

Transforming Electronics Engineering Technology by Infusing Photonics

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Abstract: During the last 15 years most of the electronics engineering technology programs across the nation have experienced a steady decline in enrollment. Today's high school students don't seem to consider a career in electronics engineering appealing enough to commit to a field of study in desperate need of new students. They still associate electronics programs with the electronics section of a department store: televisions, stereo systems, DVD and VCR players, and other disposable electronics. While this downward trend continues across the nation, Indian River State College (IRSC) has been able not only to stop it, but to reverse it by attracting a new generation of students. By introducing high school students to new and emerging technologies, their perception of established degrees has changed and their interest has been stimulated. Photonics is one of those technologies capturing students' attention. IRSC, a partner college in the National Center for Optics and Photonics Education (OP-TEC), has created the Robotics and Photonics Institute, a new way of "packaging" the Electronics Engineering Technology program. The institute requires a competitive application process, and offers an optimal schedule of classes from Monday – Thursday, 8:00 am – 12:15 pm. The targeted marketing and recruiting for the Robotics and Photonics Institute has led to an increase in full-time student enrollment of 275% in 2006, 45% more in 2007, and 15% more for 2008 at which point we have reached maximum capacity for our existing facilities.

1. Introduction

Beginning with the 1990s the state of Florida experienced a steady decrease in student enrollment in electronics engineering technology (EET) programs [1]. This decline was not only local to Florida, but was common through most of the United States [2]. Even though everyone understands that the variety of electronic equipment and devices we use daily is increasing, still we experience a reduction in interest in the study of electronics engineering technology. At many community colleges across the nation, electronics programs shut their doors without much of a struggle. Indian River State College would not accept defeat without a good fight. The problem was examined from all angles in order to discern its root causes; then a solution, and a strategic plan for implementing it was devised. Out of the traditional electronics program, the Robotics and Photonics and Institute (RPI) was created and initiated in the Fall of 2006 with 100% capacity. The photonics curriculum was developed with assistance from OP-TEC, which offers a complete series of books with associated laboratory experiments in basic optics and lasers [3]. This paper presents the successful approach of Indian River State College in solving a problem that has distressed many electronics departments of community colleges throughout the United States. It is our hope and desire to help any other college experiencing similar problems, and to provide advice and suggestions on how to overcome them.

2. The problem

The low enrollment in electronics programs is caused by the following factors: the students do not understand the depth and breadth of the electronics industry, curriculum was not updated to include the new technologies, and the marketing of the electronics programs was non-existent or inadequate. Even though many educators identified one or more of these problems, the bureaucratic system of most community colleges was slow to react and remedy the problem fast enough before the “death” of the program [4].

2.1 Students do not understand the depth and breadth of the electronics industry

The electronics industry has been around for more than 100 years and has become the under-grid of almost all modern technologies such as telecommunications, biomedical, biotechnology, genetics, computing, industrial automation and controls, robotics, electro-optics, lasers, fiber optics, entertainment electronics, warfare and anti-warfare electronics, electronic publishing, laboratory instrumentation, and many others. However, the word electronics has been stereotyped to the television, VCR, DVD, audio systems and other home appliances for which the cost of repair is higher than the cost of a newer, cheaper appliance with more features. These home electronic appliances belong to the consumer electronics sector which no longer needs technicians because of the disposable nature of these products. To change this stereotypical misconception an intensive educational and, at the same time, promotional campaign must be undertaken. All promotional material produced needs to avoid mentioning the consumer electronics sector. It should present and emphasize the new technologies of lasers, photonics, robotics, biotechnology, medical electronics, etc.

2.2 Modernizing and revisiting the old curriculum

Many instructors and institutions are reluctant to change their curriculum. Some are so adamant about not modifying their curriculum, they almost consider blasphemous any attempt to change it. The curriculum must change every so many years in order to add the new technologies in our AS or AAS degree programs. The fact that these degree programs have to remain at the length of two years and at a fixed number of credit hours makes it imperative that we revisit the existing curriculum, and remove what is no longer needed, to make room for the new knowledge. In the 1970s for example, in a digital electronics course we taught the discrete transistor circuitry that made up an individual AND gate. In the 1980s we stopped teaching what is “under the hood” of the AND gate because we had to make room for decoders, encoders, multiplexers and demultiplexers. As more digital devices were invented, we had to constantly go back and take something out in order to make room for the new. The same approach should be applied systemically to the entire electronics program. First the new technologies that need to be introduced have to be identified, and then the curriculum has to be reviewed to determine what should be removed. This needs to be done without compromising the quality of the technician we will produce. All the core courses of DC and AC circuits, Discrete and Integrated Analog circuits, need to be reevaluated, their scope aligned to the needs of today’s industry, and all the non-essential circuit analysis and design removed to make room for the new courses.

The fields of photonics and robotics are very attractive and are very well received by prospective students, young and old. Courses in these modern specialties need to be added to the curriculum and promotional materials produced, showing that education in these new technologies will lead to high-wage paying jobs in the service area of the college and beyond.

2.3 Program Marketing and Student Recruitment

Most community colleges spend very little in the marketing of their electronics programs and do not have professional marketing personnel or even a marketing department. The marketing effort of most colleges with enrollment problems consists of creating usually unattractive, single color brochures that are stacked up in a few display areas around the college. In some colleges an additional effort is made to take these brochures to different area high schools and distribute them to students. Community colleges seldom place television or radio advertisements for marketing their programs and recruiting students. In contrast to this, private electronics colleges advertise on television regularly during prime-time and on the radio more frequently. Even though the cost of attending these private colleges is usually more than six times the cost of a community college, the private schools have not experienced as dramatic a decrease in enrollment as community colleges did. To the contrary, in some parts of the country, proprietary colleges expanded. The reason for this is the intense and effective marketing and recruiting effort of the for-profit colleges. These colleges have a coordinated marketing campaign consisting of attractive colorful print publications, professionally produced interactive websites, and trained marketing people who are paid well only if they produce results. Community colleges can stand against this professionally organized campaign of the proprietary schools by selling their strong points: much lower cost to the student and better educated faculty which typically have higher scholarly credentials, accredited by the high caliber accreditation boards. This has to be emphasized with appealing colorful print and electronic promotional material, and community colleges have to employ recruiters that are constantly in the field marketing their programs and their advantages.

3. The Idea of the Robotics and Photonics Institute

At Indian River State College, the electronics department, in consultation with its industrial advisory committee, decided to infuse the emerging fields of robotics and photonics into the traditional electronics engineering technology AAS degree program.

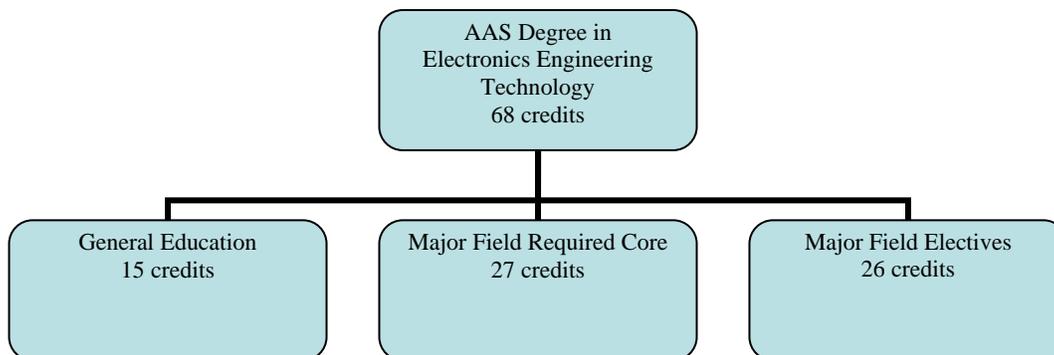


Figure 1. Breakdown of the Electronics Engineering Technology Program

The electronics program consists of 68 credit hours, 15 of which are devoted to general education courses. The remaining 53 credit hours are technical courses required to produce a quality technician. The 53 credit hours of technical courses are divided into two groups, the major field required core (27 credit hours) and the major field electives (26 credit hours), as shown in figure 1. The major field electives group included the specializations of telecommunications, computer support and biomedical. We modified the electronics program by adding the Photonics option and the Robotics/Manufacturing Automation option. Each of these options consists of a group of courses totaling 26 credit hours, as shown in table 1. Once a student completes the general education and the major field required core, he or she can choose one of the four options or “cherry pick” courses from any of the four options for a total of 26 credit hours. After studying the needs of the local industry and with the endorsement of our advisory committee, we decided to create the Robotics and Photonics Institute. This program would consist of the 15 credit hours of the general education, the 27 of the major required courses, 15 hours of photonics and 11 hours of robotics as shown in table 2, and would appeal to today’s high school students.

MAJOR FIELD REQUIRED COURSES – 27 credits

CET	1440C	Computer Aided Schematic Design	3 credits
EET	1015C	DC Circuits.....	3 credits
EET	1025C	AC Circuits.....	3 credits
EET	1180C	Troubleshooting & Repair Techniques.....	3 credits
EET	1215C	Introduction to Electronics.....	3 credits
EET	2141C	Electronic Devices I.....	3 credits
EST	2542	Programmable Logic Controllers I	3 credits
EST	2544	Programmable Logic Controllers II.....	3 credits
MTB	1322	Technical Mathematics II	3 credits

SPECIALIZATION ELECTIVES – 26 credits

PHOTONICS OPTION

CET	1112C	Logic Circuits I.....	3 credits
CET	1113C	Logic Circuits II.....	3 credits
EET	2142C	Electronic Devices II	3 credits
EST	2210	Introduction to Photonics.....	3 credits
EST	2215	Geometrical Optics	3 credits
EST	2220	Fiber Optics and Data Communications	3 credits
EST	2230	Laser Technologies.....	3 credits
EET	2930	Special Topics in Electronic Engineering.....	5 credits

ROBOTICS/MANUFACTURING AUTOMATION OPTION

CET	1112C	Logic Circuits I.....	3 credits
CET	1113C	Logic Circuits II.....	3 credits
EET	2142C	Electronic Devices II	3 credits
EST	2630	Manufacturing Processes	3 credits
EST	2631	Advanced Manufacturing Processes	3 credits
EST	2676	Introduction to Robotics	3 credits
EST	2678	Industrial Robotics.....	3 credits
EET	2930	Special Topics in Electronic Engineering.....	5 credits

BIOMEDICAL OPTION

CET	1112C	Logic Circuits I.....	3 credits
CET	1113C	Logic Circuits II.....	3 credits
EET	2142C	Electronic Devices II	3 credits
EST	2424	Biomedical Electronics.....	3 credits
EST	2427	Advanced Biomedical Electronics	3 credits
EST	2408	Biomedical Seminar.....	2 credits
HSC	2531	Medical Terminology I.....	3 credits
EST	2210	Introduction to Photonics.....	3 credits
EST	2230	Laser Technologies.....	3 credits

TELECOMMUNICATIONS OPTION

CET	1112C	Logic Circuits I.....	3 credits
CET	1113C	Logic Circuits II.....	3 credits
EET	2142C	Electronic Devices II	3 credits
CET	1854	Introduction to Wireless Technologies	3 credits
EET	2325C	Communication Circuits I.....	3 credits
EET	2335C	Communication Circuits II	3 credits
EST	2220	Fiber Optics and Data Communications	3 credits
CET	1854	Introduction to Wireless Technologies	3 credits
EET	2930	Special Topics in Electronic Engineering.....	2 credits

COMPUTER TECHNOLOGY OPTION

CET	1112C	Logic Circuits I.....	3 credits
CET	1113C	Logic Circuits II.....	3 credits
EET	2142C	Electronic Devices II	3 credits

CET	1041	HTI+ Certification	3 credits
CET	1178	A+ Certification Training I.....	3 credits
CET	1179	A+ Certification Training II.....	3 credits
CET	1588	Network + Certification	3 credits
CET	1854	Introduction to Wireless Technologies	3 credits
EET	2930	Special Topics in Electronic Engineering	2 credits

Table 1. The modified AAS Degree Program

MAJOR FIELD REQUIRED COURSES – 27 credits			
CET	1440C	Computer Aided Schematic Design	3 credits
EET	1015C	DC Circuits	3 credits
EET	1025C	AC Circuits	3 credits
EET	1180C	Troubleshooting & Repair Techniques.....	3 credits
EET	1215C	Introduction to Electronics	3 credits
EET	2141C	Electronic Devices I	3 credits
EST	2542	Programmable Logic Controllers I.....	3 credits
EST	2544	Programmable Logic Controllers II.....	3 credits
MTB	1322	Technical Mathematics II.....	3 credits
PHOTONICS/ROBOTICS SPECIALIZATION COURSES - 26 credits			
CET	1112C	Logic Circuits I	3 credits
CET	1113C	Logic Circuits II	3 credits
EST	2210	Intro to Photonics	3 credits
EST	2220	Fiber Optics and Data Communications.....	3 credits
EST	2230	Laser Technologies	3 credits
EST	2676	Introduction to Robotics.....	3 credits
EST	2678	Industrial Robotics	3 credits
EST	2630	Manufacturing Processes.....	3 credits
EET	2930	Special Topics in Electronic Engineering.....	2 credits

Table 2. Robotics and Photonics Institute Curriculum

4. Marketing and Promotional Campaign

Colorful flyers were produced explaining the program in detail and educating the reader about the many high-wage jobs awaiting upon graduation. A point was made to compare the high cost of the proprietary schools to the cost of IRSC. The newly packaged program was marketed as the Robotics and Photonics Institute (RPI), a selective admission program requiring an application process with minimum entrance requirements. The courses for RPI are scheduled Mondays through Thursdays from 8:00 a.m. to 12:15 p.m., and the applicants commit to taking all the courses as a cohort group from the beginning to the end of the degree. The complete program of study of the Robotics and Photonics Institute can be seen in table 3. The RPI is presented by a dedicated recruiter to ten area high schools and the workforce retraining office. The recruiter visits every high school every other week and meets with students, counselors and teachers. The students showing interest in the program are assisted and guided through the

college application process, taking the college placement test, and applying for scholarships and financial aid. The recruiter organizes monthly information sessions for prospective students and their parents. During these sessions the department chair explains the RPI, the type of employment available to graduates, the future outlook and salaries, and then gives a tour of the labs. A special open house for high school seniors is organized every year during the fall semester, and an evening open house for students and parents is typically organized in the spring semester. During the summer semester a one-week summer camp in emerging technologies is offered for high school juniors and seniors.

FIRST YEAR							
FALL TERM	Days	Time	Cr	SPRING TERM	Days	Time	Cr
EET1215C Intro to Electronics	T/R	8:00-9:15	3	CET1140C Schematic Design	T/R	8:00-9:15	3
MTB1321 Tech. Mathematics I	T/R	9:30-10:45	3	MTB1322 Technical Mathematics II	T/R	9:30-10:45	3
CET1112C Logic Circuits I	T/R	11:00-12:15	3	CET1113C Logic Circuits II	T/R	11:00-12:15	3
EET1015C DC Circuits (Fall A)	M/W	8:00-10:30	3	EET2141C Electronic Devices I (Spring A)	M/W	8:00-10:30	3
EET1025C AC Circuits (Fall B)	M/W	8:00-10:30	3	EET2142C Electronic Devices II (Spring B)	M/W	8:00-10:30	3
Term Total:			15	Term Total:			15
SUMMER TERM							
ENC1101 English Composition I			3	PHY1020			3
EET1180C Troubleshooting and Repair Methods			3	Principles of Physics			
SECOND YEAR							
FALL TERM	Days	Time	Cr	SPRING TERM	Days	Time	Cr
EST2542 Programmable Logic Controllers I	M/W	8:00-9:15	3	EST2544 Programmable Logic Controllers II	M/W	8:00-9:15	3
EST2676 Introduction to Robotics	M/W	9:30-10:45	3	EST2630 Manufacturing Processes	M/W	9:30-10:45	3
EST2210 Intro to Photonics	M/W	11:00-12:15	3	EST2230 Laser Technologies	M/W	11:00-12:15	3
ECO 2000 Intro to Economics	T/R	8:00-9:15	3	EST2220 Fiber Optics and Data Communications	T/R	8:00-9:15	3
POS 1041 American Government	T/R	10:00-11:15	3	EET2930 Special Topics	T/R	9:30-10:45	2
Term Total:			15	Term Total:			14
Program Total:						68 Cr	

Table 3. Photonics and Robotics Institute Program of Study

5. The Fruits of Our Labor

By the middle of July 2006 the RPI was full to capacity and we had to direct many applicants to our evening program. As it can be seen from figure 2 the enrollment increase was sharp from 2006 onwards. For the upcoming semester of fall 2008 we are already full to capacity, and the only future growth will be in our evening program until we build new labs and classrooms. The cohort arrangement brought the students close to each other, and a strong feeling of camaraderie is evident in the classroom. They all help each other toward their common goal, which is graduation and the landing of a good paying job. The students form their own study groups and assist each other not only with college activities, but give each other private personal assistance as well.

On our departmental website, which is used for instructional purposes, we have added general information about the robotics and photonics industry, about how to transfer to a bachelor's degree program at the University of Central Florida, and we also keep an active board posting part and full-time jobs. All these synergistic activities produce a spirit of caring and cooperation between the students and the faculty of our department.

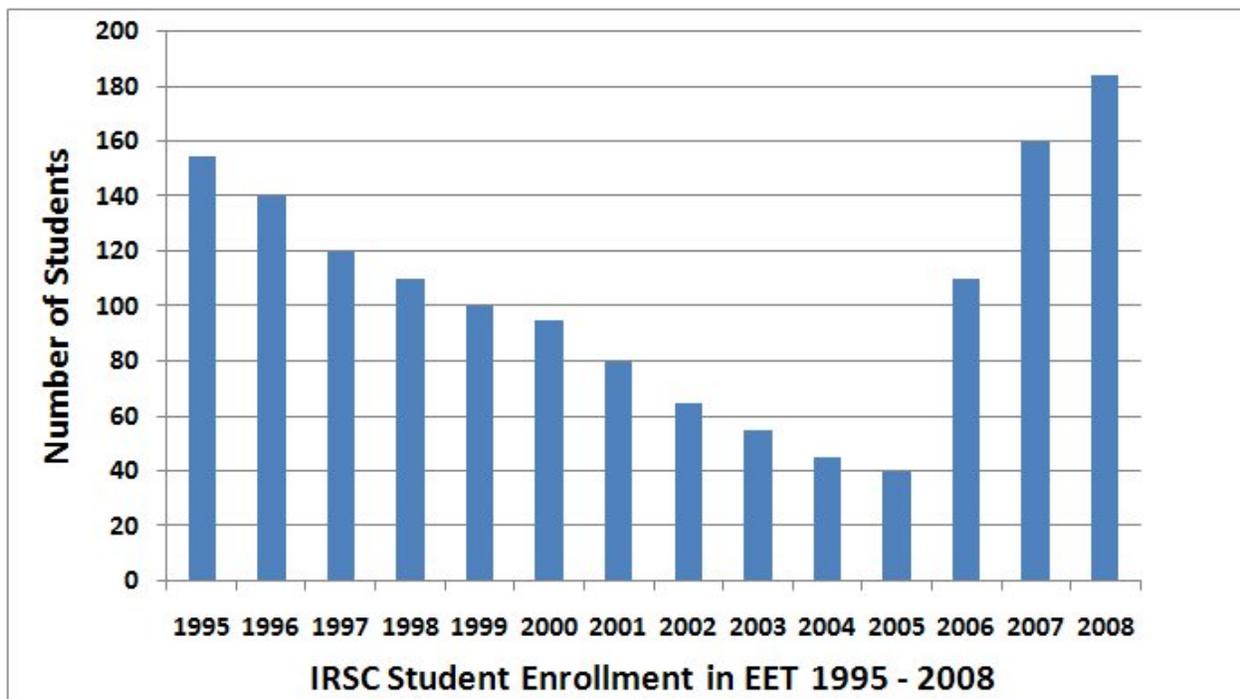


Figure 2. Enrollment History

6. Future Plans and OP-TEC

We are planning to add a fourth course in the photonics option which will consist of several modules of laser technology applications. These modules are under development by OP-TEC with support from the National Science Foundation. The location of IRSC on the Atlantic coast

of Florida, and its proximity to three world-class ocean research institutions, prompted the exploration of a cutting-edge application of photonics in bioluminescence. We are in discussions with all of our research partners for the purpose of creating educational materials for these technologies, training technicians for their special needs, and assisting them in their mission of exploring and protecting our oceans and ports.

7. Conclusion

Electronics engineering technology education is a moving target. One cannot rest after the successful implementation of a program. We need to be vigilant and continually scan the horizon for the new technologies that are appearing and taking root. Curriculum must be revisited, updated, and modernized to not only satisfy the needs of today's industry, but to anticipate the new needs created by the emerging technologies. Engineering departments need to be visionary, forward-looking, risk-taking, and flexible in the creation and delivery of new knowledge. Industry cannot wait for the slow bureaucratic wheels to turn. Colleges have to deliver at the speed of industrial changes and not the speed of intra-college bureaucracy. The presentation and marketing of our educational programs is as important as the technical content of our degrees. Hiring a dedicated part-time recruiter is the most effective way to ensure continual and steady student enrollment. The revenue from just two new full-time student will more than cover the cost of the part-time recruiter.

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