# AC 2007-96: OUTSOURCING ? RESILIENT ECE CURRICULUM

**Ismail Jouny, Lafayette College**

# OUTSOURCING-RESILIENT ECE CURRICULUM

Ismail Jouny
Electrical and Computer Engineering
Lafayette College, Easton, PA

**Abstract**

This paper addresses the issue of outsourcing of electrical and computer engineering needs, and its impact on the future of ECE engineering education in the United States. The paper highlights areas of ECE that has seen significant outsourcing activities and future trends in outsourcing of ECE expertise. The intent is to offer suggestions on how to revise the ECE curriculum to; 1) help future graduating ECE engineers work in a global environment, and 2) strengthen areas of ECE that are not likely to be outsourced, and to minimize focus of areas of the ECE discipline that are most likely to be outsourced. These recommendations will in no way weaken the fundamental requirement for understanding basic ECE principles, but are merely an attempt to structure the ECE curriculum to be more resilient to outsourcing, so that ECE graduates in the United States have expertise that are not easily outsourced and can compete in a global environment. Research of what's being currently outsourced clearly identifies the need for US engineering curricular innovation to produce ECE graduates that can work in an environment that may rely on outsourcing a portion of its operations, and also make the knowledge base of these graduates stronger in areas that are not likely to be outsourced, or perhaps should not be outsourced for security reasons or for physical and logistical constraints.

## Introduction

This paper focuses on changing the electrical and computer engineering (ECE) curriculum in response to outsourcing. The assumption is that outsourcing of certain ECE functions will continue in the short term and may perhaps strengthen to include more design related ECE projects [10]. Outsourcing of several technical responsibilities to the Far East is not only an accepted practice in many high tech industries but is seen in some cases as the only way for a company to stay competitive and profitable. There are many proponents of outsourcing that argue that by delegating some jobs overseas, a company can focus on strengthening its fundamental elements that have an impact on quality, sustainability, and marketing. In fact, many companies are interested in hiring technical staff that can function on outsourced projects with teams from around the globe with distinctive cultural differences. Furthermore, many business schools are teaching about outsourcing models that are efficient, profitable, and successful. So, the challenge is to prepare engineers to work in an environment that involves outsourced projects but yet maintain an individuality that has long been distinctive of the US educated engineer. The paper shows that the ECE engineer of the future must do both, function in a global network of teams, and distinguish himself/herself with unique abilities and skills that are resilient to outsourcing and are desirable on a long-term basis. It is no secret that the ECE profession has suffered severely due to outsourcing which had a significant impact on

future ECE enrollment, and the sustainability of some ECE programs around the country. Some of the US finest institutions have seen noticeable drop in ECE enrollment over the last five years, and most attribute this to outsourcing. Many promising undergraduates have seen their relatives either lose an ECE position or worry constantly about the viability of their ECE profession. Some sources estimate ECE unemployment to be near or above the national average in 2003 after being well below that level for over three decades [10]. This phenomenon of decreasing interest in ECE may have serious long-term consequences on the US economy, competitiveness, and security. Enrollment data for ECE programs have shown a steady decline since peaking in 1987 [5]. Some schools are reporting a sharper decline in computer engineering than electrical engineering, and some are reporting a modest increase in EE enrollment that offsets some of the decline in CE enrollment. The National Academy of Engineering, the National Science Foundation, and the ECE Department Heads association have all commissioned studies, workshops, or committees to examine the issue of outsourcing, its impact on engineering, and how to best prepare our future engineers. The results of these studies are widely reported in several publications that are available on the World Wide Web (see nae.edu, nsf.gov, ecedha.org).

## Current State of Outsourcing

It has been reported [9] that 40% of US firms would have completed some phase of an outsourcing strategy, and that about 80% of US companies have at least considered outsourcing. Companies that outsource have such diverse products that range from accounting to radiology and engineering. We will focus on what is being outsourced in Electrical and Computer engineering which is only a part of the overall globalization/outsourcing picture.

Some studies have shown that some ECE companies are investing heavily in the Far East. Intel is investing $1 Billion, Microsoft is investing about $1.7 Billion, and CISCO is also investing about $1 Billion in overseas ventures that include engineering, manufacturing, and business related activities [10]. Some studies have shown that one in every ten software jobs have been outsourced, and others predict that 3.3 million jobs in the high-tech and service sectors would have moved overseas by 2015 [3]. It is estimated that these jobs would provide $136 Billion in wages [3]. A survey conducted by EETIMES and Electronic Supply & Manufacturing in 2005 showed that 55% of companies are planning to increase their design outsourcing activities compared to 11% that are planning to decrease them [11]. These surveys have shown that software design, board level design, and chip level design account for 60%, 55%, and 40% of the outsourced design activities. System level design outsourcing is at a 29% level [11]. More specifically, these surveys have shown that about 60% of logic verification, chip design, and synthesis and analysis are being outsourced. The EETIMES surveys show that PC board layout, and board level design are highly outsourced activities, while system verification, software verification, power and thermal analysis, and component evaluation are least outsourced functions [11]. From a software standpoint, these surveys show that 77% of high level coding and debugging is being outsourced while only 29% of architectural design is being outsourced. About 47% of assembly and hardware

dependent coding is also being outsourced. These surveys report that companies are by enlarge satisfied with their outsourcing activities in terms of overall time to market, unit cost of product, development cost, and project time. It is acknowledged that outsourced design activities carry a higher risk percentage than normal in house operations. These surveys show that 79% of companies view outsourcing as a net asset to them while 21% view it as a liability. The EETIMES surveys have also reported that most of the problems encountered are related to project time, communications, and higher than anticipated cost [11]. An interesting result in this survey indicates that outsourced projects require close collaboration of hardware and software designers, associated with cost sensitive products, and represent state of the art or leading technology.

Other well-known issue related to ECE outsourcing is that analog design or even mixed signal analog/digital design is not as easily outsourced as digital design. Unfortunately, digital designers outnumber analog designers by a factor of 200:1 [1]. Radio Frequency communications design, security related identification systems, and defense related system level design projects are also not easily outsourced. Power related projects are also not easily outsourced although some of the power electronics design and manufacturing is. On the other hand, it is anticipated that non-engineering firms particularly in the financial and service sectors will be hiring more engineers [12].

## Changes to the ECE Curriculum in an Outsourcing Age

Outsourcing is a reality, not a fiction. It does have a significant impact on ECE employment, enrollment, and ECE related activities. The ECE engineer of the 21st century must be ready to work in an environment that embraces, accepts, and accommodates global production via outsourcing. That same engineer must also have unique qualifications that distinguish him/her from the rest of the world, and make them worthy of high wages that are currently 5 to 10 times higher than those attained in the Far East. The goal is not to go back to the days of heavy ECE enrollment, but to chart the course for a sustainable ECE curriculum that meets the needs of industry and continues to move the US forward as a leader in a high-tech world. The change needed is twofold: macroscopic and microscopic. At a macroscopic level the change is largely related to enhancing the soft skills of the graduating engineer, while at a microscopic level, the change is specific and is related to classical ECE study subjects. Underlying both aspects of change are three key factors that are a must for all engineers:

- Engineering graduates must be capable of teaching themselves.
- Engineering graduates must have capstone design experience and research experiences, thus learning how knowledge is generated and applied [12].
- American engineers are the most creative [3]. The spirit of innovation, problem solving, and creating new products should be nourished.

<u>Macroscopic level change (the soft skills):</u>

- Enrich the entrepreneurial experience. Provide graduates with an appreciation of consumer needs, domestic and foreign markets, and market needs [12].

- Strengthen multi-disciplinary and inter-disciplinary team experiences [1-6].
- Offer the opportunity for students to study abroad, experience another culture. Also, encourage graduates to learn a foreign language, and strengthen global awareness.
- Strengthen communications skills, particularly across international boundaries.
- Encourage early involvement with industry through externships, internships, coop programs, or simply training [2].
- ECE graduates must be skilled team leaders and project organizers [12].

Microscopic level change (technical skills):

- Use State-of-the-art software packages and design suites. Employers are still asking about these skills because they need engineers that are ready to produce [4].
- Strengthen the analog electronic program particularly analog integrated circuit design and mixed signal design. Analog design requires collaborative efforts with sustainable skills that are passed on from team to team, class to class, and instructor to instructor [1].
- Strengthen the RF communications program.
- Prepare graduates through courses and research to undertake defense and security related projects.
- Provide the graduate with a system level design experience. This can be done in senior design or in junior level design projects.
- Introduce graduates to embedded system design, operating system development, and sanity control.
- Teach power systems, energy conversion, power electronics, and power transmission.
- Avoid any projects that require mundane and repetitive work. These are the skills that are most likely to be outsourced. Expose graduates to these skills but there is no need for continuous drilling and emphasis. Focus on the system level view.
- Consider requiring courses in biology, neuroscience, and nanotechnology. The life sciences are the fields where significant discoveries are likely to occur. At least make sure your graduates can teach themselves about these issues should they become critical for continued employment.
- Do not ignore the fundamentals in mathematics, physics, and chemistry. Creativity thrives on solid grasp of the fundamentals. Be flexible, however, with allowing students to explore discrete mathematics, linear algebra, probability and statistics, combinatorics, in addition to traditional calculus based mathematics [12].

Many institutions have began to adopt many of the changes listed above. While some of the well known technically-driven ECE programs have began to reconsider the soft skills of the graduating engineers, new programs have adopted the approach of increased industry involvement, research experiences, and capstone system level design. The proposed microscopic level changes are also taking place and are simply driven by the students themselves. Students are demanding these experiences from their institution in response to market changes and employment opportunities.

## Conclusions

When EE unemployment exceeded the national average [10], warning bells rang across the US. While some defended outsourcing, and others attacked it, many companies outsourced a sizable portion of their activities, and are continuing to consider further outsourcing. With significant wage differential and tough competition in a global market, outsourcing is a flourishing business practice. While ECE professionals and programs are recovering from the impact and shockwaves of outsourcing of the last few years, it is clear that change in the ECE curriculum is necessary. Change is needed not just for the viability of the ECE profession but also for the leadership, potential, and security of the US. This paper has proposed two levels of change; one that focuses on the soft skills of the graduating engineer, and one that strengthens technical ECE skills that are not easily outsourced and are in fact hard to find. The proposed changes are based on numerous reports and studies that have examined the issue of outsourcing. These proposed changes are already taking place at many US institutions. While it is not expected that the number of ECE professional would go back to the peak levels of 1987, it is crucial that ECE curricula respond to outsourcing by graduating creative engineers that are multidisciplinary team leaders, knowledge generators, system level designers, and that are globally aware, business minded, and strong in the fundamentals.

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## Biographical Information

ISMAIL JOUNY: He received his BS degree in Electrical Engineering from Beirut University (with Honors) and his MS and Ph.D. degrees from The Ohio State University in 1984, 1987, and 1990 respectively. He has been with the Department of Electrical and Computer Engineering at Lafayette College, where he is currently Professor and Head of the department.