General Engineering Technology- A Broader Spectrum of Student Needs

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Abstract

The need for energetic focus on workforce development is well documented. However, there is no clear road map on how community colleges and universities should collaborate to support these programs. This paper examines an innovative, new baccalaureate degree that provides a possible model for these efforts. Old Dominion University has developed an extensive distance learning system that includes 32 remote community college sites and a total of fourteen hospital, military, and industrial sites in several states. As an essential element of the program offerings in this system, the Department of Engineering Technology has traditionally offered TAC of ABET accredited options in Civil, Electrical, and Mechanical Technology. Based on close collaboration with the community college system and industry participants it became clear that there was a large group of technology -oriented students who were not served by these programs. To address this issue, the General Engineering Technology option with a number of specialization areas has been developed. This degree program has been enthusiastically welcomed and appears to have great potential to improve the technology based workforce.

I. Introduction

A basic search of the World Wide Web for sites related to "workforce development" provides testimony to the number of cities, states and regions in this country and the world that have developed agencies or departments to focus on this critical area of economic growth and development. A report by the Center for Workforce Success [1] identified the key issue as the supply of well trained people capable of performing the tasks required by the high-technology, global economy. This report further highlighted several indicators of the serious problems in meeting this challenge in the United States:

- Sixty percent of manufacturers report they reject half of all job applicants as unqualified.
- Tens of thousands of high-technology jobs go unfilled.
- 36 million adults lack a high school diploma

An implication of these facts is that the United States cannot maintain its position as an economic leader without the advantage of a skilled work force.

Education at all levels must develop cohesive approaches to address these issues. Davis, Burck and Wessel [2] identify the significant role that education must play in solving this problem and indicate that education has a two level impact. First it quickens the pace of change in the workplace by augmenting the skills of workers. On another level, by enlarging the supply of qualified and educated workers, education narrows the wage gap issues between socio-economic groups.

The possible economic impact of workforce development and education can be stunning. The Center for Workforce Success cites a study that indicates a 2% increase in productivity for every 10% increase in the number of training hours [1]. A recent joint report by the Departments of Labor, Commerce and Education [3] indicates that, on average, workers with higher education earn 77% more than workers with only a high school education. A study of the skill gap in high technology and manufacturing conducted by the National Association of Manufacturers (NAM) provided a number of examples of the positive impact of training and workforce development on business performance [4]. These ranged from a 23% reduction in turnover among trained workers to over 50% reduction in product rework based on a trained workforce.

The next section examines the issue of how the education community, in particular the engineering and technology sector, contributes to resolution of this problem.

II. Impact of The Education Community

The education system has the potential to make a significant contribution to work force development. The 2001 NAM study of skill gaps [4] surveyed manufacturers and identified a combination of issues that provides a direction for education to consider:

- Two- thirds of respondents said the manufacturing workplace suffers from a poor and outdated image in attracting competent workers.
- Respondents recommended steps and programs should be identified and implemented to make technical and manufacturing careers preferred career options.
- This study encouraged the nation's community and technical colleges to expand certificate and degree programs to ensure they are effective and attuned to workforce needs.
- It urged the university system to be more attuned to changing workforce needs and play a role in supporting resolution of the issues the nation is facing.

Training requirements in corporate America are varied both in content and delivery mode. Many companies realize that it is cost effective to partner with local agencies, schools, and colleges for some level of their training. These partnerships with local school systems and community colleges have a special potential for promoting the continuous and life-long learning that is essential to maintain currency in the constantly changing work place. Considering the issues noted above from the NAM survey [4], this paper proposes that a basic initiative for education is to promote workforce development by means of flexible degree programs that enhance the image of high technology and manufacturing careers and at the same time integrate with the university system to provide growth and life long learning potential. Unfortunately, this goal is not simple to achieve.

Many community college programs, developed to support high technology and manufacturing needs, are classified as AAA or AAS (Associate in Applied Arts or Science) programs and are not considered "transfer' degrees such as the AA and AS (Associate in Arts or Science) options. This presents an immediate aura of diminished desirability that reduces student interest for these programs. In addition, parents see these options as less than attractive for their children. The key issue is that they do not provide a gateway for future educational development.

Exhibit 1 provides a comparison of the typical degree requirements for these options and illustrates the critical distinction in these degree programs. The AAA / AAS programs contain a much larger proportion of elective and major area credits in line ten. This credit area contains the curricular content that focuses on the immediate career or workplace needs that these programs address. It is essential to maintain this content since this is the immediate value both to industry and the students since these credits enable pursuit of a career immediately. In that sense, the AAA / AAS is a terminal degree. On the other hand, these students should have the opportunity to finish the baccalaureate degree in the long term if they desire. The central problem for both the university and the community college is how to resolve this issue.

Exhibit 1 Typical Community College Degree Requirements

	A.A.	**A.S.**	**A.A.A.**	**A.A.S.**
1. Written & Oral Communication	9	9	6	6
2. Humanities	3	3	-	-
3. Foreign Language	6	-	-	-
4. Social Sciences	12	6-9	6	6
5. Mathematics	6	6	0-3	0-3
6. Natural Sciences	8	8	0-3	0-3
7. Student Development Elective	1	1	1	1
8. Physical Education/Wellness	2	2	2	2
9. Computer Usage	0-3	0-3	0-3	0-3
10. Elective & Major Area Requirements	7-16	22-34	44-57	44-60
Total Credits	**60-63**	**60-63**	**65-69**	**65-72**

Table 1 highlights several issues related to articulation of AAA / AAS programs that are essential for community colleges to implement in the development phase:

- Courses in social science, humanities, mathematics and other areas must be college transfer level courses. This option may not be for all program participants but it must be provided for the group that wishes to continue to a four- year degree.
- The major area requirements must map as closely as possible to a content area in the first two years of a four – year degree.

The transfer problem for a university is particularly complex since it must consider how to integrate a 2+2 degree program with a range of possible community colleges and AAS options. For example, to facilitate development of these degree programs by the various colleges, the Virginia Community College System (VCCS) has developed the Technical Studies AAS degree. The primary purpose of the Technical Studies degree is to provide a flexible tool for partnerships with business and industry targeted at workforce development. The AAS Technical Studies degree is designed to offer the opportunity to define new educational goals and targets that cannot be met through existing program options at the college. In this workforce development oriented degree option, apprenticeships appropriate for degree study may be used to satisfy the work-based learning component.

The next section examines a degree in engineering technology that was developed to integrate with community college programs, such as this AAS Technical Studies, in an innovative approach to 2+2 programs.

Exhibit 2 Technical Studies Degree Example

MECHANICAL MAINTENANCE Purpose of Program: Promote advanced training for mechanical maintenance personnel	**Institution Specific Courses**	**Credits**
General Education		
English Composition	ENG 111	3
Humanities	SPD 100	3
Social/Behavioral Sciences	PSY126, SOC 115	6
Mathematics/Natural Science	MTH 103	3
Wellness	HLT 116	2
Student Development	STD 107	1
	Total Credits	**18**
Technical Foundations		
Principles of Technology	IND 116	3
Microcomputers/programming/software	IST 100 + IST or EEE course	6
Technical Writing	ENG 115	3
Quality Control	IND 101	3
Team concepts/problem solving	IND 137	3
	Total Credits	**18**
Content Skills & Knowledge		
Courses selected from existing certificate or diploma + electives to define content area needs.		21
Work-based Learning	IND 197	6
	Total Credits	**27**
TOTAL CREDITS REQUIRED	**Degree Credits**	65

III. General Engineering Technology – A Flexible Degree Option

Beginning in the early 1990s, Old Dominion University created a distance - learning program called TELETECHNET, in which junior and senior level instruction was provided by one-way video and two-way audio to numerous sites in the Commonwealth of Virginia. Since then, the program has developed into an extensive distance learning system that includes 32 remote community college sites and a total of fourteen hospital, military, and industrial sites in several states. The overall TELETECHNET initiative has grown to the point where Old Dominion University now has the largest undergraduate distance - learning program in the nation, and the institution has been cited by Forbes Magazine as one of the "top 20 cyber-universities" in the country [5].

The Department of Engineering Technology at Old Dominion University offers TAC of ABET accredited baccalaureate programs in Civil Engineering Technology, Electrical Engineering Technology, and Mechanical Engineering Technology via TELETECHNET in addition to its on-campus site. Due to a very high demand on the part of industry, these engineering technology programs were among the first to be offered in this manner, and the televised programs have become an integral part of the department's mission. The Department has developed and maintained a long and productive relationship with community colleges in Virginia and the nation. Consequently, when the VCCS developed the new degree programs related to workforce

development, the Engineering Technology Department immediately took steps to examine integration issues.

It was clear from the beginning of this work that the target student population was oriented to specific career areas that did not typically include professional licensure as professional engineers or surveyors. Consequently, this effort developed a path that was an alternative to the TAC of ABET programs. The result was the Bachelor of Science in General Engineering Technology (GET) and was designed primarily to meet the needs students who have an associate in applied science degree in a technical field from a community college and are interested in a career focus in the world of manufacturing or other high technology area. The diverse technical education and career background of these students required an interdisciplinary mixture of courses utilizing more than one engineering technology field to meet specific educational and career objectives. The GET degree is structured to provide this flexibility and to allow delivery through the existing TELETECHNET delivery system existing in every community college in Virginia.

The general structure of the BS in GET is described below. Section I describes the general course structure that interrelates with the lower division courses that will primarily be taken at the community college through workforce development related programs such as described in Exhibit 2. Section II describes upper division courses and is divided into two components. The "A" part describes courses in general education and mathematics that can be taken at local community colleges. The "B" part describes those courses provided by ODU through TELETECHNET.

I. GET Lower-Division Courses

(These requirements may be met fully or partially through completion of an associate in applied science degree in a technology related field at an accredited community college. Specific programs should be reviewed with the program director for articulation.)

Credits

1. Technical Base **32**

The lower-division technical base reflects elective and major area credits earned through AAS courses in the content skills area of an accredited, technically oriented program and must contain three credits of basic computer proficiency.

2. Mathematics **6**

Technical AAS programs require three credits of mathematics. For GET articulation, the program should include content similar to the technical mathematics (MTH 115-116 or MTH 163-164) sequence in the Virginia Community College system.

3. Natural Science **8**

Technical AAS programs include 3 credits of natural science. For GET articulation, an 8-credit sequence that satisfies the ODU natural science requirement in Physics, Biology, or Chemistry (such as Physics 201-202) should be included.

3. Written and Oral Communications

AAS programs require at least six credits of written and oral communications. Nine credits are recommended for articulation with the GET program. These should be college transfer level courses similar to:

Composition (Eng 111) and/or Technical Writing (Eng 115) **6**
Public Speaking (SPD 100) **3**

4. Other General Education (Social Science, Humanities, etc.) 6

AAS programs usually require six credits of social science and no humanities credits. For articulation with the GET program, the general education courses should include six credits of college transfer general education that match either the requirements for the AS in general studies or the ODU Lower Division general education requirements in the table below.

Total Possible Lower-Division Transfer Credits from AAS studies 61

II. Additional Credits Beyond the AAS Degree

124 credits are required for the BS GET degree. It is anticipated that 61 will be fulfilled related to the AAS degree, leaving 63 for upper division work. This section examines alternatives for completing these credits. Section II.A examines credits that can be taken at the community college in general studies and mathematics areas and section II.B describes credits that must be taken through engineering technology at ODU.

II.A- Courses available both from ODU and the community college system

It is possible for GET students to take additional credits either from ODU or from the community college system. These courses fulfill general education and mathematics requirements of the degree.

1. General Education Courses 9

Beyond the six credits of general education that are often contained in AAS programs, students must complete a total of 15 credits to fulfill either the VCCS general education requirements for the AS in general studies or to fulfill ODU requirements per the table above.

2. Mathematics 3

The GET program requires completion of mathematics studies that include a course covering differential and integral calculus similar to MTH 270 in the Virginia Community College System. The MTH 273-274 sequence is also acceptable and in this case three credits are counted as an elective noted below.

Total additional credits beyond AAS degree from VCCS or ODU 12

II.B ODU Engineering Technology Upper Division Requirements

1. Upper division minor 12

As part of upper division studies, ODU students must complete a minor or cluster. The engineering management or the mechanical engineering technology minor is recommended to fulfill this requirement. The Engineering management minor courses are listed below:

ENMA 301, Engineering Management
ENMA 302, Engineering Economics
ENMA 401, Project Management
ENMA 420, Statistical Concepts

2. ODU Engineering Technology Studies **33**

Students must complete 33 credits of Engineering Technology courses in their selected study area. This group of courses must include a capstone senior project in which the student demonstrates proficiency in the selected area. Several popular options are described in the table below.

3. Electives **6**

Selected from technology, business, or other area supporting student career interest.

Total Upper Division Credits beyond AAS **63**

TOTAL GET CREDITS **124**

IV. GET Option Areas:

At the state level, several areas of workplace focus were identified and are described in Exhibit 3.

Exhibit 3 VCCS Work Force Institutes for Excellence

Information Technology
Advanced Technology
Manufacturing
Electronics
Drafting and Design
Construction Management
Bio technology

In support of these specific cluster areas identified by the VCCS workforce development group, several GET options were identified that could be supported and delivered through existing offerings, faculty, and broadcast slots. These GET options w provide course content that should integrate well with their student career goals and meet industry needs: Electromechanical Systems, Technical Operations, Network Information Systems, and Geomatics / Geographical Information Systems.

- Electromechanical Systems: Complex machinery, automated manufacturing, and building systems often require integration of electrical and mechanical systems. This option is designed to provide support career interests related to this critical system interface.
- Technical Operations: Many career opportunities involve the support of technical operations including manufacturing, maintenance, planning, and other related areas. This option is designed to support career interests in this general area.
- Geomatics and GIS: Geomatics is an emerging field involving integration of data from a wide range of sensors (satellites, photographs, etc.) to develop geographical information systems (GIS). This option develops skills to enter this emerging field and is of interest in land development, site planning, and environmental issues.
- Computer and Network Operations: Design, operation, and maintenance of computer networks require a person with knowledge of electronic hardware, software, and topology (network planning) skills. In addition, it is often essential to understand the interface with machine controls in an automated manufacturing environment. This option is designed to fill this complex need.

V. Summary and Conclusions

This paper has discussed the importance of workforce development and a number of the issues and challenges related to involvement and support of these programs by the educational system. A unique alternative baccalaureate degree was developed to meet these challenges in Virginia and this solution may be a possible alternative in other states or regions. The authors plan to present results of this effort through future conference and educational journal avenues so that the lessons learned can be shared for the benefit of national workforce competitiveness.

Bibliography

1. Center for Workforce Success. "Education and Training, Manufacturer's Competitive Advantage." National Association of Manufacturers, Washington, DC.
2. Davis, Bob, Charles Burck, and David Wessel. *Prosperity: The Coming 20-Year Boom and What It Means to You*. New York: Random House, Incorporated, 1998, p. 245.
3. National Institute for Literacy. "Twenty-First Century Skills for 21st Century Jobs: A Report of the United States Department of Labor, Department of Commerce, Department of Education." Washington, DC: Government Printing Office, 1998.
4. Center for Workforce Success. "The Skills Gap 2001." National Association of Manufacturers, Washington, DC, 2001.
5. Ebeling A. and S. Bistayi, "Wired Degrees Forbes' 20 top Cyber-U.S." Forbes Magazine, June 16, 1997.

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