A METHODOLOGY TO DEVISE DIGITAL ELECTRONIC APPLICATIONS

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Abstract

The development of abilities such as creativity and innovation is a challenge for higher education. For Digital Electronics major the challenge is to confront students to design new applications. This article presents a methodology that has been taught in a VHDL (VHSIC Hardware Description Language, VHSIC = Very High Speed Integrated Circuit) course to stimulate the development of creativity in designing electronic devices. VHDL is a powerful tool to describe, simulate and implement electronic circuits. As VHDL simplifies the implementation of an electronic device, the course has been oriented to make the students face the necessity to create problems instead of solving the ones designed by professors. Innovative devices have been the product of this endeavor.

Keywords: Electronic design, creativity, innovation, educational methodology, higher education.

1. Introduction

Nowadays the development of abilities such as creativity and innovation is a challenge for Tecnologico de Monterrey, a large university system located all over Mexico. In general, this is a challenge for higher education in Mexico.

The author considers that creative mentality is as important as scientific thinking in higher education.

For Digital Electronics Engineering, which is the field discussed in this document, an important educational challenge is confronting students to design new applications.

This article presents a methodology that has been incorporated in a VHDL (VHSIC Hardware Description Language, VHSIC = Very High Speed Integrated Circuit) course to stimulate the development of creativity, specifically in Digital Electronic design. VHDL is a powerful tool to describe, simulate and implement electronic circuits. As VHDL simplifies the implementation of an electronic device, the course has been oriented to make the students face the necessity to create instead of just practice. This change of orientation leads students to create problems instead of solving the ones proposed by professors.

The idea of developing creativity and innovation skills in students is based on the assumption that exposing them to problems related with devising specific circuits forces them to react by reinforcing or emerging their capacity to imagine new electronic applications.

On the other hand, another assumption on which the methodology is based is to consider that digital electronics has no limits. In today's market, it is possible to find transducers and sensors that convert almost every kind of signal into an electronic one. Also, there is a broad spectrum of actuators that allow circuits to interact with the world. Therefore, assuming that any kind of signal could be measured and produced makes any constraints on digital electronic processing disappear.

2. The Methodology

The methodology consists of a series of steps that empower the way in which the environment is observed. The idea behind the methodology is that a student that observes the world with the scientific method in mind allows clarity of detail that is not typically available to others. Furthermore, once the methodology of creativeness is assimilated, objects and events are seen under a different perspective.

The methodology consists of the following steps:

1. When observing the world, relate attributes to objects, events, facts, etc. (in order to generalize, the term object will be used). These attributes may be requirements, capabilities, characteristics, possible uses, etc. Objects could be concrete or abstract.

2. Establish relationships between different objects and between their attributes (this leads to observe the world as a relational database).

3. Make "queries" (as the ones made to obtain information from a relational database) to discover what objects may be added to relate two objects or attributes that were not directly related.

4. Analyze if the added objects exist or not. If not, imagine circuits (or appliances) that satisfy the characteristics of these objects (if possible).

In other words, the idea is to create a relational schema of a subset of the observed world (in the same manner as a relational database schema is created). The premise is that by establishing relationships, a non-existing electronic device will emerge to satisfy any given relationship.

Taking into account the General Systems Theory (Von Bertalanffy, 1976) in that "the whole is more that the sum of its parts", relating elements with ideas has the potential to emerge innovative devices.

Events observed on a daily basis should lead to the development of consumer electronic devices, while industrial events should trigger the inception of measurement instruments, electronic devices geared to enhance the quality of any given product, etc.

In the other hand, experience has taught us that when the world is observed under this perspective, this becomes the natural way of doing it. The opportunity for the arousal of creative ideas is related to the degree of interiorization of this type of observation.

3. Conclusion

The course in which the methodology is used takes place in the classroom and the lab. Theory related to circuits design using VHDL is taught in the classroom.

In the lab, students must complete several projects. The first ones consist in the design of circuits for commonly used devices, requiring the students to innovate functionality. In this way, students are required to develop their creativity by observing a determined universe. In the final project, students are imposed no restrictions and must create an electronic device from scratch. This maximizes and reinforces their creative potential.

In the last year the methodology was used with 103 students, 90% of the final projects worked properly, vs. 30% when the project was very specific. This fact has to do with the motivation of the students towards construct devices product of their own ideas. This semester it is being applied to other 48 expecting ambitious results.

With respect to education, assessment is the hardest part because it is hard to determine the degree of potential of use of a new device. Besides, the complexity of a circuit is not necessarily related with its creativeness.

Some innovative devices that have been developed are: a robot with a circuit that protected him against falling down from an elevated surface (with application in instruments for handicapped persons), a device for tuning musical instruments, videogames and so on.

These students will be followed up to observe if they continued creating in some other required projects of their academic curriculum. The expectation is to observe creative behavior in their careers.

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5. References

1. Bhasker, J. VHDL Primer. 3rd edn. Prentice Hall, Upper Saddle Rivwer, N.J. (1999)
2. Boud, D. and G. Feletti. The challenge of problem-based learning, London, UK: Kogan Page (1997)
3. Duch, B., S. Groh & D. Allen. The power of problem-based learning: A practical "how to" for teaching undergraduate courses in any discipline, Sterling, Virginia: Stylus Publishing, LLC (2001)
4. Elmasri, R. and Navathe S. Fundamentals of Database Systems. . Addison Weley, USA (1989).
5. Roth, Ch., Digital Systems Design Using VHDL. PWS Publishing Company, Boston Ma (1998)
6. Von Bertalanffy, L. General Systems Theory. George Braziller; Revised edition (1976).