curriculum development, the authors are unable to share a more comprehensive example of a fully developed curriculum at this point. However, we do intend to present a much more detailed example at the conference this summer.

Conclusion

This paper has attempted to present a preliminary version of a curriculum design approach using quality principles. The curriculum seeks to offer a minor in sustainability to students. Given the multidisciplinary aspect of sustainability, it was demonstrated that quality principles can be effectively used to design said curriculum.

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