AC 2009-427: THE NEW ELECTRONICS TECHNOLOGY, CIRCA 2015

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The New Electronics Technology – Circa 2015

Abstract - *Across the nation, numerous legacy electronics technology (ET) programs at the two-year college level are experiencing declining enrollments and are struggling to maintain their existence in the face of a persistent lack of students and a nation-wide declining demand for electronics technicians. As Moore's Law continues to impact and transform the electronics field one wonders what skills will be needed by electronics technicians by the middle of the next decade (2015) and beyond or if there will be any demand for students that have the typical skill sets of electronics technician graduates of this decade. Recently, within the faculty ranks teaching in this area, there has been more discussion about the future and an increasing sense of urgency that curriculum change is needed or there will be an ever increasing disconnect between what skills business and industry desire and what is being taught in typical ET associate degree programs. Many forward looking faculty have signed on to the idea that a more systems oriented approach is needed but are unsure as to exactly how one implements that on a course by course or total program basis. A recent National Science Foundation funded Advanced Technology Education (ATE) project has started to develop system based course materials and has asked for input from faculty from across the nation. However, the basic question remains, what will be the skills needed in the middle of the next decade or in the year 2020? How can we as faculty predict the future of the field and modify curricula appropriately in anticipation of change? A good place to start is the most recent report (2007) of the International Technology Roadmap for Semiconductors (ITRS) organization coupled with several obvious technology trends that have been in progress over the past decade and that in all likelihood will continue over the next decade. Furthermore, new student-centered teaching strategies such as case studies and problem based learning that emphasis a systems approach must be considered as part of the equation. This paper will attempt to provide an insight into the new electronics of 2015 and what it will mean to the education of electronics technicians.*

I. Overview

The changes brought about by the predictable, ever shrinking dimensions of the basic semiconductor device, the transistor (as originally observed by Intel's Gordon Moore in a 1965 paper), have started to have an increasingly adverse impact on two-year college programs that have traditionally educated students for careers in the occupational field known as electronics engineering technology (EET) or simply electronics technology (ET). Nationwide, overall enrollment in many of these legacy technology programs have continued to be running below historic averages and have even caused the faculty of some programs to become fearful of eventual program elimination! If one looks at the statistics available from the National Science Board (NSB), the total number of students enrolled in the field of Engineering Technology (typically in the fields of civil, electrical/electronics, construction, computer, and mechanical technology) continues to follow a downward trend from an all time high in the early 1980s to today's lower full time equivalent (FTE) student count. The figures for the most recent year available (2005) indicate an almost 50% drop in the number of Engineering Technology degrees awarded during a twenty year period. Coincidently, one might note that during the same time period there has been an over 200% increase in the number of AS degrees awarded in the computer sciences[1]. Enrollment problems in electronics technology programs have not occurred overnight but after approximately four decades of the self-fulfilling prophecy of what has become known as Moore's Law, continued semiconductor microminiaturization and the attendant, relatively recent, evolution to system on a chip (SoC) technology has become in this author's opinion one of the major drivers of the decline in EET program enrollments. Ironically, according to Moore, "Moore's Law is a violation of Murphy's Law. Everything gets better and better."[2] and that is the real crux of the problem! Many would submit that Moore's Law describes the driving force of technological and social change in the late 20th and early 21st centuries and that change has indeed been considerable. This fairly accurate prediction of the evolution of semiconductor technology has also precipitated a significant change in the role of the electronics technician as the industry has been transitioning to a "systems based" implementation of electronics and will continue to do so for the foreseeable future. EET programs that continue to teach electronics from a "component perspective" will be handicapping their graduates in this newer, systems based, paradigm.

So what has been the reaction to declining enrollments? As pointed out elsewhere[3], in the United States, government policy setting organizations like the NSB have been busy attempting to advance the agenda of increased enrollment in the engineering technologies under the umbrella discipline know as "science and engineering" (S&E). The major thrust of this undertaking has been through the efforts of the National Science Foundation (NSF) and in particular the Advanced Technology Education (ATE) program and its ATE Centers[4] at the post-secondary school level and through science, technology, engineering, and mathematics (STEM) initiatives at the K-12 level. While many of the ATE projects and Centers tend to address new and emerging technologies, several ATE projects are attempting to address the perceived declining state of electronics technology education. One of these NSF funded projects is titled, "*A New Systems View of Electronics for 2010",* and is run under the auspices of MATEC[5] a mature NSF ATE Resource Center. This particular project has enlisted ET and EET faculty from across the nation to provide input into the transformation of the classic "component oriented" electronics technology curriculum to an updated "systems oriented" approach that is more student centered and provides for an earlier introduction to applications of electronics. This multi-year project (nicknamed eSyst) has started the process of transforming curricula for the core electronics technology courses (i.e. basic DC/AC circuit theory, solid-state electronic devices, digital fundamentals, etc). An eSyst web site[6] presents the results of these efforts to-date and news about the project's overall status and future goals. Each summer an eSyst workshop is held in conjunction with the annual SAME-TEC conference (a name change will occur for the 2009 conference – to be now called the HI-TEC conference). This workshop allows for feedback and interaction from a national audience of interested and enthusiastic faculty participants. Other efforts have been on a more ad hoc basis. This author has presented several papers and given presentations[7,8,9,10] about needed curriculum change at national conferences and others have presented or written position papers about their views on this topic and have proposed possible ways to alleviate the problem of declining enrollments and also how to modify the curriculum in a way that makes it more appealing to today's students[11,12,13]. In a related initiative, a regional, collaborative group of EET faculty typically get together twice a year to provide direction and modifications or changes to the electronics portion of the curriculum of the long running Verizon NextStep Program[14] that leads to an AAS degree in Telecommunications Technology. Recently, the decision was made by this group to adopt a change in curriculum to emphasis "systems" and in doing so discontinue the detailed presentation of the theory of discrete semiconductor operation as an important electronic curriculum topic. More will be said about this innovative curriculum modification later.

How have EET faculty reacted to the problem of declining enrollment? During this past decade, numerous legacy EET programs at the two-year level have opted to become networking (read Cisco) and computer repair oriented (read A+) based programs by adding these options to their degree requirements. Many EET faculty will say that these changes have prolonged their teaching careers and raised program enrollments. Others have modified their curricula to present electronics applications earlier in the sequence of courses to keep student interest high and/or added courses that are perceived to be high interest topics to attract new students. Still others have embraced emerging technologies, retaining core electronics courses and offering second year technical specialty courses that lead to several different degree options that are electronics based. This philosophy has been recently put forth as a solution to declining EET enrollments in a detailed white paper[15], issued by the NSF ATE OPTEC Center, that outlines the process. Lastly, one of the results of the continued microminiaturization of electronics is the proliferation of electronic systems into legacy and emerging technology areas that are both non-electronics and partially electronics based such as alternative energy, automotive, biomedical, computer, energy systems, laser optics, photonics, building automation, and telecommunications technology, to name but a few. This trend has led to EET faculty being asked to teach more and more courses in DC/AC electrical circuit fundamentals or customized electronics courses or modules to support students of these other technologies. EET has started to assume the roll as a support or service department for these other technologies similar to the roll of math, physics, etc.

II. What does the future hold?

Moore's Law has been vilified earlier in this paper by implying that it has somehow been having a detrimental effect on EET program enrollment. Of course it is not Moore's Law that one should point to but rather the evolutionary change in technology due to the successful industry realization of improvements in semiconductor manufacturing that has been and still is predicted by Moore's Law. This author would submit that a tipping point was reached sometime during this current decade when the semiconductor industry made yet another decrease in the smallest dimensions (line width) needed to manufacture transistors. While no one has attempted to put a number on this tipping point or assign it a date, it occurred when it was possible to integrate enough transistors on a chip to allow the move to the system on a chip (SoC) technology paradigm and some of the other closely related integrated circuit architectures like the programmable system on a chip (PSoC), the sensor system on a chip (SSoC), or the less effective, system in package (SiP) design. The goal of this paper is not to explore these particular technologies but to instead make educated inferences as to how they will affect the teaching of electronics technology as they evolve further. Many of us involved in the business of educating students in this field have been well aware of the ever increasing number of transistors that it is possible to be put on a chip but have been much less prepared for this fairly disruptive technology embodied by the SoC paradigm. A good example of this is how quickly industry transitioned from legacy 7400 series logic to programmable logic arrays (PLAs) and the concept of "functional cores" (i.e. general purpose sub-systems that can be designed or programmed to perform needed system functions). If you can, find a 7400 series logic chip on a PC board manufactured recently or during the last decade for that matter! However, we still find that the best selling text books on digital logic have only recently added material on today's very pervasive and firmly entrenched PLA technology. Today's technology allows for the integration of digital, analog, mixed-signal, and RF functions all on the same chip eliminating the need to use separate ICs to achieve complex system designs.

So what does Moore's Law and the International Technology Roadmap for Semiconductors[16] (ITRS) report tell us? Let's start with Moore's Law (see Figure #1).

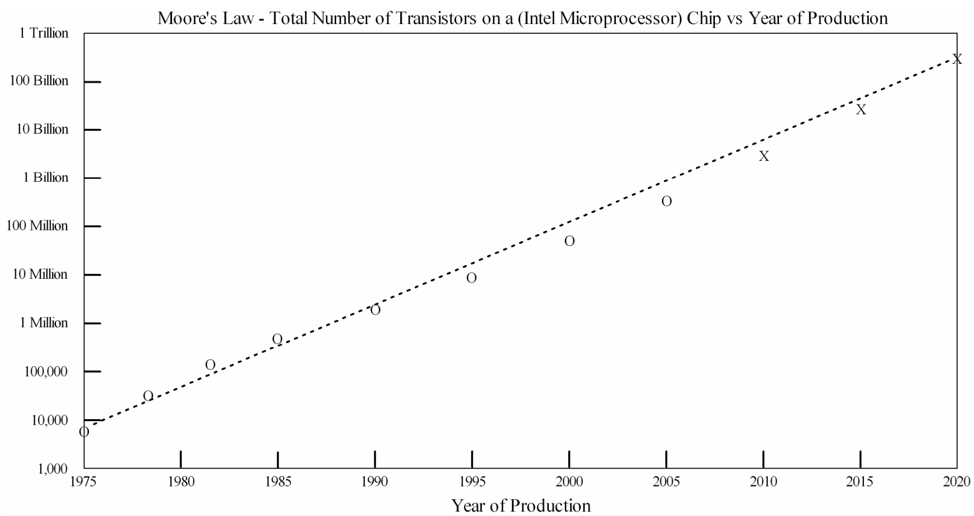

Figure #1 – Moore's Law and the total number of transistor on Intel microprocessor ICs

If the progression in the number of transistors on a chip maintains its present pace, by 2015 the number of transistors theoretically possible on a fairly homogenous (i.e. single function) chip will be somewhere in the order of 10s of billions to 100s of billions (approaching trillions by the end of this next decade). For more complex mixed-signal chips the total numbers of transistors are conservatively an order-of-magnitude less. At this point, the sheer numbers of transistors possible should not raise many eyebrows since this type of continuing increase in memory size for PCs has been going on for the last three decades. However, what is somewhat more thought provoking, is the fact that a memory stick in the latter part of the next decade might have a capacity that is approaching the order-of-magnitude of a terabyte! Again, many are use to the seemingly never ending increase in random-access-memory or flash memory chip size or the constantly increasing capacity of a computer hard drive. But what about the chips that we use to build electronic systems or to build these PCs? For some time now VLSI/GSI/ULSI (take your pick) designers have been transitioning to "system-on-a-chip" (SoC) technology as we have passed into the gigascale technology era. Repeating an earlier theme, what this means is that by combining complex electronics with MEMS and/or nanoscale device technology we can build entire subsystems and/or complex (electronic/photonic/biomedical/etc) systems on a single IC chip. The benefits of this are many for the end users of the products but not very helpful in maintaining a demand for EETs. Essentially, the electrical engineering profession is increasingly designing consumer products that do not need the support personnel or support system that they used to. This does not mean that there are never any failures in electronic or electronic based systems, on the contrary, as large numbers of a typical product are sold, probability theory tells us that there will be so many failures per month or some other standard time frame with the total number of failures proportional to the number of units in operation. However, today and even more so in the future, the cost required to repair items fabricated in mass production quantities usually does not justify the repair and typically the item is simply replaced (often by a more functional, lower costing, equivalent device). Hence, another example of the so called "throw away society"! Of course, very expensive electronic based systems that have a limited market and yet are mission critical for the enterprise that uses them will certainly need service and repair in the case of failure. In the end, we will continue to need some technical expertise in the manufacturing of mass produced products, more closely coupled technical expertise for more costly limited market products, but overall a lesser need for electronics technicians for product support!

This last contention is also supported when one looks at reliability theory. When applied to electronic components, it is non-intuitive. It tells us that the number of transistors integrated on a chip does not fundamentally influence the chip's failure rate. Rather amazingly, the chip failure rate remains fairly constant whether there are 50 or 500 million transistors integrated on the chip! The net result of this fact tends to be more reliable electronics based systems simply due to the denser packing of transistors on the chip even in the face of increased chip functionality! Certainly, redundancy will most likely be increasingly used to increase reliability even if the overhead is high because the incremental cost to implement it in will be relatively low! Again, more reliability translates into less after-market support and less need for EETs in product support!

What about the IRST prediction? This report is produced every two years (during odd numbered years) and is updated every even number year by an international consortium of semiconductor manufacturers using years of collective manufacturing experience, known, predicted, and perceived manufacturing roadblocks, and predicted or proposed production work-arounds that will allow for the continued doubling of the number of integrated transistors approximately every 24 months. The report for 2009 has not yet been released but the 2008 update (see Figure #2) calls for continuing improvements in many areas of semiconductor technology in conformance with Moore's Law, with functions per chip for some technologies even exceeded Moore's Law and this trend extending past the start of the 2020 decade. Figure #2 shows the ITRS predictions of growth in the number of functions per chip for digital circuits in particular (i.e. logic gates and various types of memory) and in some cases the growth rate is actually greater than predicted by Moore's Law (note that the phrase "more than Moore" has already been coined by the industry!).

Functionality and maximum frequency of transistor operation are two of the key predictors of future trends in the electronics industry and an indication of the products that will be possible to be built. Both of these features continue to scale exponentially[17]. Of course, one can not predict the future with a great deal of certainty but one can see trends that appear to be ongoing. In summary, the overall trend predicted by Moore's Law and the IRST roadmap is for more complex, less cost/function, and more reliable systems on a chip that will operate at higher frequencies (RF applications). To further confirm this fact, one only needs to look at the yearly program for the annual IEEE International Solid-State Circuits Conference[18] (ISSCC) to see descriptions of future IC sub-systems and new, more sophisticated applications of electronics in IC or SoC form as designers showcase their newest electronics innovations and future products.

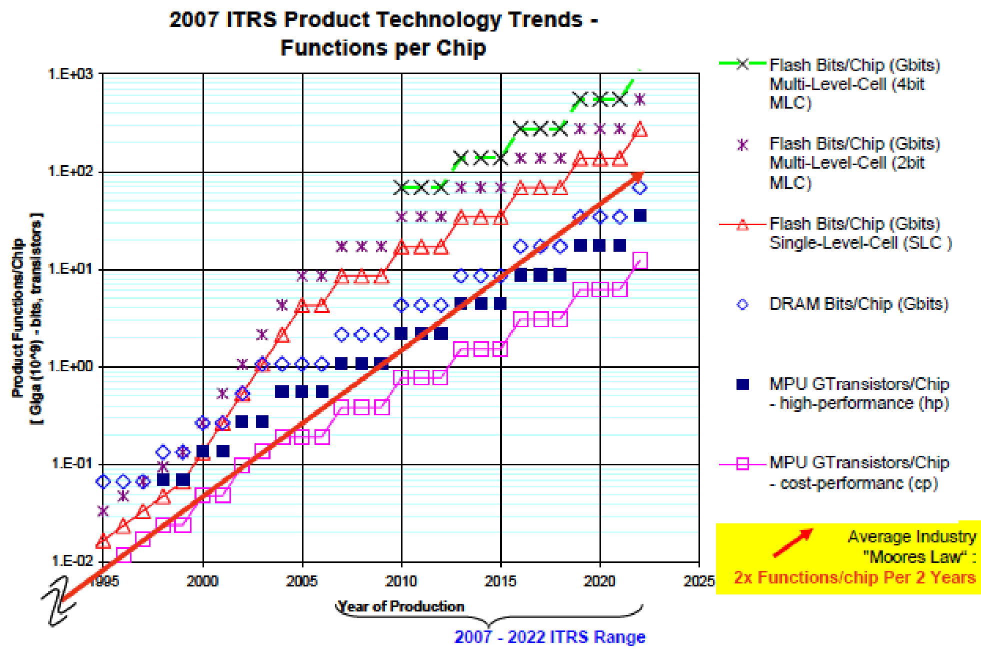

Figure #2 – IRTS Product Function Size Trends – Source: ITRS 2008 Update – Overview

III. Other relevant technology trends

Other relevant technology developments might not seem so obvious to everyone but this author is convinced that several trends that have become integrated into the fabric of today's electronics/computer technology will continue and have an impact on future electronics based systems. The two major trends are as follows: in the near future, every electronic system will be able to be networked (have an IP address if you will) and the network interfaces available will gradually transition to include wireless. Furthermore, the vast majority of electronic based systems will be reconfigurable via either reprogramming (through their network interface) or through self-reconfiguration (evolving functionality) due to the ability of the system to be "user aware", a goal of Intel's technology initiative known as "Platform 2015".

The first trend is a logical extension of what has been happening for some time now. Computing technology has evolved from an era of large centrally located mainframe computers to personal, distributed computing with small form factor computing devices including "hand-held" devices (mobile computing). In all cases, we are now able to access information from any other computer (that will allow us access) from locations anywhere in the world through the world's largest computer network, the Internet. Furthermore, the evolution of semiconductor technology has brought us to a new age of inexpensive embedded controllers accessible through built in web servers or popular network or standard computer interfaces. This trend will continue so that all electronic systems and sub-systems are accessible via the Internet or through some form of in-house network. Having network access to the system will allow for remote diagnostics, software up-dates, and reprogramming to implement a change in function, use, or system characteristics. An extension to this idea of networked electronic systems is the present hot research area of wireless sensor networks. This author is of the opinion that an important new technology convergence is occurring. It is the deployment of systems consisting of networks of complex sensors with embedded (ambient) intelligence coupled with advanced actuators. Combined with modern networking technologies and application-enabling software these systems have the potential to change how we live. Many have predicted a future world with a ubiquitous sensing skin that provides data about almost every aspect of our environment. Networked embedded sensor systems have the potential to significantly impact almost every aspect of human endeavor and commerce by increasing productivity, reducing energy consumption, and improving health and safety[19]. Of course, we as humans have already overwhelmingly expressed our preference for untethered network connections (i.e. wireless) and for many non-personal applications this type of connection makes a great deal of sense for such purposes as machine-to-machine (M2M) or vehicle-to-vehicle (V2V) or vehicle-to-roadside (V2R) connectivity. Or for those instances, where the connection needed can not be fixed and therefore must be wireless in nature.

The second trend is closely tied to the first, in that, future systems having networking connectivity will in all probability allow access to the electronic "cores" of the system and therefore provide the ability to reconfigure the function/purpose of the system as well as provide a mechanism for software updates and diagnostic capabilities. The ability of a system to be reconfigurable is a consequence of the evolution of the electronics "physical layer" from a single fixed purpose (e.g. an amplifier with a gain of 100, a fixed frequency radio transmitter, etc) to programmable electronics "cores" that allow either the user or the system itself to change the operational flow and function of the different hardware elements that make up the system. Of course, this evolutionary trend has been made possible by our ability to integrate sufficient transistors, typical circuit building blocks, and processing cores on an IC chip! Mullett's model of the new physical layer as shown here in Figure #3 illustrates this new paradigm in hardware control and management of the physical layer with access provided by a simple network or computer interface[20].

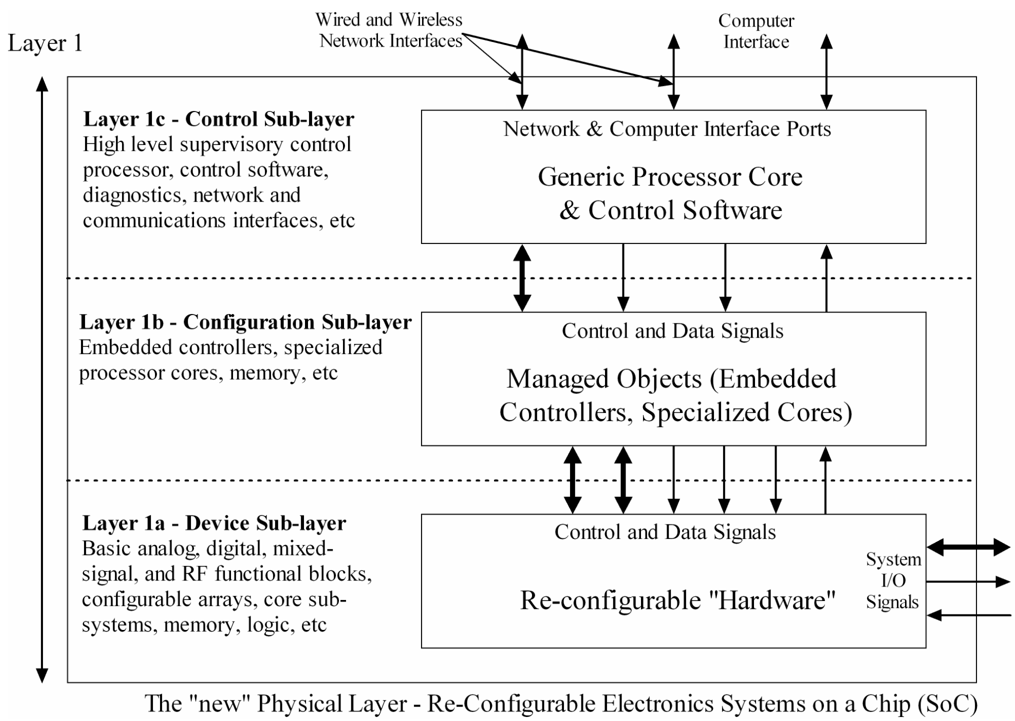

Figure #3 – Mullett's model of the new Physical Layer (Adapted from: *The 2010 Gigascale Imperative*, Proceedings of the 2005 ASEE Annual Conference and Exposition)

Intel's Platform 2015 takes this ability to physically "reconfigure" or "evolve" a step further with "user awareness". In the near future, this is to be accomplished through the use of multiple parallel-processing cores that can not only reconfigure their architecture and interconnections but more importantly can sense the particular use or application that a human has for the hardware and respond accordingly. These evolutionary trends are not the only ones driving the technology of the future but in this author's opinion they are certainly near the top of the list in importance. The integration of extremely large numbers of semiconductor devices and other MEMS devices and nanoscale structures on a silicon substrate and the ability to communicate with these devices in a way that allows for a reconfiguration of their functions, borders on what would be viewed as science fiction a mere twenty years ago. As the industry gains more experience with this technology and makes even more progress at shrinking devices further, the relative cost of the electronics that will be used to perform many amazing applications in the future may tend to approach zero (recall the nickel VAX)!. Furthermore, as we become more comfortable with the technology, realizing that we are physically unable to touch it but are able to "talk to it" and transform it with software, we will talk about repair not in terms of replacing a defective device but in terms of "software patches" or upgrades or reconfigurations or if all else fails – simple, total system replacement.

So what is left for the electronics technician or is there even a need for such a person? The EET that graduates in 2015 will most likely need to still have skills in the following technical areas: basic fundamental knowledge of DC and AC concepts and circuits, embedded controller knowledge coupled with interfacing skills (i.e. sensors, actuators, A-to-D and D-to-A converters, amplifiers, filters, etc), networking knowledge, systems knowledge (i.e. programming, operating systems, electronic system building blocks), and the ability to perform software diagnostics/downloads coupled with electromechanical skills and dexterity with small hand tools. Like today, in the future, system failures will still occur due to connection problems and power supply failures and the technician will still need to be able to deal with these issues. However, by the middle of the next decade, one might want to drop the term "electronics" in EET and replace it with systems. A systems engineering technology (SET) degree might more accurately describe the skill sets needed by the person that deals with the electronics based systems of the future. Furthermore, this technician of the future will most likely be equipped with a handheld multi-purpose "electronic measurement/diagnostic toolkit" as opposed to small hand tools! The need for a soldering iron with today's and tomorrow's reliance on surface-mount technology and multilayer printed circuit boards will be extremely rare! Hand-in-hand with the evolution in technology is the need for the technician of the future to have the soft skills necessary to deal effectively with the end users of technology and/or the team that makes up the group with overall responsibility for the design, manufacturing, sales, and updating/maintenance of sophisticated electric/electronics systems. While soft skills have been a buzz word in the United States for some time (late 1990s), the European Union has more recently undertaken a program of change (*Education and Training - 2010*) to incorporate more of these soft skills into their post-secondary technician education system and to move towards a student centered approach to teaching[21] that focuses more on outcomes and competencies and promotes a culture of life-long learning for all citizens. It is unclear in this author's research whether or not a systems approach has been at the center of any discussions associated with this initiative. Recently, there seems to be more international conferences on engineering and technology education. This is a good development, but international collaborations of faculty at the associate degree level are certainly lacking at the present time and unless there is a government sponsored initiative to promote this type of activity this will probably remain the case for some time.

IV. How can we prepare for this change?

A recent survey of over sixty ABET accredited electrical and electronics associate degree programs reveals that the vast majority (over 94%) of these programs still teach the classical component oriented fundamentals courses (i.e. two DC and AC circuit theory courses, two analog electronic devices courses [sometimes three], and a digital devices course). What has changed somewhat is the earlier introduction of the digital course in the sequence of courses, but what has not changed is the emphasis on components. As components are reduced in importance due to evolving technology these courses lose their relevance to the real world that will greet graduates of these programs if they enter the workforce upon graduation. How do we get from where electronics technology programs are today to where we must go? By morphing our EET programs from component based to system oriented. Of course we can not totally disavow the existence of electronic parts and components but we just don't have the luxury of spending a great deal of time on individual components. Electronics system designers will create the necessary circuits to perform desired system functions. If we focus on the components, we lose the big picture of the system that they are part of. Components are arranged into basic building blocks and connected together to create more complex systems which eventually are marketed as products. The functioning of the system is what needs to emphasized. Transistors, if properly configured through biasing, can be made to amplify or switch signals among other things. But what is more important for the EET student to learn, the correct way to bias the particular device or the concepts of frequency response and/or the gain of the resulting amplifier sub-system? This question becomes even more pertinent in light of the technician's increasingly difficult task of physically accessing the transistor or a particular component or sub-system integrated within a system. More of the EET curriculum should be focused on activities and projects that involve practical systems. Starting with structured activities/projects and simple systems to more open-ended projects and more complex systems, the future EET curriculum should prepare the program's graduates to deal with typical electronic systems. Furthermore, the program focus should be on giving the students experience with the evaluation of system performance and hands-on activities that allow the student to deal with the system through software and network interfaces. At Springfield Technical Community College we have recently moved our Electronics Systems Engineering Technology (ESET) program in this direction. Our new ESET curriculum is posted at www.stcc.edu/academics/electsysengtech.asp .

Earlier in this paper, the eSyst project was mentioned. One could argue that the objectives of this initiative are actually too tame. While the project goal is to make the core fundamental electronics courses more systems oriented this is accomplished within the basic framework of presently existing courses. This still keeps the system components at the forefront instead of the system taking on the main focus, while the components play a supporting role. Recently, the EET faculty associated with the Verizon NextStep Program took this a step further when they essential threw out a course on electronics devices that had a really heavy emphasis on Op-Amps as the basic active device building block component. In an effort to provide the Verizon employees with a course that would be more reflective of their world of work and at the same time give them a useful course on maintaining and troubleshooting electronic systems used in the telecommunications industry, a course titled "Electronic Systems" was conceived by the group and is in the process of being developed for implementation in the Fall of 2009. The major course topics are listed here while a more detailed outline is available at www.nspinfo.com .

1. Introduction to electronic/photonic systems
2. Signals/Noise
3. Signal Processing Concepts
4. Signal Processing Systems
5. Signal Conversion
6. Power Supply Concepts
7. Control Systems
8. Typical Telecomm System – PSTN
9. Typical System Overview – Block Diagram Level

All electronics based systems consist of basic sub-systems like the power supply, sub-system control, the man-machine interface, signal processing sub-systems, memory and processing cores, I/O interfacing, network interfaces, etc. With the type of core functional sub-systems dependent upon the particular application the system addresses. These are the topics that the curriculum should be built around with individual components viewed as the core building blocks of these sub-systems (i.e. amplifiers, filters, logic sub-systems, etc). Of course, presently, there is no known text book that has been published that would be appropriate for this course and therefore support/text materials will need to be created. It should be noted here that the presently available texts, typically used to teach electronics technology, will need to be revamped fairly significantly if this transition to a systems approach is to happen. One might note that the most popular circuit theory, analog electronics, and digital logic texts all are component oriented and all seem to be in their 8th through 10th editions. They have become "cash cows" for the publishers of these texts and will not fade away willingly! Hopefully, in this age of electronic publishing some ambitious souls will lead the way with books about these same core topics that will be written from a systems oriented perspective.

V. Conclusions

In conclusion, electronics technology has always been one of the fastest changing technologies and today continues to morph and evolve in some ways that are easy to predict and in other ways that are not so easy. For many years, these changes, driven by the evolution of semiconductor manufacturing, have provided a steadying influence on the field because it was easy to predict how technology would improve in the next several years in a particular sub-discipline of the field. The industry was driven by predictable increased capacity and speed in a component oriented technology and the educational programs appropriately reflected this fact. During the first half of the twentieth century when vacuum tubes were industry's electronics building blocks, electronics applications where implement with fairly simple systems that did not evolve rapidly. With the invention of the transistor and soon afterward the IC, this paradigm changed and the pace of technologic change quickened, becoming exponential in nature (as predicted by Moore's Law). The impact of this fact on EET education was a continual accretion of component and new device oriented material added to the typical curriculum until eventually other derivative programs (i.e. computer, laser-optics, etc) spun off of the core EET program. Today the electronics industry is on the threshold of another paradigm shift with the current and future levels of semiconductor, MEMS, and nanoscale device integration that are becoming possible. What impact will this new paradigm have on EET education? Today's technician typically does not troubleshoot systems that have any type of real complexity or are highly functional, to the part level. This reality will only become more the norm as we approach 2015. The technician of the next decade will evaluate system operation and performance through their knowledge of the system's intended function and a knowledge of acceptable parameters of operation. This evaluation might take place *in situ* but more often than not could be accomplished through a network connection from anywhere in the world at anytime and facilitated through diagnostic software and sophisticated built in self test (BIST). EET programs with curricula that does not respond to this changing environment and become systems oriented are doing their students a disservice and are probably destined to experience continued declining enrollments and possibly eventual elimination. On the other hand, forward looking EET programs that embrace the systems approach, craft their curricula carefully, and embrace new teaching techniques like case studies and problem based learning techniques (student centered and systems oriented techniques that work well for this evolving technology) will have a better chance of not only surviving but even thriving through the next decade and beyond!

"Change is the essence of life". Is EET dead? Far from it, it's just changing! Maybe that is the reason why some of us have remained in this field and are always looking forward to tomorrow.

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