AC 2010-477: SYSTEM-ON-CHIP AS A THEME FOR ACHIEVING SEAMLESS TRANSITION FROM A TWO-YEAR COLLEGE TO A FOUR-YEAR UNIVERSITY

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System-on-Chip as a Theme for Achieving Seamless Transition from a Two-Year College to a Four-Year University

ABSTRACT

System-on-Chip (SoC) is the major revolution taking place in the design of Integrated Circuits (IC). However, progress in this rapidly evolving area hinges critically on the availability of well-educated engineers able to bridge the architectural and physical gaps in SoC design. There is a strong consensus from industry and academic institutions on the importance and urgency of reflecting the impact of the SoC paradigm shift in engineering education, as traditional programs, especially at the undergraduate level, have not kept pace with this evolution. This paper presents progress using SoC as a theme to achieve a seamless transition from a two-year community college (Camden County College) to the junior level of a four-year Electrical and Computer Engineering (ECE) program at Rowan University. The crux of achieving this seamless transition lies in reconfiguring and developing new courses at Camden County College that not only introduce key concepts taught in the first two years at Rowan but also replicate the innovative lab experiments in SoC introduced at Rowan. To this end, a new course sequence in Electronics and Digital Circuits is being developed at Camden County College. In addition, several concepts from the Freshman Clinic sequence at Rowan have been included at Camden County College in the Introduction to Engineering course. This course introduces key SoC concepts (like the timing circuitry of an electric toothbrush), reverse engineering, measurements and emphasizes oral and written communication skills. The paper presents details of these transition activities as a work in progress.

INTRODUCTION

System-on-Chip (SoC) is the major revolution taking place in the design of Integrated Circuits. There is a strong consensus from industry and academic institutions on the importance and urgency of reflecting the impact of the SoC paradigm shift in engineering education, as traditional programs, especially at the undergraduate level, have not kept pace with this evolution [1]. Recognizing the acute national demand for a new breed of SoC engineers, our project proposes an innovative curricula prototype that cuts across the artificial course boundaries and introduces SoC knowledge through vertically-integrated and problem-oriented laboratory experiments [2]. In addition, we value the important role that community colleges play in starting students on the road to engineering careers, as well as realize the obstacles the transfer students often face in their continuing education at a four-year institution. Particularly, we collaborate with Camden County College

(CCC) and develop new courses that use innovative laboratory experiments on fundamental and contemporary SoC knowledge and introduce key concepts taught in the first two years at Rowan ECE. Such efforts help students achieve a seamless transition from CCC to the junior level of a four-year ECE program at Rowan.

COURSE AND EXPERIMENT DEVELOPMENT

The focus of the collaboration with CCC is the development of a bridge program to facilitate the transition for CCC students to major in ECE at a 4-year college/university. Our activities include:

1) Inclusion of engineering design activities in CCC *ENG 101: Introduction to Engineering course*
2) Revision of the existing circuit analysis course to have a laboratory component
3) Design of two bridge courses in Digital and Electronic areas

Introduction to Engineering: This course is an introduction to the Engineering Profession, Curriculum, and Design experience. The emphasis is on providing the student with the tools necessary to succeed in the Engineering Curriculum and to introduce topics that engineering graduates will encounter in the workforce. Students will be presented with problem solving techniques, analytical tools, design processes, and ethical concepts and responsibilities that comprise skills that an engineer should have. We have developed and implemented three engineering design projects in this course.

1. *Project 1 - Report on Electric Toothbrush:* in this project, engineering design teams are assigned to study current electric toothbrushes in the market and prepare a report to the CEO of their company with the ambitious plans of manufacturing a competitive (cost effective, environmentally friendly, high performance etc.) electric toothbrush [5]. The report has to provide detailed information including but not limited to the design, operation, ergonomics, aesthetics, safety, and cost issues related to the current products. The result will be recommendations for product improvements.
2. *Project 2- Toothpaste and Manufacture*: extended from Project 1, the engineering design teams are required to study different types of toothpaste, analyze the results and prepare a report to suggest a design improvement for a new brand of toothpaste. Since an electric toothbrush is being studied in detail, it is quite natural to gain some knowledge of different types of toothpaste.
3. *Project 3-Drowsy Driver Car Alarm*: research has shown drivers that fall asleep at the wheel are a major cause of highway accidents. The engineering design teams are assigned to research existing products and propose an alternative design for an alarm to warn the driver that they are falling asleep. The design should answer questions such as:

- How will it work?
- How intrusive should it be?
- Are there legal ramifications for such a device?
- Under extreme conditions the alarm may have to disable the car. Is such an action ethic?

The Freshmen Engineering Attitudes Survey developed by Besterfield-Sacre, Atman, and Sherman at the University of Pittsburgh [3] was adopted and modified to meet the needs of our community college students. The survey was then administered during the 2007-2008 and the 2008-2009 academic years. During the spring 2008 and spring 2009 semesters 17 and 21 students enrolled in the course, respectively. Students completed the survey after receiving information describing engineering disciplines. Specifically, part of the lecture on Electrical and Computer Engineering described the concept of a SoC.

There are three questions at the end of the survey that determine if the SoC lecture had provided useful information about the discipline. One question is also used to determine whether the lecture had persuaded the students to change prospective disciplines to the ECE Curriculum upon transfer. The survey showed that in each year approximately 20% of the students had an intention to major in ECE upon transfer. In each year 95% of students indicated that the lecture was helpful in explaining a concept in the ECE curriculum. However, only 1 student in each year said the lecture persuaded them to change majors to ECE.

Revised Circuit Analysis Course: Due to the lack of laboratory components, the circuit analysis course offered at CCC is often not acceptable upon transfer to a 4-year college of engineering. As a direct result of our collaborative effort, this course is currently revised with a laboratory component integrated. In addition to the traditional lecture contents on DC and AC fundamentals, the supplemental lab experiments introduce students to industrial test equipment and procedures, as well as the cutting-edge computerized simulation software.

Two New Courses in Digital and Electronics Areas: Many U.S. engineering programs have instituted courses to provide engineering design experience in the earlier part of the engineering curriculum [4]. As a result, many 4-year ECE programs have pushed fundamental ECE courses, such as digital design and electronics, to the sophomore or even the freshman years. However, most community colleges do not offer such courses, which makes it impossible for their students to transfer to the junior level of a four-year ECE program. To resolve this problem, our effort develops two new courses at CCC, one for digital design and the other for electronics, as a recommended summer bridge-program option for students transferring to colleges of engineering in the ECE

curriculum. The learning materials developed through this project are implemented in these courses. We refer readers to [2] for the detailed laboratory experimental contents.

CONCLUSION

This paper presents a collaborative effort by the faculty of the Electrical and Computer Engineering department at Rowan University and the Engineering Science department at Camden County College to integrate SoC concepts across the curricula. In particular, the paper addresses the activities of reconfiguring and developing courses at CCC to facilitate their students' transition to major in ECE at a 4-year educational institution. These newly developed or modified laboratory-oriented courses not only teach students basic ECE principles, but also give students skills and tools necessary to advance their knowledge in SoC.

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