AC 2008-2197: ARTICULATING NEED SENSITIVE VERTICALLY INTEGRATED PROGRAMS FOR ELECTRONIC TECHNOLOGY

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Articulating Need Sensitive Vertically Integrated Programs for Electronic Technology

Abstract:

Our department has entered into articulation agreements with several two-year colleges. Subsequently, we have commenced a dialogue with our community college partners as to how we can be more effective and student-centered in our approach to vertical integration. Traditionally, community colleges have done a good job of preparing technicians for industry, but graduates of two-year technical programs have more difficulty in getting appropriate credit for their technical courses. When transferring to a four-year program a direct equivalency is not always possible due to regulatory requirements, but in an outcome-based culture, it should be possible to create supplementary 1-credit or 0-credit courses that make such transfers possible. This paper will detail our initial efforts in that direction.

Motivation:

Within the framework of this manuscript vertical integration represents the process by which high school students, community college students, or certificate holders, are encouraged and given meaningful opportunities to obtain four-year degrees that they would not have sought otherwise. In a sense, this is recruitment, and recruitment strategies will have bearing on vertical integration. The electronic and computer engineering (ECET) option of the engineering technology department has many reasons to promote electronics education at all levels -- local, state and national[1]. At the local level, we primarily need to increase the number of recruits in the ECET program to continue to provide opportunities for students to excel and keep our program viable. At the state level, we know from talking to prospective employers that the demand for our graduates is extremely high: 4 to 5 jobs for every graduate. At the national (and global[2-8]) levels, the US is getting out-produced by India and China 30:1 in the numbers of engineering graduates; we are in desperate need of people who will manage America's technical and financial interests around the world. Unfortunately, we are far from getting the job done at any one of these levels.

At the forefront of any recruitment exercise, we need to think about new and innovative ways to increase the number of students in any electronics area without regard to whether it is in electrical engineering, electronic engineering technology, or electronics technology. This means we are not concerned with the particular degree to which students aspire, as long as they select a specialization within electronics (this approach benefits electronics all levels – local, state, and national).

We also need to be able to differentiate our programs from the vocational, the AAS and the B.S. degrees in engineering. We need to design a vertical integration plan that invites students that are most suited to enter our program either from community colleges or from high schools (Figure 1). Finally, we need to tailor our program to meet the criteria set by the task force for Engineer 2020 and the TAC of ABET general criteria[9, 10] (both criteria implicitly and/or explicitly contain some of the same ideas).

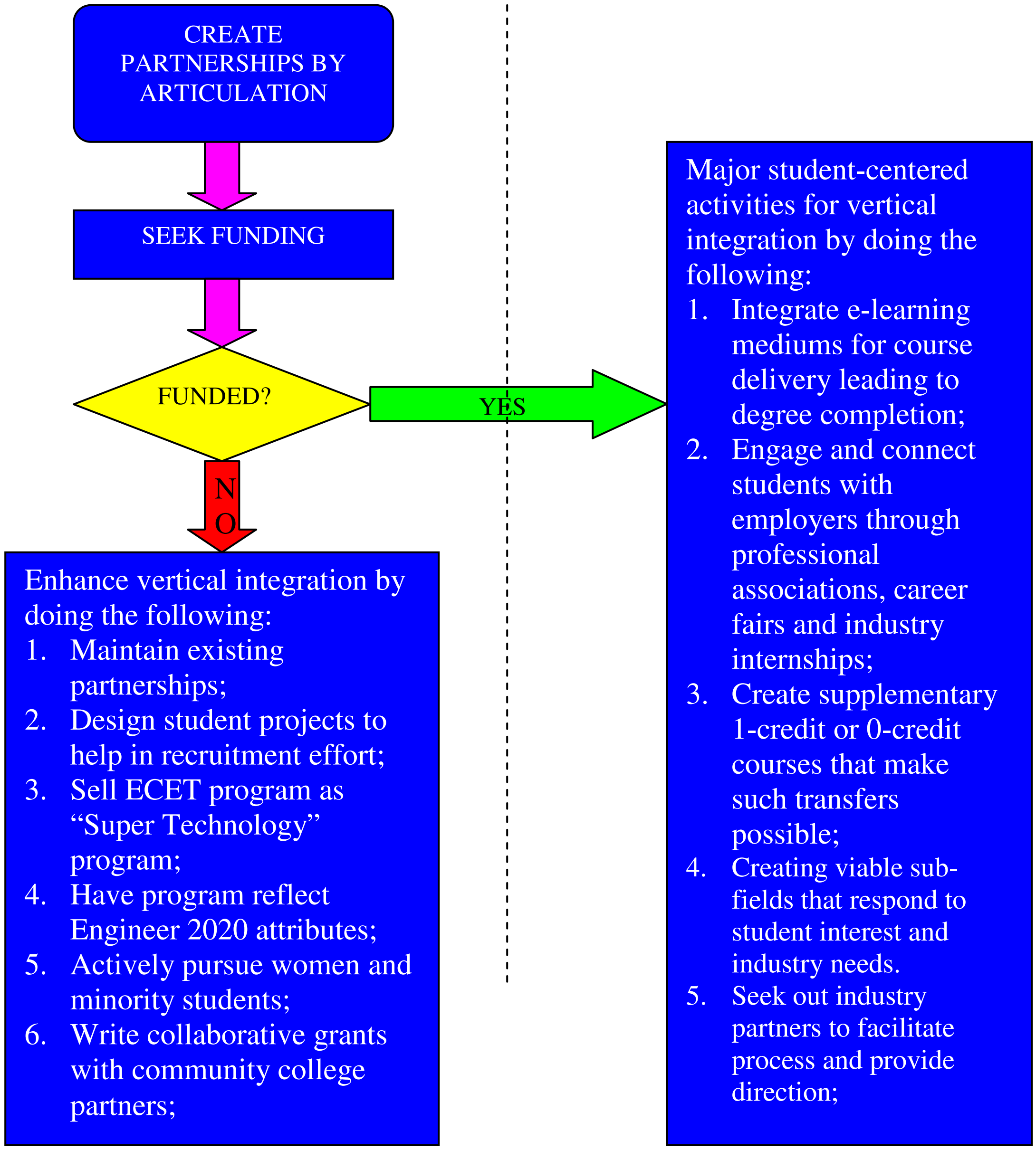

Figure 1. Some major components of the vertical integration plan

Getting to the Promised Land:

So, how do we get to where we want to be in a few years? It may be worth taking the time to examine our ongoing activities (as a program or as part of the departmental or college initiative) and the steps we have taken in the recent past. Table 1 summarizes these initiatives.

Table 1. Ongoing Recruitment Related Activities at ECET				
Activity	Date Initiated	Status	Currently Required Maintenance Levels	Payoffs/ Possible Payoffs
Articulation initiatives with different community colleges in the state	Fall 2005	Almost complete	Minimal	Have articulated with nearly all of the State's community colleges. It is hoped that this will enhance recruitment
Interdisciplinary initiative with Aviation department to teach Avionics	Spring 2006	Resulted in created a Avionics Emphasis (Fall 2007) in ECET	Minimal	Some student interest. Too soon to predict payoff level Interdisciplinary grant with Aviation resulted in $13,000 Targeted Excellence money used to buy equipment to help with creating online material
Butler Initiative launched in Spring 2006 to offer MET program at Butler Community College	Fall 2005	Offering Basic Electronics (ECET 100) and Elec. Power & Devices (ECET 304)	High	Currently MET degrees are offered at Butler. ECET providing a support function
Meeting with prospective students in small and large groups	n/a	Ongoing	Moderate	High payoff when meeting with individuals
Creation of emphasis areas and emphasis area brochures	Spring 2007	Complete	Minimal	Promising
EILITE (NSF grant)	Fall 2006	Complete	Minimal (from a Co.PIs point of view)	Very High Payoff with several ECET students getting scholarships

Most of the initiatives listed in Table 1 are fairly new, and their long term effects are as yet unknown. Activities that require minimal levels of maintenance are preferred because they are less disruptive to our primary function of teaching. It is important that any new activity that involves ECET faculty have a reasonable initial cost and minimal maintenance level unless special additional funding can be secured.

New Strategies for Vertical Integration (with or without Funding):

Any new vertical integration endeavor will require external funding unless it can be done with reasonable initial cost. It is also evident that if funding is secured, it must be used judiciously to forward well-thought-out ideas and plans. We propose that the following steps be taken with or without funding**:**

1. Have students work on projects that generate excitement and interest among themselves and prospective students. The ECET program has had some success in this area. Students have built robots, sonar devices, candy dispensers, electronic displays, roulette wheels and video games. We need to continue with these types of projects while making them more robust and portable so that they can be also displayed by admissions staff and faculty during school their visits. This is obviously a win-win situation, where our efforts will only add value to an ECET education.

2. Assess and modify ECET program to reflect Engineer 2020 competencies. The list of attributes desirable for the engineer that will be active in the year 2020 can be found in the National Academy of Engineers report "The Engineer of 2020: Visions of Engineering in a New Century[11]**."** The 2020 report not only lays out a list of attributes, but emphasizes certain knowledge and skill sets. Table 2 compares TAC of ABET criteria with attributes and skills deemed important for the Engineer of 2020. The ECET program outcomes are listed in column 1.

3. One of the most difficult things we run into in our recruitment efforts is in distinguishing engineering technology from engineering. The department of labor does not have a formal classification for the technologist (B.S. degree holders in Engineering Technology). The National Society of Professional Engineers (NSPE), an organization that has not always acted as a friend to engineering technology graduates, differentiates between the engineer from the engineering technologist using the following words,

   Engineering technology is defined as "that part of the technological field that requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer." In other words, the engineer is the person who conceives the design, while the engineering technologist is the person who implements it.
   To rephrase, engineering graduates design and engineering technology graduates implement that design. National salary trends, positions held by engineering technology graduates, and employer feedback, suggest that the NSPE definition is an oversimplification. Senior design projects and in some cases six-sigma[4] training do provide engineering technology students with good design experience. While engineering technology students have fewer mathematical tools at their

disposal, we feel that they are still capable of being valued as designers in many areas. In other words, we teach our students both design and implementation.

We have come to a point where the numbers of engineers that the US can produce annually are severely limited by the students who have the interest and capability to study engineering. We believe engineering technology students are well-placed to take up positions that require design and innovation skills.
A possible answer to the problems faced by recruiters might be to describe engineering technology as a program for the "Super Technologist." From the marketing point of view, the term "Super Technologist" embraces our status as a technology program while distinguishing us from the average A.A.S. or certificate programs, and engineering degrees. It also indicates our graduates will have comprehensive theoretical background, superior technical skills and a layer of soft skills sitting on top (Figure 2). We define a super technologist as a person who not only possesses desirable technical skills, but has also amassed necessary leadership, management and other soft skills (personal and interpersonal). By our definition, the super technologist can be an engineering technologist, an engineer, or even a successful entrepreneur with a high school degree. The super technologist must possess the necessary attributes to thrive in a global economy. It is, however, our belief that the Engineering Technology program is more likely to produce Super Technologists given the balance between theory and real world skills that is developed through the course of such a program.

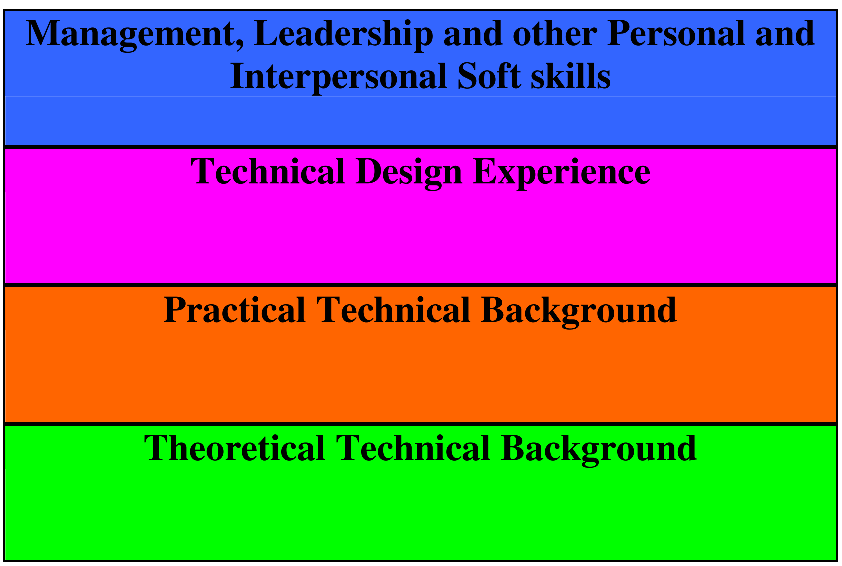

Figure 2. 4-Tier model for the "Super Technologist"

4. Become a program that works toward actively encouraging women and minorities. Women and minorities are keys to improving the number of ECET recruits each year. Studies show, unfortunately, that women have been made to feel uncomfortable in laboratory settings. We hope that the growing importance of software usage in labs will help to alleviate this problem, but, in addition broader steps need to be taken to encourage women to become involved in technology.

This type of information needs to be disseminated to high school counselors. The NSF funding and ELITE scholarships are another way to provide encouragement to women and minorities.

TABLE 2 ECET outcomes mapped to TAC/ABET and Engineer 2020		
Electronic and Computer Engineering Technology Option Student Learning Outcomes *The Electronic and Computer Engineering Technology program option of the Engineering Technology degree program equips graduates with skills in the following areas:*	**Corresponding TAC/ABET General Criteria** ***Reference:** 2005-2006 Criteria for Accrediting Engineering Technology Programs – Technology Criteria 2000* *An engineering technology program must demonstrate that graduates have:*	**Attributes of Engineer 2020** ***Reference:** National Academy of Engineering Report "The Engineer of 2020: Visions of Engineering in the new century.," The National Academies Press, 2004*
A. Technical Skills and Knowledge. 1. the understanding of electric circuits, circuit analysis techniques, and analog circuit design. 2. the understanding of computer programming, digital circuit design, microcomputers, operating systems, and local area networks. 3. the understanding of industrial electronic control components and systems. 4. ability to construct, operate, and maintain electrical and electronic systems, computer systems, and associated software systems.	a. an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines. b. an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering and technology.	• **Strong analytical skills**
B. Creative Design, Application, and Lifelong Learning. 1. ability to analyze, design, and implement control systems, instrumentation systems, communication systems, and computer hardware and software systems. 2. ability to utilize statistics/probability, transform methods, discrete mathematics, or applied differential equations in support of electrical and electronic systems, computer systems, and networks. 3. application of physics or chemistry to electrical, electronic, and computer systems in a rigorous mathematical environment at or above the level of algebra and trigonometry. 4. ability to be life-long learners. 5. commitment to quality and continuous improvement.	c. an ability to conduct, analyze and interpret experiments and apply experimental results to improve processes. d. an ability to apply creativity in the design of systems, components or processes appropriate to program objectives. f. an ability to identify, analyze, and solve technical problems. h. a recognition of the need for, and an ability to engage in lifelong learning. k. commitment to quality, timeliness, and continuous improvement.	• **Skill in planning, combining, and adapting using science and practical ingenuity.** • **Ability to pursue lifelong learning** • **Creative out-of-box thinking**
C. Communication. 1. ability to write clear and effective technical reports, proposals, and business correspondence. 2. ability to communicate orally technical information to a variety of audiences.	g. an ability to communicate effectively.	• **Good communication skills**
D. Professional Behavior in a Diverse World. 1. an understanding and respect for diversity in the workplace. 2. an understanding of the importance of working effectively as teams. **3.** an awareness of the impact of technology on our society.	e. an ability to function effectively on teams. j. a respect for diversity and a knowledge of contemporary professional, societal and global issues.	• **Understand the social, global and professional context of engineering practice**
E. Professional Development. 1. ability to apply project management techniques to electrical and electronic systems or computer systems. 2. ability to practice professional ethics and social responsibility.	i. an ability to understand professional, ethical, and social responsibilities.	• **Business and management skills** • **High ethical standards** • **Strong sense of professionalism** • **Dynamism, agility, resilience and flexibility**

5. Write an NSF Advanced Technological Initiative grant with community college partners who themselves possess high school partners. This has a moderate initial cost that must be borne by grant writers. In the event that funding is denied there are tangible benefits to be had in developing partnerships that may forward recruitment goals.

New Strategies for Vertical Integration (with Funding):

In order to find funding for enhancing vertical integration we have written a grant and are in the planning stages of another one.

Completed grant: ECET faculty has participated as senior personnel in the Kansas Schools of Technology and Engineering Technology Partnership Program (KanSTEPP) grant. The KanSTEPP (Kansas Schools of Technology and Engineering Technology Partnership Program) plan will help ensure increases in (a) STEM retention rates, (b) the number of STEM associate degree graduates, (c) the number of community college students who complete credit toward a STEM baccalaureate, (d) the total number of community college transfers into the BSET degree and (e) the number of awarded baccalaureate degrees in the State of Kansas. The KanSTEPP consortium involves the following partners: Kansas State University at Salina, Barton County Community College, Butler Community College, Dodge City Community College, and Wichita Area Technical College. The consortium has outlined a plan for bridging select institutional programs for the purpose of enabling community college students to matriculate directly into one of three Kansas State University at Salina Bachelor of Science in Engineering Technology (BSET) degree options: Computer Systems Technology, Electronics and Computer Engineering Technology, and Mechanical Engineering Technology.

The KanSTEPP proposal is founded on the principles of quality and affordable engineering education without sacrificing degree integrity, or deflating learner social presence (social connectivity between students, faculty and support services). It outlines an effective and efficient system for delivery of engineering education anywhere, anytime, to interested student cohorts. The operating premise guiding this project is the maximization of current and potential human, technological and equipment resources. This venture entails extension of engineering education to community college students who might not otherwise be able to take advantage of such experiences, either because this type of instruction is not offered at their respective campuses, or because they are facing barriers (i.e., financial, geographical) that prohibits them from enrolling in face-to-face- courses at Kansas State University at Salina. While Dodge City Community College is offering electronic courses, there are none currently being offered at Barton County Community College. Through e-Learning, Barton students will be privy to these courses at community college tuition prices. Students will have the option of applying earned credit to an associate's degree or as transfer credit into the BSET at Kansas State University at Salina. Finally, KanSTEPP builds upon prevailing partner recruitment, retention and job placement philosophies and strategies. Funds afforded through this grant opportunity will lead to enhancements and innovations to assist in the realization of increasing the number of engineering professionals.

KanSTEPP project goals amplify a win-win situation for Kansas State University at Salina, its community college partners, the students they serve, and the hi-tech industries of Kansas. Stated goals will help the program team steward the project to achieve maximum return on executed efforts.

1. Improve educational opportunities for postsecondary students.
   - Promote the KanSTEPP project, especially to underrepresented groups.
   - Link with targeted Project Lead The Way (PLTW) high schools.
   - Articulate seamless transfer of community college course credit.
   - Integrate e-learning mediums for course delivery leading to degree completion.
2. Increase retention to degree achievement.
   - Target traditionally underrepresented student populations.
   - Sustain current financial scholarship incentives to students entering and persisting in the study of Engineering Technology
   - Identify a pool of eligible transfer students for participation in Kansas State University at Salina's ELITE scholarship program.
   - Utilize multidisciplinary media and electronic methodologies to increase student engagement and tenacity (i.e., blogging—student to student, faculty to student, e-Journals, podcasting).
3. Improve student support programs at institutions of higher education.
   - Assist KanSTEPP transfer students with academic advising, career planning and student support services.
   - Facilitate e-Coaching; engage students in personal and professional development activities.
4. Increase numbers of well educated and skilled employees in technical areas of regional and national need.
   - Assist students with preparation for career planning and placement.
   - Engage and connect students with employers through professional associations, career fairs and industry internships.

Grant (In the planning stages):

ECET faculty will write an NSF Advanced Technological Initiative (ATE) grant to facilitate vertical integration. The central focus of this proposal is to regionally increase the number of globally competent graduates produced in the region at both two-year and four-year levels in the fields of electronics and/or computer engineering technology. The electronic and computer engineering technology (ECET) program at Kansas State University at Salina (KSU-S) will establish a collaborative relationship with community college partners to create educational opportunities responsive to global needs for technicians and technologists. The collaboration will aim at accomplishing the following,

1. Creating more opportunities for traditional and non-traditional students holding two-year degrees to move into four-year degree programs by articulation agreements;

2. Encouraging high school students and electronics technology certificate holders to seek four-year engineering technology degrees.

3. Creating supplementary 1-credit or 0-credit courses that make such transfers possible. This is a student-centered approach to articulation. It will help the keep

down cost of transfers to four-year programs. Collaborating faculty interaction will benefit both programs. This relationship will also allow four-year faculty to closely study the systems approach taken (top down) by two-year institutions in contrast to our bottom up approach. This is an area where two-year/certification schools have more expertise than four-year schools who favor a bottom up model. NSF ATE funding would allow two-year and four-year collaborators to learn from each other and add value to their programs.

4. Creating viable sub-fields that respond to student interest and industry needs.

5. Fostering cooperation between partners in reviewing and improving a curriculum that provides a globally competent technician/technologist education by the adaptation and implementation of new educational materials.

Summary:

We began our discussion by defining vertical integration, the importance of vertical integration, and the paths that lead to vertical integration. We took a look at the list of ongoing activities in student recruitment and the level of maintenance required in each case. These activities are not mature enough for us to judge whether or not any of them have succeeded or failed (and thus cannot be abandoned at this stage). We then go on to list some of the activities we might be able to engage in for the near future (some of these activities are contingent upon receiving grants while others are not).

In conclusion, while we (the Engineering Technology department of Kansas State University) are the State's most prolific articulator, articulation agreements are little more than pieces of paper if left by themselves. Relationships must be maintained and enhanced. The recently completed KanSTEPP grant, and ongoing efforts on the NSF ATE grant are examples of some activities that create working relationships with community college partners. If funded, both grants would immensely benefit our ability to offer students opportunities that make a four-year degree real possibility by allowing us to create supplementary courses and online courses that will enhance educational opportunities and reduce cost.

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