Developing Engineering & Technology Academic Programs

A Passport to Success How-To Guide

Objective:

The objective of this guide is to facilitate the academician or administrator in the process of developing new engineering science, engineering technology or applied technology programs. It will illustrate common difficulties and will offer suggestions (that we have previously found to be successful) to overcome these challenges. An example of a program set, including career, transfer and certificate programs, will also be included. Much of this material may also be useful in evaluating or redesigning an existing program. It is the intent of this grant team to pass on the benefits of our experience providing these advantages to other educators.

Challenges

The process of developing an academic program or programs can involve a complex balance with multiple varying objectives and diverse participants. Some common challenges that must be overcome during this process include:

- Naming Your Program
- Creating New Course & Redesigning Existing Courses
- Balancing Academic & Vocational Goals
- Developing Career (for Employment), Transfer (for Future Education) and Certificate Programs
- Recruitment & Retention Concerns

Many of the lessons learned are common to all of these areas. In addition we will offer some specific suggestions for each of these categories.

Initial Stages:

It is extremely important to prioritize your goals before initiating the development process. Technical education programs face the dual challenges of high initial equipment and infrastructure costs (often with limited useful lifespan) and historic recruitment and retention problems (resulting in small class sizes). Due to these concerns individuals taking on the development process are often trying to accomplish numerous goals with limited resources. As an educator you must evaluate the needs of all of the constituents involved. This includes your institution and program (which may not need the same thing), feeder and transfer schools, future employers and most importantly your students. That is not to say that you may not have important secondary goals. These are appropriate as long as they are not counter to your primary goal or do not require too many resources to accomplish.

Initial Stages Do's and Don'ts:

- Do solicit input from all interested parties – workshop style meetings can be an efficient method for handling large groups while building a sense of community.
- Don't develop in a vacuum – other institutions with similar programs can provide a wealth of experience.
- Do be realistic – work within the time, money and manpower constraints you have.
- Don't try to be all things to all people – this is a sure recipe for failure.
- Do be open to change – initial plans are rarely perfect.

What's in a Name?

Although the name of your program may not appear to be extremely important it is the source of most people's first impression. As a result it is essential to communicate a clear and accurate picture of what your program is trying to accomplish. One important constituency to consider is your target population(s). These students frequently approach their education with limited knowledge and

forethought. The program name must account for this. A balance of clarity and marketability must be struck that will entice a student to look further without obfuscating the content. Other considerations include the transferability of your program (where similar names may be of assistance) and the marketability of your graduates (where program names implying academic rigor may be helpful). Another important consideration is the level of specificity. Many technical education programs have fallen by the wayside because industry and technical changes have made them obsolete. An explicit program name can lead to strong ties to a single industrial sector or even a single company. This over reliance results in a fragile program with limited potential. A more universal program, with elective choices, can serve the goals while maintaining its more widespread lasting appeal.

Naming Do's and Don'ts:

- Do clearly delineate between engineering, science and technology programs.
- Don't rely on sophisticated jargon – this limits your market.
- Do use exciting and current terminologies – outdated names imply outdated programs.
- Don't use names that imply one job track.
- Do research what has been effective for other programs.

It is important to reevaluate program names regularly to avoid obsolescence.

Creating and Redesigning Courses

Nearly every new technology program is going to require the development of new courses. There are numerous questions to answer that will impact the course content including:
- What is the skill level of your target population and how does this compare to the prerequisite skill level of the course?
- What courses can be offered with few prerequisites in the first semester (before students complete English, Math and Science classes)? To encourage a sense of belonging and progress,

Engineering and Technology students want to be enrolled in core classes as soon as possible.

- What is the most effective and practical course sequence considering prerequisites and individual semester workloads?
- Can this course serve multiple programs? This will increase your class sizes and can lead to interdisciplinary projects.
- Will this course be supported by a didactic laboratory? Most technology students learn more effectively when a hands-on component is integrated with a lecture.
- Is this course content similar to material offered in our feeder high schools? If so will articulated credit be offered? This can be a very effective promotional tool and have the added benefit of allowing you input into high school curricula. It should be noted that articulated courses are impacted by technological and personnel changes and do require systematic review and updating.

One final issue is transferability. You must consider if this course will transfer and to what institutions and programs. The level of transferability will vary from school to school so you must prioritize your potential transfer schools and programs. Many schools make a clear distinction between engineering technology and engineering science courses, usually based on theoretical content.

Course Development Do's and Don'ts:

- Do keep your course description as general as possible. Specifying software or detailed contact may unnecessarily restrict future updating.
- Don't use a single four year program as a predictor of transferability.
- Do consider articulation agreements with high schools and vocational schools for introductory courses. They can be effective for marketing your program and at reducing your students workloads
- Don't try to be all things to all people. It is more important to develop a course that works for your program than for any other agency.

- Do be prepared to evaluate and update your courses and programs regularly.

Balancing Academic and Vocational Goals

All associate degree programs must overcome the limitations of the relatively short two year time frame and few total courses (usually twenty or less). This, combined with prerequisite math and science courses and other general education requirements (for technical programs this may exceed 10 courses), results in a restricted amount of time and credits devoted exclusively to your technical subject. This will limit the amount and level of the material that can be adequately covered. It is our experience that one of the most difficult balances to maintain is between academic and vocational content. This becomes even more challenging if you are trying to serve the dual purposes of a career program (vocational) and a transfer program (academic). Your math and science departments can be helpful in determining this balance. Although technical educators would prefer to concentrate the available credits on job related skills it is important to realize that a common failure of technical programs is the level of academic (communication, math and science skills) ability of their graduates. Additional credits devoted to these fundamental skills courses will likely result in a better qualified student in your courses and a more marketable employee when they graduate.

Balancing Do's and Don'ts:

- Do rigorous placement testing in math, reading and writing and place accordingly. High initial standards will result in better long term performance but adequate developmental education is mandatory.
- Don't allow students to avoid academic subjects – these are prerequisite skills that will dramatically affect their future performance.
- Do create different academic courses for career and transfer programs when necessary.

- Don't downplay the importance of general education – these courses may provide your students with extremely important employment and life skills.
- Do seek input from all interested parties – their expertise is extremely valuable.

Developing Career, Transfer and Certificate Programs

A common objective of many Engineering and Technology departments is to provide their students a diverse offering of academic programs that reflect the students' levels of skill and educational objectives. These usually fall into three main categories: career programs for individuals preparing to enter the workforce, transfer programs leading to enrollment in a four year bachelor's program and certificates that provide short term education in a specific subject area. The content of these programs varies substantially and is usually developed for different audiences. If possible, some level of commonality between these three programs should be maintained. This will allow students to internally transfer with minimal impact on their progress. A single classroom with students drawn from these three groups is also more reflective of the workplace they will eventually be employed in.

Certificate Programs Do's and Don'ts:

- Do develop certificate programs with courses that articulate into your degree programs. This will introduce students to your program without requiring a long term commitment.
- Don't make certificate programs too similar to associate degree offerings. Their content should require limited academic rigor and be able to be completed in one year.
- Do associate your certificate programs with industry standard certification tests where available – this can provide an additional (and more widely recognized) qualification for your graduates but may have additional requirements to become a "certified" program

<u>Career Programs Do's and Don'ts:</u>

- Do use you local industry as a guideline for career programs requirements (see An Effective Industrial Advisory Board – passport to success guide)
- Don't include courses that require unnecessary academic rigor – students in this program are clearly looking for employment related skills.
- Do utilize guest speakers, site visits and past graduates to maintain a strong link to the workplace.
- Don't forget evening programs – there are many students who are currently employed but still want to further their education.

<u>Transfer Programs Do's and Don'ts:</u>

- Don't develop transfer programs to a single or few institutions – a more general program may provide more opportunities for future graduates.
- Do try to develop program based agreements rather then course based agreements. This will prevent having to constantly update the agreement anytime either institution changes a course.

<u>And for All Types of Programs:</u>

- Do carefully advise students on program choices. Most students do not understand the distinction between the various levels of instruction.

<u>Recruitment and Retention Concerns</u>

Although recruitment and retention may seem to be independent of the development process it should be noted that curriculum content will strongly impact these two areas. Because engineering and technology programs are traditionally under-enrolled, particularly in terms of female and minority populations, particular emphasis should be placed on these areas (see Recruitment and

Retention Strategies for Manufacturing Technology Programs – a passport to success guide).

It has been our experience that potential students find engineering programs and even the word engineering off-putting. This word has become synonymous with demanding mathematics and science subjects. In response to this we have marketed our "Engineering Technology" programs as solely "Technology" programs and have emphasized the less rigorous math and science required. In our recruiting activities we have compensated for this negative attitude by emphasizing the positives. Although we include future career and educational opportunities and potential salaries in our "sales pitch," the opportunity to use state-of-the-art equipment and techniques is often a more compelling argument. A modern laboratory with cutting edge technologies can be more convincing than any speaker. Other areas that can be stressed include financial aid, transfer and internship opportunities. It is extremely important that this issue be in the forefront of your decisions. Without a consistent, dedicated recruitment effort (consider including a recruiter in your proposal) a poorly enrolled program is nearly guaranteed.

Once you have students you need to hold on to them. Engineering and technology programs can be very challenging and frequently suffer from poor retention rates. The most effective method we've used to counteract this trend is to develop individual personal relationships with each and every one of our students. This is accomplished by regular advisor and program meetings and a commitment from the faculty. We receive assistance from other college personnel including advisement, placement and the tutoring center staff. A cohort model is utilized to increase personnel interaction between students and to facilitate group activities. One significant problem that continues to be a challenge is the low level of student preparedness upon admission. This results in students taking developmental courses that interrupt their planned schedule. Students who have taken advantage of summer courses have been able to ameliorate this problem somewhat.

Program Example

The following program curricula are included to help illustrate the types of courses and course sequences used in BCC's

manufacturing programs. This curriculum has served us effectively and allowed our students to remain on schedule in the face of numerous challenges. Although this example is drawn from our project it is intended to be utilized as a guide to develop a similar tool for your own.

Manufacturing Programs at Bristol Community College

Computer Integrated Manufacturing (CIM) Technology Option

Engineering Technology <u>Career</u> Program

Semester 1:

ATK31	Materials Processing I	3 cr
CAD15	Computer Aided Drafting	3 cr
ENG11	Writing from Experience	3 cr
MTH17	Technical Math I	4 cr
PHY01	Technical Physics	<u>4 cr</u>
		17 cr

Semester 2:

ATK32	Materials Processing II (CNC)	3 cr
CAD19	Advanced Computer Aided Design	3 cr
ENG12	Introduction to Literature	3 cr
ETK13	Computer Tools for Eng.	3 cr
MTH18	Technical Math II	<u>4 cr</u>
		16 cr

Semester 3:

CAD22	Computer Aided Manufacturing	3 cr
*ETK62	Electrical Machinery	3 cr
ETK64	Hydraulics and Pneumatics	4 cr
	Behavioral and Soc. Sci. Elective	3 cr
	History Elective I	<u>3 cr</u>
		16 cr

Semester 4:

ETK63	Industrial Automation	4 cr
ETK79	Engineering Material Science	4 cr
ETK99	Engineering Projects - CIM Projects	4 cr
	Humanities and Arts Elective	3 cr
	History Elective II	<u>3 cr</u>
		18 cr

Total Credits: 67

* New Course Fall '02

Manufacturing Engineering Technology Option
Engineering <u>Transfer</u> Program

Semester 1:

ATK31	Materials Processing I	3 cr
ENG11	Writing from Experience	3 cr
ETK13	Computer Tools for Eng.	3 cr
MTH10	Elemental Functions	3 cr
MTH13	Trigonometry	2 cr
PHY01	Technical Physics	<u>4 cr</u>
		18 cr

Semester 2:

ATK32	Materials Processing II	3 cr
ENG12	Intro. to Literature	3 cr
ETK79	Engineering Material Science	4 cr
*MTH14	Calculus I	4 cr
PHY2	Technical Physics II	<u>4 cr</u>
		18 cr

Semester 3:

CAD15	Computer Aided Drafting	3 cr
CHM13	Fund. of Chemistry I	4 cr
ETK59	Mechanics and Str. of Matls	4 cr
ETK62	Electrical Machinery	3 cr
HST20/21	Western Civilization	<u>3 cr</u>
		17 cr

Semester 4:

CAD18	Computer Aided Design	3 cr
ETK63	Industrial Automation	4 cr
HST22/23	Western Civilization	3 cr
	Behavioral and Soc. Sci. Elect.	3 cr
	Humanities and Arts Elect.	<u>3 cr</u>
		16 cr

Total Credits: 69

* New Course Fall '02

Applied Manufacturing Technology Certificate

Certificate offered: Certificate of Recognition

Credit Required: 13

Information about the program

   This one year certificate program provides students with the skills to become a Manufacturing Technician or Machine Tool Programmer/Operator. Modern industry requires a workforce that understands how to utilize standard machine shop equipment and operate and program CNC machinery while understanding the materials that will be processed, being able to interpret technical drawings and utilize CAD software (AutoCAD®). This program serves as a solid base for continuing education in an engineering specialty (all courses transfer to Engineering Technology Programs).

Course Requirements:

ATK31 Materials Processing I   3 cr

ATK32 Materials Processing II   3 cr

CAD15 Computer Aided Drafting   3 cr

ETK79 Engineering Material Science 4 cr

Total Credits: 13

Computer Aided Design & Drafting

Certificate offered: Certificate of Recognition

Credit Required: 12

Information about the program

This one year certificate program provides students with the needed skills to become a professional Computer Aided Architectural Draftsperson, Civil Draftsperson or Mechanical Designer in the Engineering industry. Students learn fundamental concepts of engineering drawing through advanced computer aided design techniques. This program serves as a solid base for continuing education in an engineering specialty (all courses transfer to Engineering Programs).

Course Requirements:

ETK13 Computer Tools for Engineers	3 cr
CAD15 Computer Aided Drafting	3 cr
CAD18 Computer Aided Design	3 cr
For Architectural Option	
CAD53 Construction Drawing	3 cr
For Civil Option	
CAD58 Mapping and Site Planning	3 cr
For Mechanical Option	
CAD19 Adv. Computer Aided Design	3 cr

Total Credits: 12

Additional Resources:

The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC)For Information about or the complete text of state or national standards
http://www.enc.org/professional/standards/

Accreditation Board for Engineering and Technology
For Information Accreditation of Engineering and Technology educational programs.
http://www.abet.org/

American Association of Community Colleges (AACC)
For info. On CC's policy initiatives, innovative programs, research and information and strategic outreach to business and industry
http://www.aacc.nche.edu/

The NJCATE Curriculum Development Model
For a process for the creation of integrated, interdisciplinary engineering technology programs
http://www.njcate.org/content/academic/currdevmodel.htm

The California Engineering & Technology Alliance
For High School Engineering/ Technology Curriculum examples
http://www.engineering-ed.org/

Developing Academic Programs: The Climate for Innovation by Daniel T. Seymour, Ashe-Eric Higher Education Reports, 1989

Handbook Of The Undergraduate Curriculum, by Jerry G. Gaff, James L. Ratcliff, and associates, Jossey-Bass, c1997.