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The Future Trend of the Electronics Engineering Technology Programs Over The Next Decade

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Abstract:

Presently, the dynamic nature of the electronic industry is posing challenges to electronics engineering technology (EET) programs to keep pace with the explosive and disruptive changes in the electronics field. The urgency to establish new directions for ET education becomes more critical each day as industry and society processes become more mediated by electronics devices and systems. During the past century electronics has evolved from the basic methodology of electrical signal modification, transmission, and re-conversion for useful human sensory perception to a mediating technology that is at the core of most human activity. The fuzzy disciplinary boundaries, the ubiquitous and covert nature of electronics technology's influence on human processes create great difficulty for EET educators in identifying the future directions of the program of study. Today, these boundaries are dissolving rapidly and therefore confusion is rampant in the ability of educators to layout sustainable EET curriculum directions that confidently address the future workforce needs of industry and society. The focus of this paper is to illustrate the whole process of road mapping to create new program focus areas in the field of electronics and closely related fields that yield employment to our graduates into the new emerging technological disciplines.

Introduction:

To build a successful technology enterprise, it is vital to have a knowledge based workforce with skills in science and engineering (S&E). In addition, having knowledge based workers with appropriate skills also enhances the nation's health, security, and prosperity. According to the US Bureau of Labor, the portion of the U.S. labor force with S&E skills is growing closer to 5 percent per year compared to 1 percent growth in the rest of the labor force.[1] At the same time that global competition for the S&E workers is increasing, other countries are making larger investments in S&E education and workforce than is the United States. "*The United States has always depended upon the inventiveness of its people in order to compete in the world marketplace. Now, preparation of the S&E workforce is a vital arena for national competitiveness.*"[1]

The second aspect that contributes towards this road map effort is that technology is everywhere; we use it everyday and probably never stop to think about how different our lives would be without it. Managing rapid and complex technological-driven change is in itself a daunting challenge. It is now swiftly becoming a disruptive force on today's markets, business, economics and society. As the innovations fostered by Convergent Technologies emerge faster, disruptions will become deeper.[2] To support the rapid change in technology many other things will also require change: educational curricula, workforce skill sets, business models, etc. This manifestation is rapidly becoming the case in today's electronic industry. Therefore, new and savvy thinking will be required about the real potential of the emerging technologies of the next decade so that higher education institutions can prepare the graduates to face the challenges associated with these emerging technologies.

The Future Emerging Technology Predictions

The IEEE organization reported results of the technology opinion survey distributed to their elite group of IEEE Fellows in the IEEE Spectrum magazine, January 2004. One of the key components of this survey includes the prediction of future technologies, which will have a major societal impact over the next decade. The results are shown in Figure1.[3]

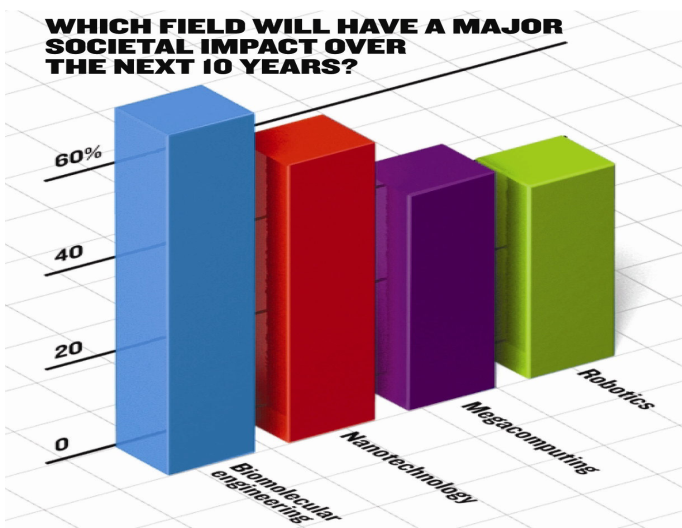


Figure 1. Emerging Technologies prediction by IEEE Spectrum.
Source: *IEEE Spectrum Magazine, January 2004*

The predictions shown in Fig. 1 portray that 72% of IEEE Fellows are betting that the bimolecular engineering discipline will be the leading emerging technology, and it will have a greater societal and economic impact over the next decade. Some Fellows also drew the conclusion that bimolecular engineering will have either equal or greater impact during the 21st century compared to what electronics engineering had during the 20th century. Nanotechnology came in second as the next promising technology for the 21st century; megacomputing and robotics were a distant third and fourth. Some of the survey respondents identified energy (in particular from renewable and alternative sources), transportation, and communications as technologies that will remain important even though they did not make the list.

According to Dr. Canton's report to the National Science Foundation,[2] emerging architecture for the 21st century represents convergent technologies; these consist of Nanotechnology, Biotechnology, and Information Technology as shown in Figure 2.

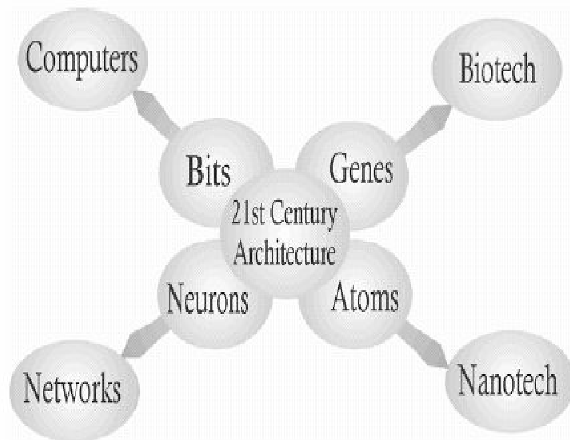


Figure 2: 21st Century Architecture
Source: Dr. Canton's Contribution to the 2002 National Science Foundation Report,
The Impact of Convergent Technologies and the Future of Business and the Economy, 2002

Dr. Canton's report also identifies the next technology power tools that will have immense impact on the nation's economy: Biotech, Computers, Nanotech, and Networks. However, this report does not prioritize these emerging technologies as does the IEEE report as shown in Fig.1.

The next questions that come to mind are: "how often do these forecasts prove to be accurate" and "what is the expected lifespan for these technologies to justify long term Investment?" These questions are important considerations in developing the knowledge based, skilled workforce at higher education institutions. Based on the historical data shown in Figure 3, the basic technological advancements associated with wealth creation opportunities are not that frequent and on average occurs twice a century.[4] From inception to maturity each technological evolution has spanned 50 years. Based on this historical information it is not unrealistic to expect the predictions for the 21st century technologies to follow a similar path.

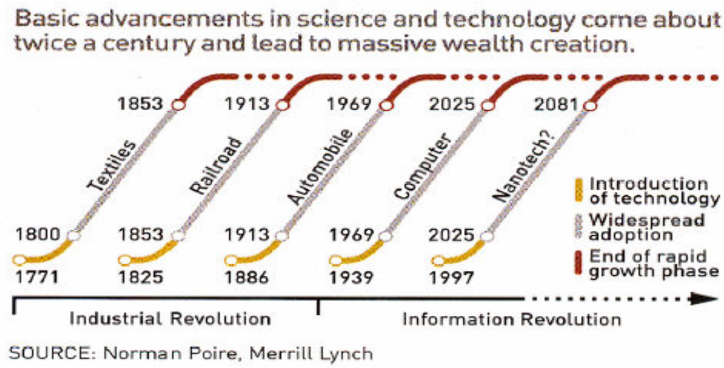


Figure 3. Historical time lag for wealth creation after the introduction of a new technology

Source: *TechStrat Conference Call: Nanotechnology is the Future,* Merrill Lynch. October 2001.

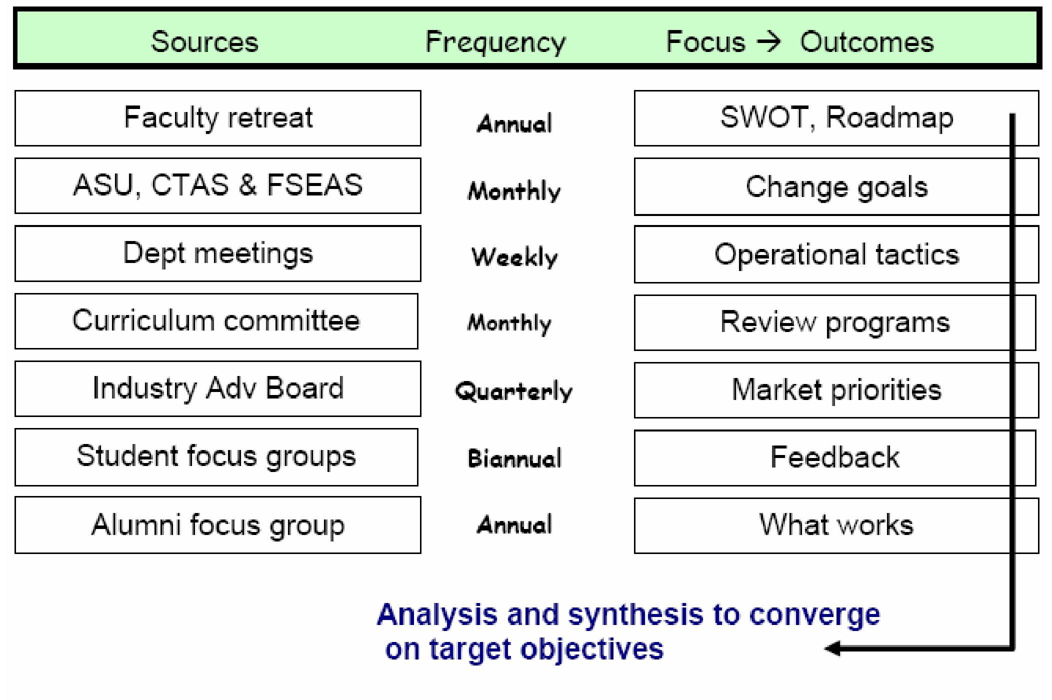
The premise of emerging technologies is multidisciplinary in nature, whereas previous technology trends followed a silo structure. Therefore, to take advantage of the opportunities brought about by the emerging technologies, a system wide collaborative model is essential. This model promotes interdisciplinary, inter-science interactions among various disciplines as opposed to the more typical academic structure which resembles a silo structure. To shift from a silo structure to an interdisciplinary structure is not a trivial matter for higher education institutions because of the needed culture shift. Therefore, envisioning the new academic programs to address the workforce needs of these emerging technologies requires a disciplined approach such as road map activity. In addition, the emerging technology predictions covered are intended to address the needs at a much higher dimension. Now, the challenge is to distill this information to a finer degree to satisfy the needs of the academic program. The approach we are exploring at this time is a road map process, which is commonly adopted by industry. The result will be refined using strategy maps to get to the program level objectives.

Electronics Engineering Technology Road Map process

The Electronics Engineering Technology (EET) program at Arizona State University (ASU) polytechnic campus, Mesa, AZ, is working diligently to establish a road map. This road map will help craft EET's future direction and offer programs that yield employable graduates in new and emerging technological disciplines. The focus of this paper is to illustrate the whole road map process effort to create new program focus areas in the field of electronics and closely related fields. These, in turn, will prepare high quality, recognizable and employable graduates over the next decade and beyond.

The process started with a simple idea as illustrated in Figure 4.

A documented process by which the objectives are determined and periodically evaluated based on the needs of the constituencies served by the program.



Note:
CTAS- College of Technology and Applied Sciences
CEAS- Fulton School of Engineering and Applied Sciences

Figure 4: Electronics Engineering Technology Road Map process

Prior to implementing any changes data will be gathered from stakeholders, market priorities will be reviewed, and curriculum changes will be initiated by faculty groups with input from the Industry Advisory Council. Over the last eight months the Industry Advisory Council has engaged in very intense activity to identify the process to create the road map for the EET program. The paper covers some pertinent details embedded in this process.

The attempt is to address the future workforce needs using technological predictions. The ambiguity surrounding forecasts makes it difficult to project meaningful future employment numbers especially when the technology is still at its conceptual stage. We have used the following approach: 1st to identify what the generic graduate attributes needed to meet the industry standards, 2nd fine tune these attributes, 3rd add a few more relative to a specific industry. With the assistance of our Industry Advisory Board the following prioritized list of attributes were identified for the graduates from the electronics engineering technology program from ASU's polytechnic campus.

Attributes of successful EET graduates of ASU's polytechnic campus:

1. Basic Sciences/electronics
2. Teachable/Trainable
3. Communication skills
4. Project management
5. Financial implications
6. Basic business operations
7. Team work/Team player
8. Critical thinking
9. Results oriented
10. Deadline driven
11. Statistics including SPC &DOE
12. Interpersonal skills
13. Problem solving
14. Attention to details
15. Ethics
16. Know where to find /research

The next stage of this road map process is the creation of a document that enables us to compile all relevant information into a single page. This would then be communicated with the upper administration of the university. The approach suggested by our IAB chair, Phil Vaney, was the creation of a Strategy Map. A Strategy Map is a diagram that describes how an organization creates value by connecting strategic objectives in explicit cause-and-effect relationships with each of the specified objectives.[5] The proposed strategy map for the EET program is shown in Figure 5.

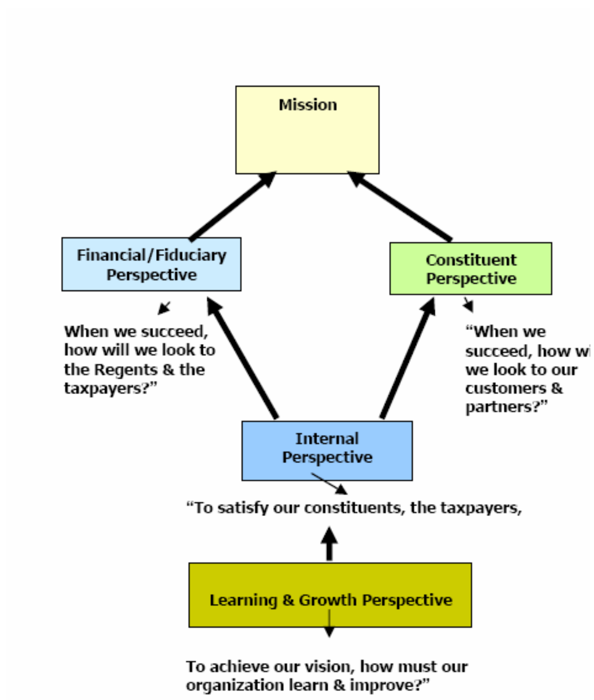


Figure 5: EET program Strategy Map

The four core elements of the strategy maps are: financial, customer, internal, and the learning/growth perspective. Making the transition to the academic environment requires program resources and attractive program offerings. These offerings must meet future industry demands for skilled workers in the emerging technologies. The strategy map helps to construct the basic building blocks that are required to complete the road map process. The draft strategy map with basic building blocks is illustrated in Figure 6. Then the detailed information such as target programs and associated curricula will be achieved through creating a balanced scorecard followed by the action plan to accomplish the targeted objectives. Integrating balanced scorecard information and action plans with a strategy map will complete the roadmap process.

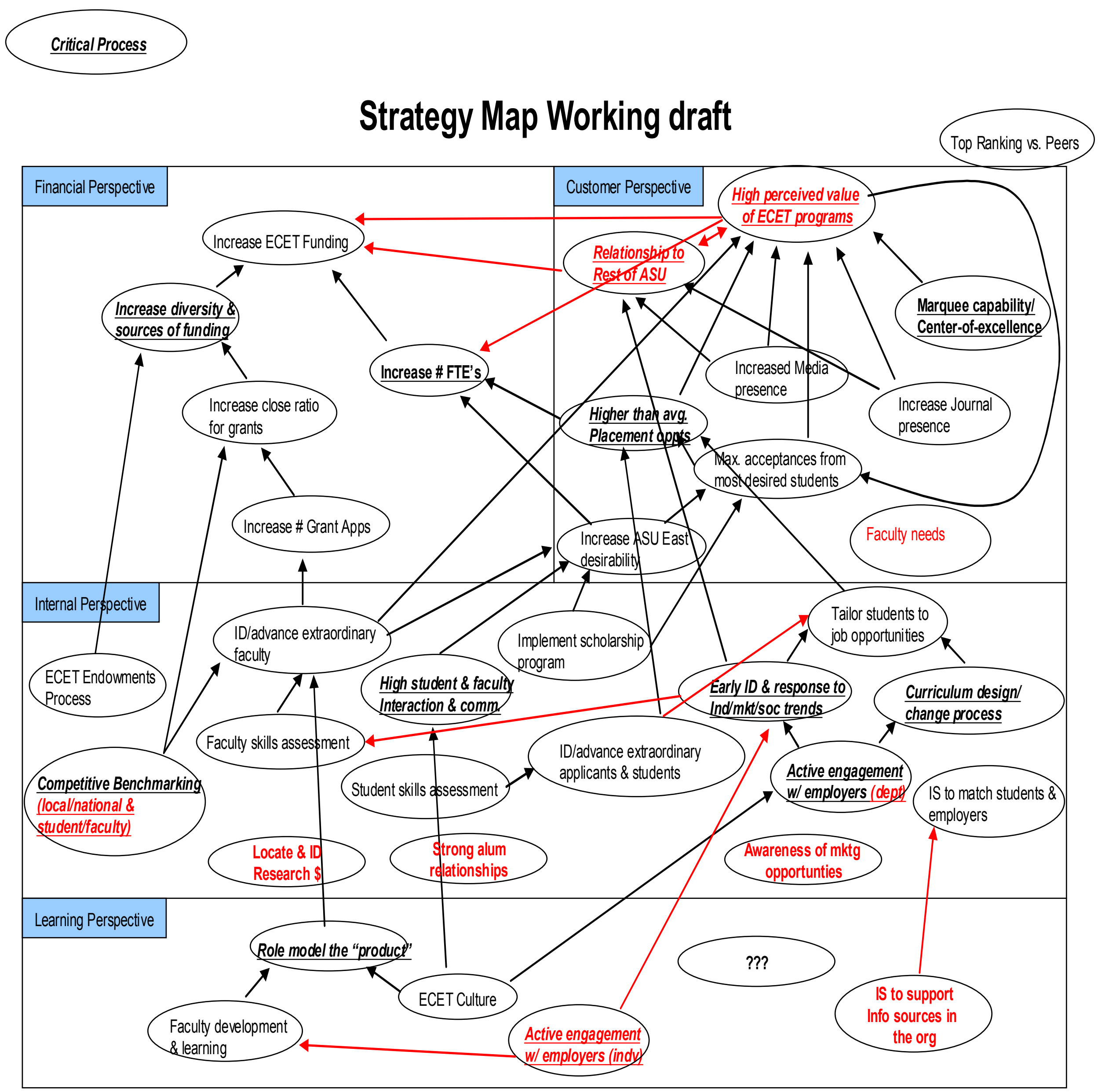


Figure 6: EET Program Draft Strategy Map

Conclusion

The Electronics Engineering Technology program at ASU's polytechnic campus is striving to identify the future direction of the EET programs by creating new focus areas that align with emerging technology forecasts. With the assistance of our Industry Advisory Board, and the EET faculty we are working on a road map activity using the strategy map approach to identify the potential new programs to be offered in the near future and also to reshape the existing programs to meet the needs of the industry. The work in progress to date is shown in figure 6 in the form of a strategy map. A road map process is illustrated and identified using building blocks such as strategy maps, balanced scorecards, and action plans to achieve the objective of identifying the new focus areas. The new focus areas eventually translate into academic programs to produce high quality, distinctive, and employable graduates. Based on this exercise the new program that EET is looking to develop and offer is alternative and renewable energy, which appears to have long term sustainability.

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Biographical Information

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Lakshmi Munukutla received her Ph.D. degree in Solid State Physics from Ohio University, Athens, Ohio and M.Sc and B.Sc degrees from Andhra University, India. L.V. Munukutla developed an interest in semiconductor device processing technology and characterization while she was working at Motorola Inc. She holds a Department Head position of the Electronics and Computer Engineering Technology in the College of Technology and Applied Sciences at Arizona State University at polytechnic campus.

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