The State of Engineering Technology Education in Ohio

A Position Paper of the Ohio Engineering Technology Educators Council

October 2007

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Background

Ohio Engineering Technology Educators Council

For nearly two decades, deans and directors of associate degree engineering technology programs throughout Ohio have convened a council primarily designed for networking and benchmarking activities. What started as a group congregated mostly for fellowship, the Ohio Engineering Technology Educators Council (hereafter referred to as OETEC or the "Council") has morphed into a dynamic group of leaders determined to impact Ohio's future in technology attainment and employment.

The Council meets twice each year and keeps an active itinerary of activities for its members and stakeholders. In recent years, the Council has produced a promotional CD of careers in engineering technology, created an informational website (www.ohiotechcareers.org/), and established several technology roundtables intended to keep faculty up-to-date with current instructional practices and the latest shifts in technology. Self governed and self supported, the Council has a yearly rotating chair and an active membership that represents engineering technology (ET) programs across the state. Meetings are hosted in a round-robin fashion at participating members' colleges. The bi-annual meetings focus on curriculum, enrollment, emerging technologies, best practices in education management and a host of other relevant topics.

Enrollment in engineering technology programs across Ohio continues to make it onto the Council's agenda and is often discussed in a context of concern. For the most part, college deans and directors communicate that their ET divisions or departments are lacking the overall impact that is necessary for the economic health of Ohio. In order to more formerly address members' concerns, the Council called a special meeting in June of 2006 to scrutinize major issues for Ohio's ET programs, specifically traditional (or legacy) programs. These legacy programs include electrical & electronic engineering technology (EET), mechanical engineering technology (MET) and civil engineering technology (CET).

Kepner-Tregoe Exercise

During a two-day retreat, Mr. Ray Lepore, Dean of Math, Engineering Technology, and Business & Industry at Edison State Community College, led the Council through a Kepner-Tregoe (KT) [Kepner-Tregoe, 2006] exercise to systematically define and address the major issues for ET education in Ohio. KT is an international organization that provides consulting and training services to organizations so they might gain a competitive advantage through systematic, process approaches to resolving business issues and achieving peak performance.

Using KT's systematic approach, the Council identified several major issues and concerns for engineering technology education in Ohio. The issues can be summarized as follows:

1) ET programs have visibility and image challenges;
2) ET programs have stagnant or declining enrollments;

3) ET programs have increasing competition for students from other adult education institutions, for-profit schools, and industrial vendor training;
4) ET programs struggle with maintaining contemporary and relevant technology, equipment and instructors; and
5) ET programs are receiving incoming students with increasingly weakened academic skill sets necessary for achievement.

While many of these issues are not isolated to engineering technology academics, the Council decided that it must take steps to begin addressing them specifically for the health of ET programs throughout the state. Maintaining the integrity of the KT process, the Council rank ordered this list of concerns so that the most needed might get attention first. The process elevated item number two, stagnant or declining enrollments, as the most important issue to be addressed by OETEC. David Brown, Dean of Information Technology and Engineering Technology at Rhodes State College, and Dr. Philip Weinsier, Director of Electrical/Electronic Engineering Technology at BGSU-Firelands, set out to investigate this issue on behalf of OETEC; their findings are included in this report.

The investigation began with a three-fold purpose: 1) quantify engineering technology program enrollment issues at the state level with particular emphasis on legacy programs; 2) explore factors impacting engineering technology enrollments nationwide; and 3) develop strategies to positively impact Ohio's engineering technology enrollments.

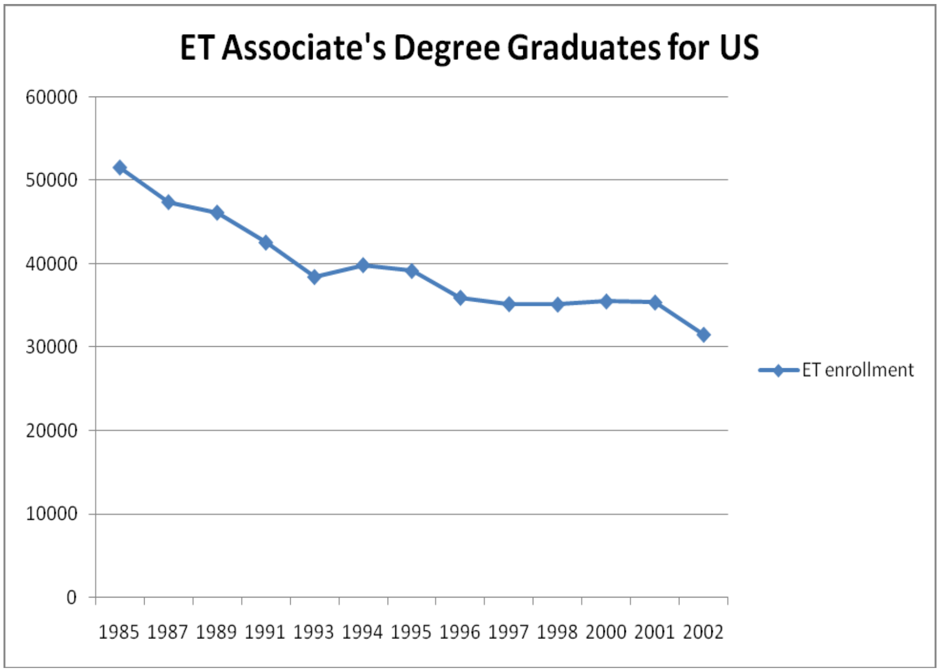
As Ohio looks to its economic future, it must view a vibrant economy secured through a technically competent workforce as a major priority. Successful engineering technology training for Ohio's residents will help us achieve that goal. Yet, if the number of residents appropriately trained for such in-demand ET fields is stagnant or declining, Ohio's technological competiveness will likewise stagnate or decline. This paper is designed to communicate OETEC's findings and promote efforts to improve ET program enrollments throughout Ohio.

> "…if the number of residents appropriately trained for in-demand ET fields is stagnant or declining, Ohio's technological competiveness will likewise stagnate or decline."

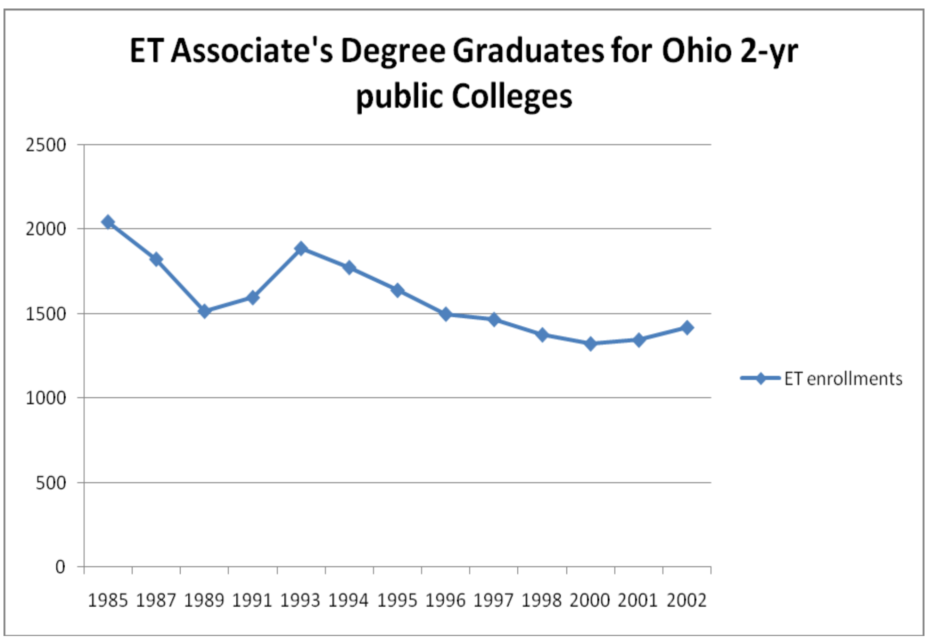
Engineering Technology Enrollment Issues for Ohio

Engineering Technology Graduation and Enrollment Trends

According to the National Science Board's (NSB) Science and Engineering Indicators 2006, engineering technology associate degree graduates steadily decreased from 51,579 to 31,557 between 1985 and 2002 [National Science Foundation (NSF), 2006a, OETEC Figure 1]. A scan of Ohio ET associate degree graduates for the same period reveals a



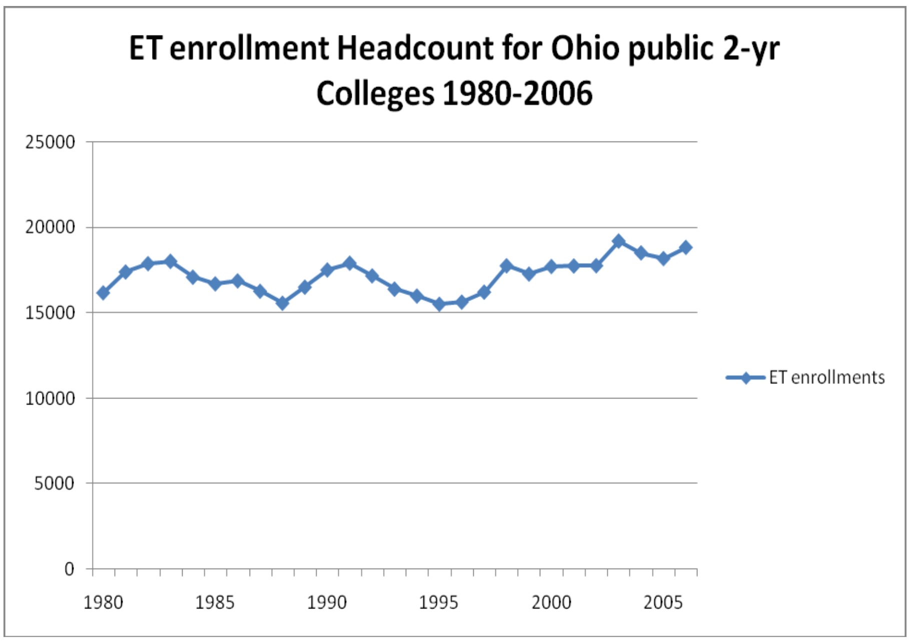
OETEC Figure 1



OETEC Figure 2

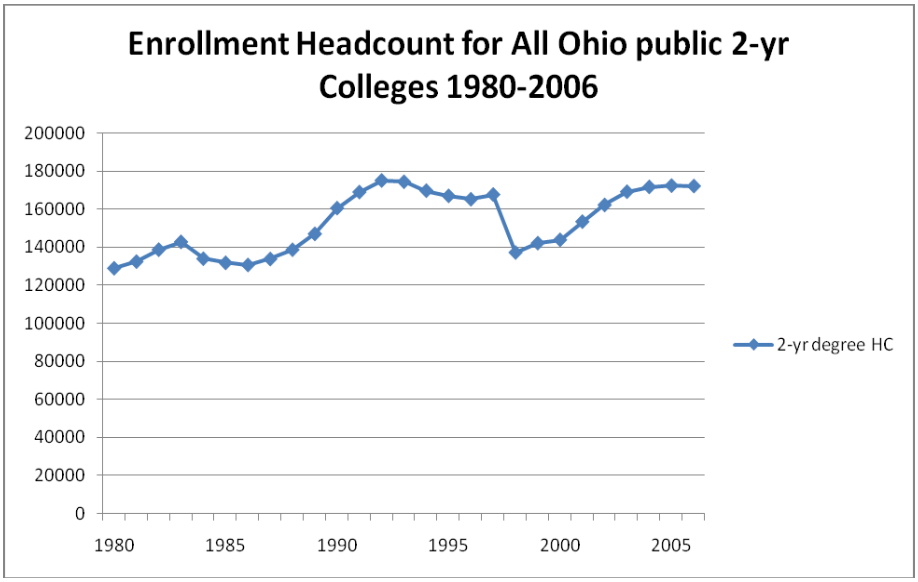
quasi-similar trend from 2,042 to 1,416 students [OBR, 1980-2006, OETEC Figure 2]. The same time period for both U.S. and Ohio 2-yr public colleges witnessed engineering technology graduates drop approximately 39% and 31% respectively. However, a survey of ET graduates does not tell the whole story.

The categorization of what is occurring with Ohio ET enrollment could be best described as "holding its own." According to data from the Ohio Board of Regent's (OBR) Higher Education Information (HEI) reporting system, Ohio's enrollment in ET programs at the community, state community and technical colleges (2-yr college sector) has achieved an overall increase from 1980 until present [OBR, 1980-2006]. HEI data include only state-subsidized colleges and does not include propriety higher education institutions. While the growth has been punctuated with periodic declines, the difference in student ET headcount from 1980 to 2006 represents a 14% increase as enrollments climbed from 16,161 to 18,839 students. Recording only fall term headcounts, the data represent total cumulative ET enrollments and are not separated according to legacy and emerging engineering technologies. OETEC Figure 3 tracks this nearly three-decade trend.



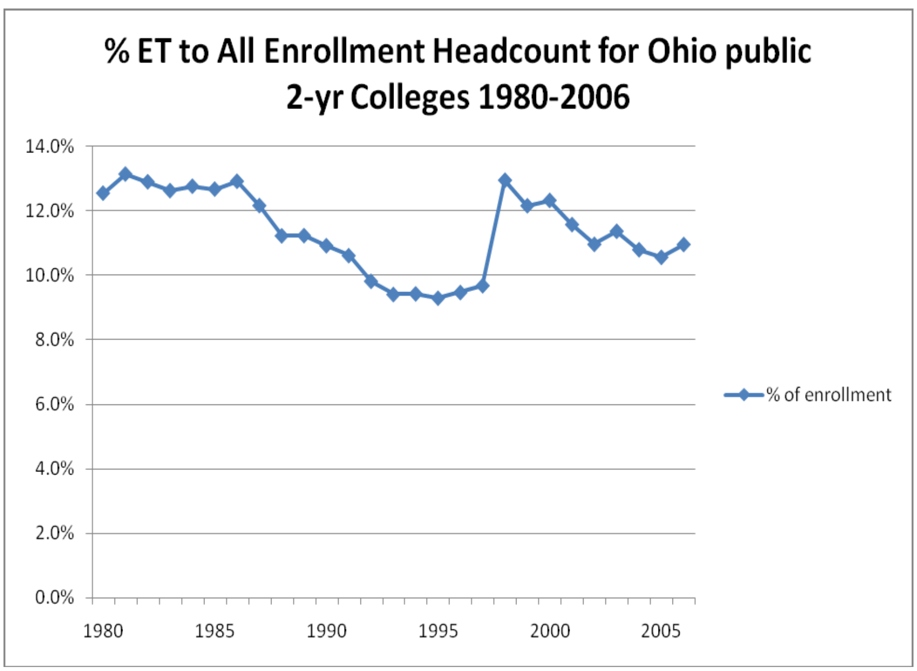
OETEC Figure 3

During the same time period, 1980 to 2006, Ohio's two-year college system experienced a nearly 50,000 student headcount increase as a whole. OETEC Figure 4 shows overall headcount growth of 25% from 128,870 to 172,118.



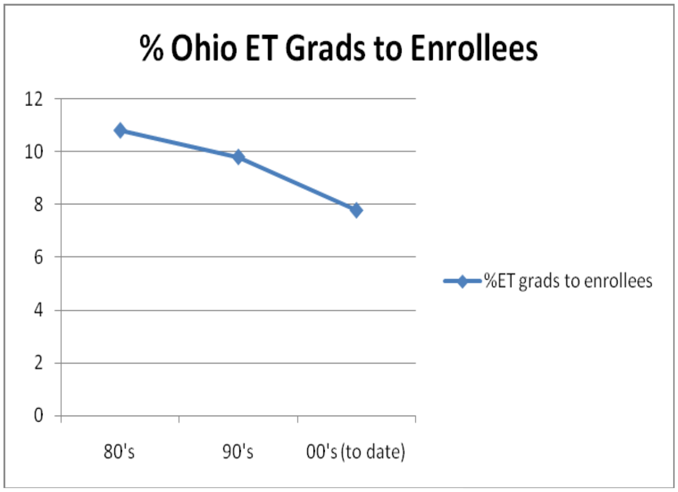
OETEC Figure 4

Therefore, ET programs for Ohio have held a proportionate range of anywhere from approximately 9-13% of total 2-year college enrollment from 1980 to 2006. While reaching its low point of 9.3% in the mid-90s, the ET percentage enrollment currently resides at approximately 11% of the total enrollment for 2-year colleges [OETEC Figure 5]. Again, "holding its own" seems a fitting description of ET enrollment statewide.



OETEC Figure 5

So, how do we reconcile the decreasing trend of ET graduates with concurrent increasing headcount enrollments? The answer may be simple: student customers of Ohio's ET education system are shopping for specific skill sets and have become less interested in degree attainment. While college academic administrators wring their hands over poor retention rates in ET programs, students continue to drop in and out of ET degrees as the workplace dictates. Individual technical courses, short- or long-run certificates, and non-credit skill-specific training events are fast becoming the preference for technology trainees.



OETEC Figure 6

In Ohio, the overall percentage of ET graduates to total ET enrollment has been declining since 1980. In other words, even though cumulatively more students are enrolled in ET programs, lesser percentages of students are degree completers. OETEC Figure 6 displays overall average percentages of ET graduates to total enrollees for the previous two decades and to-date in the present decade.

Job Market for Engineering Technology Trainees

Prepared by the Office of Workforce Development in December 2006, the "Ohio Job Outlook 2014" report [OETEC Table 1] provides a glimpse into occupational employment projections for the state. Even though the field that has traditionally provided the greatest support for ET graduates or trainees is in decline, production occupations still make up a statistically significant number of annual openings for Ohio workers.

Specifically, production occupations are listed as the greatest in predicted percentage decline by 2014 (-5.7%) [p.1], yet this same occupational group is fourth highest in rank order of total annual openings (14,711) for the state. Furthermore, if the production, construction and extraction, and installation/ maintenance/ repair groups are combined, they represent the fields most served by ET training and are equal to nearly 30,000 or 15.4% of all annual openings for Ohio.

In the High Occupational Prospects section, the Ohio Job Outlook 2014 report segregates occupations with high employment prospects by experience and credentials [Office of Workforce Development, 2006, pp. 27-32]. The experience and credential sections are listed as:

- Short-term on-the-job training (up to one month)
- Moderate-term on-the-job training (one to twelve months combined experience/training)
- Long-term on-the-job training (twelve months or more combined experience/training)
- Required work experience in a related occupation

- Required post-secondary vocational award
- Required associate's degree
- Required bachelor's degree
- Required work experience plus bachelor's degree
- Required master's degree
- Required doctoral degree
- Required first professional degree

Ohio
Occupational Employment Projections by Major Occupational Group

Occupational Group	Employment 2004 Annual	Employment 2014 Projected	Change in Employment 2004-2014	Change in Employment Percent Change	Total Annual Openings
Total, All Occupations	5,822,100	6,247,900	425,800	7.3%	190,089
Management Occupations	326,380	344,260	17,880	5.5%	7,737
Business and Financial Operations Occupations	238,620	271,040	32,420	13.6%	7,516
Computer and Mathematical Occupations	102,870	126,880	24,010	23.3%	3,850
Architecture and Engineering Occupations	97,070	103,440	6,370	6.6%	2,900
Life, Physical and Social Science Occupations	37,430	40,610	3,180	8.5%	1,259
Community and Social Services Occupations	97,810	111,220	13,410	13.7%	3,187
Legal Occupations	39,370	45,100	5,730	14.6%	1,037
Education, Training and Library Occupations	287,180	321,540	34,360	12.0%	9,716
Arts, Design, Entertainment, Sports & Media Occ.	82,300	90,120	7,820	9.5%	2,325
Healthcare Practitioners and Technical Occupations	303,900	359,710	55,810	18.4%	11,371
Healthcare Support Occupations	170,570	211,880	41,310	24.2%	6,762
Protective Service Occupations	115,080	125,050	9,970	8.7%	4,278
Food Preparation and Serving Related Occupations	464,370	514,760	50,390	10.9%	23,088
Building & Grounds Cleaning & Maintenance Occup.	199,690	220,630	20,940	10.5%	6,070
Personal Care and Service Occupations	170,750	193,230	22,480	13.2%	6,322
Sales and Related Occupations	603,970	637,530	33,560	5.6%	23,504
Office and Administrative Support Occupations	924,840	934,360	9,520	1.0%	25,538
Farming, Fishing and Forestry Occupations	14,900	14,810	-90	-0.6%	429
Construction and Extraction Occupations	259,180	284,070	24,890	9.6%	7,507
Installation, Maintenance and Repair Occupations	237,530	252,100	14,570	6.1%	7,051
Production Occupations	591,730	557,770	-33,960	-5.7%	14,711
Transportation and Material Moving Occupations	456,540	487,800	31,260	6.8%	13,936

Source: Ohio Department of Job and Family Services, Bureau of Labor Market Information, July 2006

OETEC Table 1

Listed under occupations requiring associate degree credentials, three engineering technicians are cited with modest annual job openings: electrical/electronic, industrial, and mechanical. Computer support specialist is an occupation also listed in this section, a discipline frequently associated with electronic engineering technologies in some associate degree programs. These four occupations are related to ET education. The remaining ten titles are almost exclusively health or medical oriented, with the exception of one listing for paralegals and legal assistants. Nonetheless, these ten titles combine to disproportionately outnumber the ET titles almost 10:1 in number of annual openings.

Furthermore, it is interesting to note that over half of the 98 occupations listed under moderate-term on-the-job, long-term on-the-job, and required post-secondary award categories are associated with technology training available in varied versions of credit and non-credit coursework throughout Ohio's 2-yr ET and workforce development education systems. This training is also available in Ohio's vast adult education system at vocational career centers, and in many cases is available at the high-school level too.

The correlation between dropping graduation rates and increasing enrollment trends can then be observed. A greater number of high-employment prospects related to traditional ET education are concerned with moderate and long-term technical training and experience than with full-degree completion. Performance is the key outcome that employers are looking for in this field, not necessarily the traditional academic credentials.

Economic Impact of Engineering Technology Education

Should Ohio abandon its commitment to ET training at the 2-yr level then and focus entirely on the most predominant high-growth associate degree fields instead? A survey of Ohio's investment pattern would certainly suggest against that course of action. A close examination of Ohio Department of Development's Third Frontier grant initiatives portrays a state investing heavily in advanced technologies. Third Frontier initiatives focus on five technology areas: 1) advanced materials; 2) biosciences; 3) information technology; 4) instruments, controls and electronics; and 5) power and propulsion. Under direction of Lt. Governor Lee Fisher, the Third Frontier has now expanded to 17 different programs **[**Ohio Department of Development, 2007**]**. In almost every program, one of the performance metrics includes job creation or retention.

Through the Third Frontier, the state is currently investing and continues to seek investment opportunities with hundreds of millions of taxpayer dollars to create job growth in high technology areas. These areas will require a competent and technically savvy workforce in order to make Ohio competitive. Those trained in engineering technologies are uniquely qualified to meet the workforce needs as these emerging technologies become commercialized in Ohio.

Ironically, it is the current decline in manufacturing employment that is one of the key indicators that engineering technology education should increase as Ohio steps into its future. In the Executive Summary section of a recent economic prediction report from the Ohio Department of Job & Family Services [Office of Workforce Development, 2007], the following items are called out:

- Some of the decline in manufacturing employment may be attributed to increased labor productivity that enables firms to produce more output with fewer workers. These productivity changes mean that knowledge-based industries are most likely to offer the most employment growth and earnings potential. Postsecondary degree attainment will be the key to success in the coming years.
- Education beyond high school will generally be required for jobs growing faster than average. Employers will continue to need a highly literate workforce with critical thinking and communication-related skills growing in importance. [p. v]

One of the reasons for decreasing manufacturing employment is the increasing productivity of the Ohio workforce. The application of technology systems to the production environment is making the assembly line of the industrial revolution a by-gone memory. The days of getting out (or dropping out) of high school and jumping into any number of well paying factory jobs are simply gone. Technological improvements have brought about both increased productivity and decreased manpower needs to modern U.S. manufacturing plants. Gone also are the days of thousands of employees working in assembly line operations performing repetitive motions day in and day out. Gone with it are the myriad of employees whose skill sets were basic, and focused only on technical process operations. Instead, the day of the technology knowledge worker has arrived. Fewer they are in number per facility, but greater overall is the need for technologically competent employees.

"Gone…are the days of thousands of employees working in assembly line operations performing repetitive motions…Gone with it are the myriad of employees whose skill sets were basic, and focused only on technical process operations. Instead, **the day of the technology knowledge worker has arrived**."

This is not an isolated phenomenon to Ohio. Nationwide as the number of individuals being trained in engineering technologies modestly increases, stagnates or even decreases, the need for highly skilled workers appears to be increasing. In 2004, the U.S. Department of Commerce prepared a report in which it detailed the results of over 20 roundtables held with representatives from small, medium and large companies from a broad range of industries including auto, aerospace, biotech and semiconductors [U.S. Department of Commerce]. Participants of the roundtables were asked to identify the challenges facing their sectors at that time and into the foreseeable future. Feedback was grouped into six categories, four of which dealt with various facets of trade and/or competitiveness and the remaining two were "Reinforcing America's Technological Leadership" and "Ensuring a Highly Skilled and Educated Workforce." Under the later, the report made clear that advanced labor skills is one of the decisive factors determining our nation's ability to compete in a global economy. The report sounded the alarm that the U.S. strongly risked under-mining its innovation infrastructure if it failed to produce more scientists, engineers and high-skilled workers.

This sentiment is repeated often in national and state dialogue. In a recent interview, Julian Alssid, founder and executive director of the Workforce Strategy Center in New York City, commented that as of last year nearly half of those over 25 years old had only a high-school diploma or GED, while over half of the country's fastest growing occupations required education beyond that level. "In short, it's not that the U.S. doesn't have enough jobs to go around. It's that it doesn't have a workforce trained to fill them" [Alssid, 2007].

> "Along with technology and capital, knowledge and skills are the core drivers for economic success."
> – Terry Thomas, Assistant Director of the Ohio Department of Job & Family Services/Employer Services

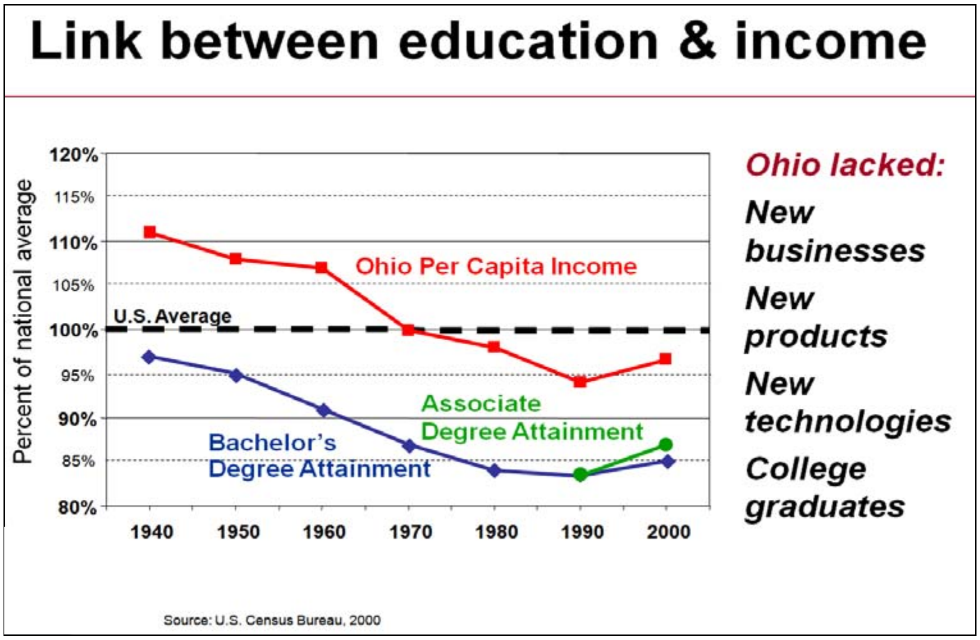
Officials from Ohio have been making similar comments. Terry Thomas, Assistant Director of the Ohio Department of Job & Family Services/Employer Services, prepared a report [2007] for Gov. Strickland and Lt. Gov. Fisher to highlight strategies for the development of Ohio's workforce. Thomas states in no uncertain terms that Ohio must invest in technology training of its workforce in order to compete in the global economy. "[Ohio's] workers must have strong work ethics, but they also must have strong academic, workplace and technical skills. Along with technology and capital, knowledge and skills are the core drivers for economic success" [Thomas, p. 2].

Among the listing of ten key assumptions regarding Ohio's talent development, Thomas says we must make better use of our postsecondary and adult education assets. The report also boldly asserts this vision: "Ohio will be a leader in talent development – in giving the state's employers a competitive edge by meeting and exceeding their needs for customized, flexible and industry driven skills training, and in helping workers acquire the knowledge, skills and dispositions that will allow them to get good jobs that pay family-sustainable wages and to succeed in the 21st century global economy" [p. 4].

> "Globalization is not a mysterious phenomenon incapable of being understood. It is an engine with operational parts that can be evaluated, measured, adjusted, and set in an opportunistic strategy."

Globalization is not a mysterious phenomenon incapable of being understood. It is an engine with operational parts that can be evaluated, measured, adjusted, and set in an opportunistic strategy. As evidenced in Thomas' report and many similar ones bouncing throughout dialogue around the state, Ohio has accurately identified the impact of globalization and made recommendations for an advantageous response; now, all that remains is to follow through.

The 2-year college system, and in particular the engineering technology sector, is needed in the emerging global economy to prepare our workforce for Ohio's future. Citing the advantage of internships, community involvement, diversity, accessibility, adaptability and breadth of training and other benefits throughout their book, Gunderson, Jones and Scanland [2005] said, "Community and technical colleges are uniquely positioned to respond to immediate employment needs in their respective communities" (pp. 63-64).



OETEC Figure 7

While the strength of Ohio's 2-yr ET education sector is in medium- or long-term certificates, the mission of degree completion should not be abandoned. In a report by Ohio's Knowledge Economy Awareness Initiative (KEA) [KEA, no date, OETEC Figure 7], the attainment of both 2-year and 4-year degrees in Ohio was inextricably linked to per-capita income. The benefit to the state and the individual for completion of the 2-yr engineering technology degree, as either a terminal degree or a component of a 4-yr degree completion path, is noteworthy insofar as it should be included in economic strategic-planning discussions at both the state and local levels.

Engineering Technology Legacy Programs

The Council began its investigation due to concern regarding ET legacy program enrollments. As mentioned at the beginning of this paper, these legacy programs include electrical & electronic engineering technology (EET), mechanical engineering technology (MET) and civil engineering technology (CET). The Council was not able to conclusively separate the roles and/or trends of legacy programs from the concerns of overall ET enrollments; yet, some interesting observations were made.

At the same time that enrollment moderately increased over the past several decades, the number of program offerings exploded. An informal survey of participating members at a recent Council meeting revealed that the number of ET program majors has more than doubled since the early 1980's. The Council attempted a more formal analysis of 2-year colleges in Ohio from the early 1980's to the present regarding specific program enrollments and found the following[1]. Of the colleges providing data:

[1] Not all colleges included legacy programs and still others did not include the more recent specialty or niche programs. Overall percentages reflect a combined effect of the two and are intended to provide a measure of the growth or decline in total student population in ET programs.

- ≈ 92% reported declines in legacy programs.
- ≈ 64% reported increases in new/specialty programs.

This information is far from conclusive and will need to be studied more in depth. But, assuming the data accurately reflects a trend, we conclude that Ohio's 2-yr system has attempted to be responsive to community needs through development of many emerging and specialized degree paths sometimes at the detriment of legacy programs.

Even though 2-year colleges throughout Ohio are developing more and more boutique programs and majors in engineering technologies, most continue to hold on to some version of one or more legacy programs. A guide to Ohio's Two-Year Colleges 2007-2008 lists all programs, majors, and major certificates for engineering and industrial technologies in Ohio's twenty-three stand-alone associate degree granting institutions (it does not include universities that also offer 2-yr ET degrees). It is interesting to note that credentials associated with legacy programs are those most common across the state. A survey of this list reveals a vast array of programs with nearly 70 different categories represented by associate degree programs and majors or major certificates. Yet, by far, the most common offerings statewide include those that the Council has identified as legacy programs [Ohio Association of Two-Year College Admission Officers, 2007]. Accordingly, when Ohio House Bill 95 mandated that the Ohio Board of Regents establish transfer policies and procedures applicable to all state institutions of higher education, the ET group could find common transfer ground only in three engineering technology areas: 1) electrical/electronics; 2) mechanical/manufacturing; and 3) civil/construction [OBR, 2007].

So, as Ohio's ET educational system responds to community needs with adoption of emerging technologies, it continues to carry the legacy programs along with it. Many of the legacy programs have incorporated emerging technologies inside existing instructional models and remained healthy or have even grown. Some have remained "pure" to their 1970's or 1980's foundational structure and have stalled or died in influence and enrollment. Still others have remained traditional and created dynamic bachelor's completion models with Ohio 4-yr ET programs, namely Miami University, and performed exceptionally. Some colleges have infused emerging technologies into traditional programs and others have segregated them as standalone programs of study. Approaches appear to have varied throughout the state and many colleges reside somewhere in the middle.

Reasons for the varied approaches have to do with name recognition, accrediting bodies, available equipment and/or capital resources, available human resources and others. Meanwhile, the pressure to remain fiscally sound puts a continual strain on low-enrollment programs, regardless of whether they are emerging, legacy or hybrid programs. While this topic needs to be studied further, it appears that a reasonable solution is for legacy programs, if they have not already, to begin incorporating emerging technologies into existing instructional structures for the maximum use of resources.

Factors Impacting Engineering Technology Enrollment Nationwide

A LITERATURE REVIEW: INTRODUCTION

While completing its KT exercise, the Council hypothesized that one or more global events caused a downturn in the number of students entering legacy ET programs sometime between the late 1970's and mid 1980's. Was this in fact true? If so, what factors impacted this downturn? The following literature review includes summaries of national events leading up to and occurring during this period. This review includes specific sections related to enrollment trends, state/federal funding, trends among high-school seniors, FTE, and employment and the economy.

PART I: ENROLLMENT TRENDS

The historical focus of vocational education had been to prepare students for entry-level jobs in occupations requiring less than a baccalaureate degree. However, in the 1980's and 1990's, this focus shifted toward a broader definition of preparation, one that included not only point-of-employment vocational skills but also academic and technical skills to be used for cross-training for a broader range of jobs; this newer image also sported a new name—engineering technology. Perhaps a consequence of this shift was the general decline in the participation of high-school students in vocational education, along with a doubling of students entering health-care and technology and communication fields [Levesque, et. al., (2000)].

There are potentially many reasons why prospective students may be steering away from traditional ET programs, but if the total number of students entering college declines, all other factors being equal, then it should follow that virtually all programs should experience declines. The opposite should also be expected, that if general enrollment increases then programs should see an increase in students entering them.

According to a study by the National Center for Educational Statistics (NCES) [NCES, 1995a, Table 175], of the total first-time freshmen fall enrollment in higher education, full-time men numbered about 761,000 in 1967. That number peaked at 942,000 in 1975 but then steadily declined to 1967-levels by 1993. Also looked at in this study were the college enrollment rates of high-school graduates. The total number of high-school graduates going on to college was about 2,525,000 in 1967, a number that increased to only 3,161,000 by 1975 [NCES, 1995a, Table 177]. After 1975, this number too began to slip and by 1993 was at 1967-levels. On the whole, then, by 1975, all age groups showed a downward trend in enrollment except the 22-24 year olds, whose numbers increased only slightly. Around 1980, however, enrollment by those 22 years old and under decreased sharply until around 1985 [NCES, 1995a, OETEC Figure 8 (Figure 15)].

Table 175. Total first-time freshmen fall enrollment in institutions of higher education, by sex of student, attendance status, and type and control of institution: Fall 1955 to fall 1993 [In thousands]

Year	Total, all freshmen	Men			Women			Type of institution, by control			
								4-year		2-year	
		Total	Full-time	Part-time	Total	Full-time	Part-time	Public	Private	Public	Private
1	2	3	4	5	6	7	8	9	10	11	12
1955 \1\ .	670	416	---	---	254	---	---	\2\ 283	\2\ 247	\2\ 117	\2\ 23
1956 \1\ .	718	443	---	---	275	---	---	\2\ 293	\2\ 262	\2\ 137	\2\ 25
1957 \1\ .	724	442	---	---	282	---	---	\2\ 294	\2\ 263	\2\ 141	\2\ 27
1958 \1\ .	775	465	---	---	310	---	---	\2\ 328	\2\ 272	\2\ 146	\2\ 29
1959 \1\ .	822	488	---	---	334	---	---	\2\ 348	\2\ 292	\2\ 153	\2\ 28
1960 \1\ .	923	540	---	---	384	---	---	\2\ 396	\2\ 313	\2\ 182	\2\ 32
1961 \1\ .	1,018	592	---	---	426	---	---	\2\ 438	\2\ 336	\2\ 210	\2\ 34
1962 \1\ .	1,031	598	---	---	432	---	---	\2\ 445	\2\ 325	\2\ 225	\2\ 36
1963 \1\ .	1,046	604	---	---	442	---	---	---	---	---	---
1964 \1\ .	1,225	702	---	---	523	---	---	\2\ 539	\2\ 363	\2\ 275	\2\ 47
1965 \1\ .	1,442	829	---	---	613	---	---	\2\ 642	\2\ 399	\2\ 348	\2\ 53
1966	1,554	890	---	---	665	---	---	\2\ 626	\2\ 383	\2\ 478	\2\ 67
1967	1,641	931	761	170	710	574	136	\2\ 645	\2\ 368	\2\ 561	\2\ 67
1968	1,893	1,082	847	235	810	624	187	\2\ 725	\2\ 378	\2\ 718	\2\ 72
1969	1,967	1,118	876	242	849	649	200	\2\ 737	\2\ 393	\2\ 776	\2\ 61
1970	2,063	1,152	896	256	911	691	221	\2\ 754	\2\ 397	\2\ 854	\2\ 58
1971	2,119	1,171	896	275	949	710	238	\2\ 738	\2\ 386	\2\ 937	\2\ 58
1972	2,153	1,158	858	299	995	716	279	680	381	1,037	55
1973	2,226	1,182	867	315	1,044	740	304	699	379	1,089	59
1974	2,366	1,244	896	348	1,122	777	345	746	386	1,176	58
1975	2,515	1,328	942	386	1,187	821	366	772	395	1,284	64
1976	2,347	1,170	855	316	1,177	808	369	717	414	1,153	63
1977	2,394	1,156	840	316	1,239	841	398	737	405	1,186	67
1978	2,390	1,142	817	324	1,248	834	414	737	407	1,174	73
1979	2,503	1,180	840	340	1,323	866	457	760	415	1,254	74
1980	2,588	1,219	862	357	1,369	887	481	765	418	1,314	91
1981	2,595	1,218	852	366	1,378	886	492	754	419	1,318	104
1982	2,505	1,199	837	362	1,306	851	455	731	404	1,254	116
1983	2,444	1,159	825	334	1,285	853	431	728	404	1,190	122
1984	2,357	1,112	786	326	1,245	827	418	714	403	1,130	110
1985	2,292	1,076	775	301	1,216	827	389	717	399	1,060	116
1986	2,219	1,047	769	278	1,173	821	352	720	392	991	\3\ 117
1987	2,246	1,047	779	267	1,200	847	352	758	405	980	104
1988	2,379	1,100	807	293	1,279	892	387	783	426	1,049	121
1989	2,341	1,095	791	303	1,246	865	381	762	414	1,049	\3\ 116
1990	2,257	1,045	771	274	1,211	846	366	727	400	1,041	\4\ 88
1991	2,278	1,068	798	270	1,209	855	355	718	393	1,070	\4\ 97
1992 \5\..	2,186	1,014	761	253	1,172	844	328	703	407	989	\4\ 87
1993 \6\..	2,161	1,008	762	245	1,153	846	307	702	411	973	\4\ 74

\1\Excludes first-time freshmen in occupational programs not creditable towards a bachelor's degree.
\2\Data for 2-year branches of 4-year college systems are aggregated with the 4-year institutions.
\3\Because of imputation techniques, data are not consistent with figures for other years.
\4\Data not comparable with pre-1990 figures because of a change in reporting procedures.
\5\Revised.
\6\Preliminary data.

---Data not available.

NOTE.--Alaska and Hawaii are included in all years. Because of rounding, details may not add to totals.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Fall Enrollment in Higher Education, various years; "Fall Enrollment in Colleges and Universities" survey; and Integrated Postsecondary Education Data System (IPEDS), "Fall Enrollment" surveys. (This table was prepared April 1995.)

Table 177. College enrollment rates of high school graduates, by race/ethnicity: 1960 to 1994
[Numbers in thousands]

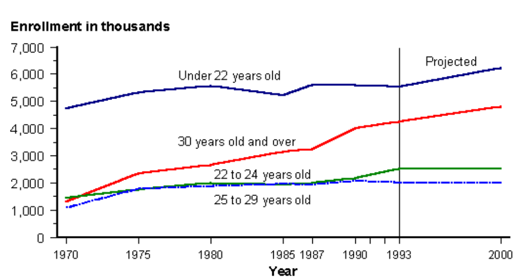
Year	High school graduates\1\				Enrolled in college\2\								
	Total	White\3\	Black\3,4\	Hispanic\4\	Total		White\3\		Black\3,4\		Hispanic\4\		
					Number	Percent	Number	Percent	Number	Percent	Number	Percent: Annual	Percent: 3-year moving average
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1960 ..	1,679	1,565	---	---	758	45.1	717	45.8	---	---	---	---	---
1961 ..	1,763	1,612	---	---	847	48.0	798	49.5	---	---	---	---	---
1962 ..	1,838	1,660	---	---	900	49.0	840	50.6	---	---	---	---	---
1963 ..	1,741	1,615	---	---	784	45.0	736	45.6	---	---	---	---	---
1964 ..	2,145	1,964	---	---	1,037	48.3	967	49.2	---	---	---	---	---
1965 ..	2,659	2,417	---	---	1,354	50.9	1,249	51.7	---	---	---	---	---
1966 ..	2,612	2,403	---	---	1,309	50.1	1,243	51.7	---	---	---	---	---
1967 ..	2,525	2,267	---	---	1,311	51.9	1,202	53.0	---	---	---	---	---
1968 ..	2,606	2,303	---	---	1,444	55.4	1,304	56.6	---	---	---	---	---
1969 ..	2,842	2,538	---	---	1,516	53.3	1,402	55.2	---	---	---	---	---
1970 ..	2,757	2,461	---	---	1,427	51.8	1,280	52.0	---	---	---	---	---
1971 ..	2,872	2,596	---	---	1,535	53.4	1,402	54.0	---	---	---	---	---
1972 ..	2,961	2,614	---	---	1,457	49.2	1,292	49.4	---	---	---	---	---
1973 ..	3,059	2,707	---	---	1,425	46.6	1,302	48.1	---	---	---	---	---
1974 ..	3,101	2,736	---	---	1,474	47.5	1,288	47.1	---	---	---	---	---
1975 ..	3,186	2,825	---	---	1,615	50.7	1,446	51.2	---	---	---	---	---
1976 ..	2,987	2,640	320	152	1,458	48.8	1,291	48.9	134	41.9	80	52.6	---
1977 ..	3,140	2,768	335	156	1,590	50.6	1,403	50.7	166	49.6	80	51.3	48.9
1978 ..	3,161	2,750	352	133	1,584	50.1	1,378	50.1	161	45.7	57	42.9	46.3
1979 ..	3,160	2,776	324	154	1,559	49.3	1,376	49.6	147	45.4	69	44.8	46.8
1980 ..	3,089	2,682	361	129	1,524	49.3	1,339	49.9	151	41.8	68	52.7	49.9
1981 ..	3,053	2,626	359	146	1,646	53.9	1,434	54.6	154	42.9	76	52.1	49.3
1982 ..	3,100	2,644	384	174	1,568	50.6	1,376	52.0	140	36.5	75	43.1	49.8
1983 ..	2,964	2,496	392	138	1,562	52.7	1,372	55.0	151	38.5	75	54.3	47.3
1984 ..	3,012	2,514	438	185	1,662	55.2	1,455	57.9	176	40.2	82	44.3	49.9
1985 ..	2,666	2,241	333	141	1,539	57.7	1,332	59.4	141	42.3	72	51.1	46.6
1986 ..	2,786	2,307	386	169	1,499	53.8	1,292	56.0	141	36.5	75	44.4	43.0
1987 ..	2,647	2,207	337	176	1,503	56.8	1,249	56.6	175	51.9	59	33.5	45.0
1988 ..	2,673	2,187	382	179	1,575	58.9	1,328	60.7	172	45.0	102	57.0	48.6
1989 ..	2,454	2,051	337	168	1,463	59.6	1,238	60.4	178	52.8	93	55.4	53.2
1990 ..	2,355	1,921	341	112	1,410	59.9	1,182	61.5	158	46.3	53	47.3	53.3
1991 ..	2,276	1,867	320	154	1,420	62.4	1,207	64.6	146	45.6	88	57.1	53.1
1992 ..	2,398	1,900	353	199	1,479	61.7	1,204	63.4	169	47.9	109	54.8	58.1
1993 ..	2,338	1,910	302	200	1,464	62.6	1,200	62.8	168	55.6	125	62.5	55.4
1994 ..	2,517	2,065	318	178	1,559	61.9	1,313	63.6	162	50.9	87	48.9	---

\1\Individuals age 16 to 24 who graduated from high school during the preceding 12 months.
\2\Enrollment in college as of October of each year for individuals age 16 to 24 who graduated from high school during the preceding 12 months.
\3\Includes persons of Hispanic origin.
\4\Due to the small sample size, data are subject to relatively large sampling errors.
--Data not available.

NOTE.--Data are based upon sample surveys of the civilian population. High school graduate data in this table differ from figures appearing in other tables because of varying survey procedures and coverage. High school graduates include GED recipients.

SOURCE: American College Testing Program, unpublished tabulations, 1987, derived from statistics collected by the U.S. Bureau of the Census; and U.S. Department of Labor, College Enrollment of 1993 High School Graduates, and unpublished data. (This table was prepared June 1995.)

Figure 15.–Enrollment in institutions of higher education, by age: Fall 1970 to fall 2000



SOURCE: U.S. Department of Education, National Center for Education Statistics, "Fall Enrollment in Institutions of Higher Education" surveys; Integrated Postsecondary Education Data System (IPEDS), "Fall Enrollment" surveys; *Projections of Education Statistics to 2005*; and U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, Series P-20, "Social and Economic Characteristics of Students," various years.

OETEC Figure 8

Even looking at specific programs, gender, race and socio-economic status, similar patterns of enrollment declines can be seen [NCES, 1995a, Table 299]. In vocational programs, general enrollment increased slightly until around 1980 before falling dramatically. Females reflected a slight drop between 1972 and 1980, but then saw a sharp decline (from about 25.7% to 12.1%) after 1980. Blacks, once representing over 33% of the enrollment in vocational programs, also plummeted to around 17% by 1992. Whites increased their numbers between 1972 and 1980, but then too dropped off from 20.8% to 11.4%. Perhaps not surprisingly, socioeconomic status played a major role in enrollment in vocational programs. "Low" socioeconomic status students were four times more likely to enroll in 1972 as were "high" students. This trend continued into the 1980's, but then numbers indicated an even greater shift of 22.6% for "low" and 3.4% for "high".

In general, the fields of science, mathematics, engineering and technology (SMET) suffered from the stigma of being predominantly white and male. Studies by the Higher Education Research Institute (HERI) at UCLA in the 1980's indicated a 20-year decline for women in science, math and engineering (SME)[2] despite enhanced recruitment efforts. Nationally, persistence rates for women were about ten percentage points lower than for their male counterparts [Strenta, et. al., 1994]. High attrition rates in SME programs were also seen for Hispanics, African Americans and Native Americans, where only one third of the Hispanics and one half of the other two groups graduated from those programs [Astin & Astin, 1993]. Furthermore, only 37% of non-white students entering SME programs graduated, compared with 68% for white students [Morrison &Williams, 1993].

National concerns about such underrepresentation generated a movement to recruit more non-white college students. By the early 1990's, the National Science Foundation alone had spent over $1.5 billion on recruitment efforts, with the National Institutes of Health following closely with $675 million [Sims, 1992, p.1185]. Fruits of these efforts to fix the problem, however, came only in the form of new non-white students entering SME programs, for attrition rates remained relatively unchanged [cf. Brown, 1994, 1995; Massey, 1992; Office of Technology Assessment (OTA), 1988].

Even considering all students, not just underrepresented students, the HERI work at UCLA brought to light the declining enrollment issues of the mid-1980's [Seymour, 2002]. These studies were based on longitudinal surveys of large, national samples of freshmen at 2- and 4-year institutions [Astin, 1985; Astin & Astin, 1993; Astin, Green &Korn, 1985; Astin, Green, Korn, & Schalit, 1985; Dey, Astin, & Korn, 1991]. The reports indicated that between their freshmen and senior years, attrition rates for SME majors were around 40%. Specifically, if we focus in on student enrollment in engineering technology programs [NSF, 2006b, Appendix Table 2-10; Green, 1989a; Green, 1989b; Ellis, 1986, p.64, Table 5], we also see a precipitous decline occurring in the mid- to late 1980's; though the decline stabilized around 1993.

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[2] Prior to 1996, none of the studies specifically included "technology" majors.

Table 299. Percentage distribution of 1980 high school sophomores, by highest level of education completed through 1992, by selected student characteristics: 1980 to 1992

Student characteristics	All 1980 soph- omores	Less than high school	High school	Certifi- cate	Associate degree	Bache- lor's degree	Master's degree	Profes- sional degree	Doctor's degree
1	2	3	4	5	6	7	8	9	10
Total	100.0	5.8	51.5	11.0	7.9	20.0	2.7	0.9	0.2
Sex									
Male......................	100.0	6.5	53.5	9.7	6.7	19.5	2.6	1.3	0.2
Female..............	100.0	5.0	49.5	12.4	9.1	20.5	2.8	0.5	0.1
Race/ethnicity									
White, non-Hispanic.......	100.0	4.9	49.1	10.1	8.4	23.1	3.2	1.0	0.2
Black, non-Hispanic.......	100.0	6.9	59.6	16.3	5.2	10.0	1.5	0.5	0.2
Hispanic..................	100.0	11.9	59.6	11.2	7.3	9.0	0.6	0.3	---
Asian/Pacific Islander....	100.0	0.6	40.9	6.9	6.2	32.7	4.7	7.5	0.7
American Indian/Alaskan Native...................	100.0	17.8	58.2	11.8	5.0	6.7	0.5	---	---
Socioeconomic status (1980)									
Low quartile.............	100.0	9.0	64.6	12.3	6.9	6.4	0.7	0.1	---
Middle two quartiles......	100.0	3.9	53.8	11.5	9.1	19.0	2.0	0.5	0.1
High quartile............	100.0	1.4	32.7	7.0	7.6	41.2	6.9	2.7	0.5
Test score composite (1982)									
Low quartile.............	100.0	15.6	64.0	13.0	4.1	3.0	0.2	---	0.1
Middle two quartiles......	100.0	3.1	56.2	12.8	10.1	16.1	1.5	0.3	---
High quartile............	100.0	0.1	26.5	4.8	7.2	49.2	8.7	3.0	0.6
Parents' educational attainment in 1980									
No high school diploma....	100.0	6.5	59.8	12.8	8.6	10.8	1.2	0.3	0.1
High school graduate......	100.0	5.2	59.1	12.4	6.0	16.6	0.3	0.4	---
Vocational/technical......	100.0	3.0	49.2	15.4	10.2	19.1	2.4	0.5	0.1
Some college..............	100.0	2.1	43.7	8.4	8.4	32.0	4.3	1.0	0.2
Bachelor's degree.........	100.0	1.4	32.6	4.9	8.1	42.4	6.9	3.1	0.5
Advanced degree...........	100.0	3.5	23.9	8.6	4.9	44.1	10.0	4.3	0.7
High school diploma status									
Regular diploma in 1982...	100.0	0.3	51.9	10.8	8.7	23.9	3.2	1.1	0.2
Returned for diploma......	100.0	6.8	68.3	14.4	7.0	3.4	0.1	0.1	---
Returned but no diploma...	100.0	27.1	47.7	19.9	3.4	1.9	---	---	---
Never returned............	100.0	51.5	35.7	9.5	2.1	0.9	0.3	---	---
Postsecondary expectations in 1982									
None.....................	100.0	15.5	71.1	9.3	3.0	1.0	0.1	---	0.1
Vocational/technical......	100.0	4.6	61.6	19.8	10.7	3.3	0.1	---	---
Less-than-4-year degree...	100.0	1.6	53.2	13.3	15.6	15.0	1.1	0.2	---
Bachelor's degree.........	100.0	0.9	35.3	6.8	6.3	44.9	5.0	0.8	0.1
Advanced degree...........	100.0	0.8	28.9	5.2	5.7	45.1	9.0	4.4	0.8
Type of start in postsecondary education									
Fall 1982 full-time 4-year..................	100.0	---	21.2	3.5	4.6	57.8	9.0	3.4	0.5
Fall 1982 full-time public 2-year...........	100.0	0.3	36.5	11.9	24.4	24.6	2.1	0.2	---
Fall 1982 part-time 4-year..................	100.0	---	52.2	6.7	10.0	27.2	3.5	0.1	0.4
Fall 1982 part-time public 2-year...........	100.0	1.6	59.5	13.4	9.4	14.4	0.9	0.8	---
Fall 1982 other...........	100.0	0.2	23.0	34.3	24.5	15.7	1.9	0.4	---
Delayed 4-year............	100.0	0.4	55.6	8.1	7.4	24.0	3.7	0.4	0.4
Delayed public 2-year.....	100.0	1.7	63.0	16.9	12.0	6.2	0.2	---	---
Delayed other.............	100.0	1.9	31.4	48.4	14.4	3.8	0.1	0.1	---
Other enrollment..........	100.0	---	---	86.5	5.1	6.0	1.1	0.4	0.8
Never enrolled............	100.0	16.1	83.9	---	---	---	---	---	---

---Data not applicable or not available.

NOTE.--Because of rounding, details may not add to 100.0 percent.

SOURCE: National Center for Education Statistics, High School and Beyond, Educational Attainment of High School Sophomores by 1992. (This table was prepared May 1995.)

The Commission on Engineering and Technical Systems (1985) also made reference to problems with enrollment in ET programs, stating that while "programs designed primarily as the first two years of engineering education are reasonably well defined", "…problems of definition exist for programs in engineering technology and industrial technology". Such issues of definition can cause confusion in the categorization and reporting of enrollments. We are not suggesting that image and program definition alone account for the enrollment woes of engineering technology, but rather that being aware of public shift in sentiment—irrespective of the origin—can cause ripple effects in enrollment. Taking a pro-active approach to dealing with potential image problems can mean stability if not growth for ET programs.

If, as suggested above, enrollment in institutions of higher education was down during the period in question, one might expect that FTE would also have been down. In fact, FTE for all public institutions in 1969 was 4,577,985, which increased by roughly 70% in 1993 to 7,812,394. Broken down by type of institution, 4-year schools registered a 50% increase (3,259,676 to 4,765,983), while 2-year schools saw 135% growth (1,318,309 to 3,046,411). What these numbers do not show, however, is that total FTE dipped by about 4% between 1976 and 1980. Even when broken down by type of institution, this dip was still observable [NCES, 1995a, Table 194]. On a more local level, between 1980 and 1985, roughly 1/3 of all states showed a dip (albeit of less than 10%) in FTE, while between 1985 and 1990 roughly 3/4 showed a large jump in FTE [NCES, 1995a, Table 196].

Nationwide, a number of trends can be observed specifically related to enrollment in the 1970's and 1980's:

- By 1975, enrollment in higher education for all first-time freshmen—even when considering specific programs, gender, race and socio-economic status—showed a downward trend.
- Historically, the focus of vocational education was to prepare students for entry-level jobs. In the 1980's and 1990's, however, the focus shifted to a broader definition of "preparation" and was renamed "engineering technology".
- In general, the fields of science, mathematics, engineering and technology (SMET) were stigmatized as being predominantly white and male. And in spite of national recruitment efforts to attract non-whites and females, attrition rates for those groups remained relatively unchanged.
- Attrition rates for all SME students, between their freshman and senior college years, were around 40%.
- Studies indicated that there were "problems of definition" for existing programs in engineering technology and industrial technology.
- FTE seemed to follow patterns in enrollment changes.

Appendix table 2-10

Undergraduate enrollment in engineering and engineering technology programs: Selected years, 1983–2003

Enrollment level and institution	1983	1985	1987	1989	1991	1993	1995	1997	1998	1999	2000	2001	2002	2003
Engineering														
Students	441,205	420,864	392,198	378,277	379,977	375,944	363,315	365,358	366,991	361,395	390,803	409,557	421,178	421,791
Full time	406,144	384,191	356,998	338,529	339,397	337,817	325,489	326,458	329,657	323,713	353,118	367,954	383,109	384,612
Freshman	109,638	103,225	95,453	95,420	93,002	88,875	86,299	90,882	94,909	93,951	101,773	106,825	107,086	103,834
Sophomore	89,515	79,627	73,317	71,267	71,257	69,974	67,981	67,879	69,608	69,941	76,706	78,348	81,854	82,542
Junior	91,233	84,875	77,085	70,483	73,516	73,449	68,894	68,812	67,638	66,975	74,055	76,938	79,806	80,703
Senior or fifth year	115,758	116,464	111,143	101,359	101,622	105,519	102,315	98,885	97,502	92,846	100,584	105,843	114,363	117,533
Part time	35,061	36,673	35,200	39,748	40,580	38,127	37,826	38,900	37,334	37,682	37,685	41,603	38,069	37,179
Engineering technologies														
Students	163,226	123,571	128,501	127,687	127,135	106,976	105,809	108,459	108,993	108,754	107,165	108,886	112,654	110,250
Full time	112,745	83,038	80,600	76,179	75,340	65,581	63,929	67,864	68,545	69,173	66,771	71,147	72,704	72,040
First year	53,032	34,389	32,685	32,225	31,302	24,824	25,665	30,227	28,367	29,490	29,531	31,588	30,252	28,033
Second year	33,799	23,293	22,906	21,627	20,815	19,962	18,863	19,106	18,426	17,326	18,318	19,171	20,360	21,009
Other years associated	925	466	1,404	1,810	2,221	2,564	2,007	3,442	6,080	5,289	2,474	2,207	2,786	3,876
Bachelor's of engineering technologies third and later years	24,989	24,890	23,605	20,517	21,002	18,231	17,394	15,089	15,672	17,068	16,448	18,181	19,306	19,278
Part time	50,481	40,533	47,901	51,508	51,795	41,395	41,880	40,595	40,448	39,581	40,394	37,739	39,950	38,210

SOURCE: Engineering Workforce Commission, *Engineering & Technology Enrollments, Fall 2003,* American Association of Engineering Societies (2004).

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Table 194. Full-time-equivalent fall enrollment in institutions of higher education, by control and type of institution: 1969 to 1993

Year	All institutions			Public institutions			Private institutions		
	Total	4-year	2-year	Total	4-year	2-year	Total	4-year	2-year
1	2	3	4	5	6	7	8	9	10
1969	6,334,139	4,899,526	1,434,612	4,577,985	3,259,676	1,318,309	1,756,153	1,639,850	116,303
1970	6,737,817	5,145,410	1,592,404	4,953,149	3,468,572	1,484,577	1,784,665	1,676,838	107,827
1971	7,148,575	5,357,708	1,790,867	5,344,356	3,660,624	1,683,732	1,804,219	1,697,084	107,135
1972	7,253,712	5,406,792	1,846,921	5,452,851	3,706,238	1,746,613	1,800,862	1,700,554	100,308
1973	7,453,467	5,439,226	2,014,241	5,629,568	3,721,035	1,908,533	1,823,899	1,718,191	105,708
1974	7,805,454	5,606,248	2,199,206	5,944,799	3,847,542	2,097,257	1,860,655	1,758,706	101,949
1975	8,479,688	5,900,403	2,579,285	6,522,310	4,056,500	2,465,810	1,957,378	1,843,903	113,475
1976	8,312,502	5,848,001	2,464,501	6,349,903	3,998,450	2,351,453	1,962,599	1,849,551	113,048
1977	8,415,339	5,935,076	2,480,263	6,396,476	4,039,071	2,357,405	2,018,863	1,896,005	122,858
1978	8,348,482	5,932,357	2,416,125	6,279,199	3,996,126	2,283,073	2,069,283	1,936,231	133,052
1979	8,487,317	6,016,072	2,471,245	6,392,617	4,059,304	2,333,313	2,094,700	1,956,768	137,932
1980	8,819,013	6,161,372	2,657,641	6,642,294	4,158,267	2,484,027	2,176,719	2,003,105	\1\173,614
1981	9,014,521	6,249,847	2,764,674	6,781,300	4,208,506	2,572,794	2,233,221	2,041,341	\1\191,880
1982	9,091,648	6,248,923	2,842,725	6,850,589	4,220,648	2,629,941	2,241,059	2,028,275	212,784
1983	9,166,398	6,325,222	2,841,176	6,881,479	4,265,807	2,615,672	2,284,919	2,059,415	225,504
1984	8,951,695	6,292,711	2,658,984	6,684,664	4,237,895	2,446,769	2,267,031	2,054,816	212,215
1985	8,943,433	6,294,339	2,649,094	6,667,781	4,239,622	2,428,159	2,275,652	2,054,717	220,935
1986	9,064,165	6,360,325	2,703,842	6,778,045	4,295,494	2,482,551	2,286,122	2,064,831	\2\221,291
1987	9,229,736	6,486,504	2,743,230	6,937,690	4,395,728	2,541,961	2,292,045	2,090,776	201,269
1988......	9,464,271	6,664,146	2,800,125	7,096,905	4,505,774	2,591,131	2,367,366	2,158,372	208,994
1989	9,780,881	6,813,602	2,967,279	7,371,590	4,619,828	2,751,762	2,409,291	2,193,774	215,517
1990	9,983,436	6,968,008	3,015,428	7,557,982	4,740,049	2,817,933	2,425,454	2,227,959	197,495
1991	10,360,606	7,081,454	3,279,152	7,862,845	4,795,704	3,067,141	2,497,761	2,285,750	212,011
1992 \3\ .	10,435,759	7,128,362	3,307,397	7,911,701	4,797,884	3,113,817	2,524,058	2,330,478	193,580
1993 \4\ .	10,351,817	7,121,323	3,230,494	7,812,394	4,765,983	3,046,411	2,539,423	2,355,340	184,083

\1\Large increases are due to the addition of schools accredited by the Accrediting Commission of Career Schools and Colleges of Technology in 1980 and 1981.
\2\Because of imputation techniques, data are not consistent with figures for other years.
\3\Revised from previously published data.
\4\Preliminary data.

NOTE.--Because of a revision in data compilation procedures, figures for 1986 and later years are not directly comparable with data for earlier years.

SOURCE: U.S. Department of Education, National Center for Education Statistics, "Fall Enrollment in Colleges and Universities;" and Integrated Postsecondary Education Data System (IPEDS), "Fall Enrollment" surveys. (This table was prepared January 1995.)

Table 196. Full-time-equivalent fall enrollment in institutions of higher education, by control and state: 1980 to 1993

State or other area	Total					Public			Private	
	1980	1985	1990	1992\1\	1993\2\	1990	1992\1\	1993\2\	1990	1992\1\
1	2	3	4	5	6	7	8	9	10	11
United States	8,819,013	8,943,433	9,983,436	10,435,759	10,351,817	7,557,982	7,911,701	7,812,394	2,425,454	2,524,058
Alabama	138,910	149,895	174,610	182,528	183,013	154,343	160,748	162,039	20,267	21,780
Alaska	10,073	14,098	18,496	19,607	19,567	17,087	18,274	18,325	1,409	1,333
Arizona	127,114	134,954	167,617	175,720	178,348	153,500	158,862	154,951	14,117	16,858
Arkansas	64,307	63,230	74,449	79,454	80,309	63,472	68,482	69,759	10,977	10,972
California	1,099,559	1,062,439	1,156,288	1,248,547	1,186,529	979,663	1,060,615	994,607	176,625	187,932
Colorado	123,589	121,804	159,032	167,832	167,652	138,350	145,887	144,843	20,682	21,945
Connecticut	112,612	107,803	115,791	113,400	111,465	70,870	69,461	67,888	44,921	43,939
Delaware	26,284	25,750	31,612	31,982	32,477	26,059	26,910	27,295	5,553	5,072
District of Columbia	62,126	59,198	61,845	62,861	62,990	7,590	7,405	6,839	54,255	55,456
Florida	290,647	308,315	383,385	411,442	412,279	302,579	324,910	328,056	80,806	86,532
Georgia	152,369	161,952	198,549	231,052	237,433	149,115	177,186	181,419	49,434	53,866
Hawaii	35,859	36,986	41,097	43,505	44,623	32,496	34,389	35,336	8,601	9,116
Idaho	33,938	32,649	41,275	45,958	47,119	31,408	35,623	36,456	9,867	10,335
Illinois	432,365	450,504	493,364	506,889	500,739	353,247	363,003	355,295	140,117	143,886
Indiana	193,445	195,630	222,835	233,272	231,193	168,984	178,406	175,236	53,851	54,866
Iowa	120,083	128,492	138,565	140,950	140,563	95,772	98,668	97,989	42,793	42,282
Kansas	101,147	100,807	118,969	123,070	123,397	106,570	109,791	109,915	12,399	13,279
Kentucky	113,709	110,539	137,651	145,999	145,725	111,858	119,640	118,851	25,793	26,359
Louisiana	132,780	148,983	154,132	166,680	164,605	129,357	143,624	140,953	24,775	23,056
Maine	34,471	37,993	42,021	42,250	41,679	29,876	29,220	28,628	12,145	13,030
Maryland	149,202	148,091	169,972	175,879	175,231	141,950	146,868	145,786	28,022	29,011
Massachusetts	315,937	321,022	320,299	325,190	321,807	130,962	129,473	127,436	189,337	195,717
Michigan	366,058	354,690	389,814	385,626	388,039	326,952	320,562	323,992	62,862	65,064
Minnesota	162,559	170,958	190,608	201,777	197,504	143,424	151,377	147,470	47,184	50,400
Mississippi	85,621	86,846	103,957	104,626	103,750	92,269	92,993	92,715	11,688	11,633
Missouri	180,156	178,090	210,104	215,859	216,343	142,953	142,484	141,391	67,151	73,375
Montana	29,428	29,992	29,905	33,525	33,797	26,835	29,127	29,670	3,070	4,398
Nebraska	68,505	70,778	80,989	88,126	83,873	65,739	71,875	67,145	15,250	16,251
Nevada	22,467	23,093	33,814	36,294	35,709	33,392	35,694	35,125	422	600
New Hampshire	39,456	41,733	45,762	49,262	49,063	24,948	26,998	27,079	20,814	22,264
New Jersey	218,838	201,270	221,468	234,572	235,483	174,324	186,062	186,934	47,144	48,510
New Mexico	43,722	47,169	59,517	67,168	69,106	57,870	63,701	66,326	1,647	3,467
New York	760,305	763,596	798,696	818,337	822,909	446,379	447,770	451,039	352,317	370,567
North Carolina	235,266	249,901	269,025	288,536	283,809	208,321	227,277	223,207	60,704	61,259
North Dakota	30,188	32,456	33,118	35,013	35,207	30,276	31,672	31,849	2,842	3,341
Ohio	369,342	383,898	420,499	434,240	426,308	317,837	325,788	320,661	102,662	108,452
Oklahoma	115,701	126,691	128,203	142,449	135,727	108,933	122,381	116,127	19,270	20,068
Oregon	110,649	102,247	120,176	120,025	118,836	101,424	100,554	99,309	18,752	19,471
Pennsylvania	404,192	422,349	464,179	480,324	475,632	261,305	272,833	267,077	202,874	207,491
Rhode Island	50,628	53,016	60,168	60,106	59,215	28,804	29,169	27,532	31,364	30,937
South Carolina	109,346	109,303	127,225	132,199	131,768	101,918	109,113	108,917	25,307	23,086
South Dakota	27,873	26,988	28,256	30,615	31,850	22,128	24,848	26,386	6,128	5,767
Tennessee	161,058	152,967	175,961	187,884	188,253	130,184	142,097	142,263	45,777	45,787
Texas	527,724	566,736	637,742	663,608	664,476	553,436	573,299	573,213	84,306	90,309
Utah	78,199	84,095	94,012	106,461	110,574	63,495	73,109	75,504	30,517	33,352
Vermont	25,572	25,649	29,072	29,634	28,784	16,048	16,176	15,894	13,024	13,458
Virginia	199,549	204,928	251,708	254,088	250,710	202,285	206,937	204,989	49,423	47,151
Washington	194,440	171,668	189,521	199,121	204,370	160,889	169,156	172,950	28,632	29,965
West Virginia	60,394	58,438	68,235	72,133	71,272	59,229	62,697	61,468	9,006	9,436
Wisconsin	206,790	211,749	229,975	229,686	230,744	192,107	188,863	188,997	37,868	40,823
Wyoming	14,725	17,037	21,888	22,232	22,040	21,185	21,478	21,340	703	754

\1\Revised from previously published data.
\2\Preliminary data.

---Data not reported or not applicable.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), "Fall Enrollment" surveys. (This table was prepared February 1995.)

PART II: REVENUE

When looking at general funding for institutions of higher education, there also seems to be a trend of reduced funding during the period in question (the late 1970's through the 1980's) [NCES, 1995a, OETEC Figure 9 (Figure 21)]. Between 1960 and 1970, federal funds to institutions of higher education increased moderately at about 4% per year. Then, in the 1970's, funding increased by more than 10% per year. These major yearly increases turned into declines by 1977, though funding did start to increase again after that [NCES, 1995a, Table 321].

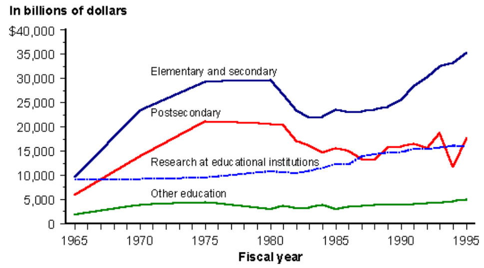


Figure 21.-Federal on-budget funds for education, by level or other educational purpose: 1965 to 1995
[In constant FY 1995 dollars]

SOURCE: U.S. Office of Management and Budget, *Budget of the U.S. Goverment*, fiscal years 1967 to 1996; National Science Foundation, *Federal Funds for Research and Development*, fiscal years 1967 to 1995; and unpublished data.

OETEC Figure 9

Table 321. Revenue of institutions of higher education, by source of funds: 1919-20 to 1992-93\1\ [In thousands]

Year	Current-fund revenue	Student tuition and fees\1\	Federal government\2\	State governments\3\	Local governments	Endowment earnings	Private gifts and grants\4\	Sales and services of educational activities	Auxiliary enterprises	Hospitals\5\
1	2	3	4	5	6	7	8	9	10	11
1919-20....	$199,922	$42,255	$12,783	$61,690	(\6\)	$26,482	$7,584	---	$26,993	---
1929-30....	554,511	144,126	20,658	150,847	(\6\)	68,605	26,172	---	60,419	---
1939-40....	715,211	200,897	38,860	151,222	$24,392	71,304	40,453	$32,777	143,923	---
1949-50....	2,374,645	394,610	524,319	491,636	61,700	96,341	118,627	111,987	511,265	---
1959-60....	5,785,537	1,157,482	1,036,990	1,374,476	151,715	206,619	382,569	102,525	1,004,283	$187,769
1969-70....	21,515,242	4,419,845	4,130,066	5,873,626	778,162	516,038	1,129,438	612,777	2,900,390	619,578
1975-76....	39,703,166	8,171,942	6,477,178	12,260,885	1,616,975	687,470	1,917,036	645,420	4,547,622	2,494,340
1976-77....	43,436,827	9,024,932	7,169,031	13,285,684	1,626,908	764,788	2,105,070	779,058	4,919,602	2,859,376
1977-78....	47,034,032	9,855,270	6,968,501	14,746,166	1,744,230	832,286	2,320,368	882,715	5,327,821	3,268,956
1978-79....	51,837,789	10,704,171	7,851,326	16,363,784	1,573,018	985,242	2,489,366	1,037,130	5,741,309	3,763,453
1979-80....	58,519,982	11,930,340	8,902,844	18,378,299	1,587,552	1,176,627	2,808,075	1,239,439	6,481,458	4,373,384
1980-81....	65,584,789	13,773,259	9,747,586	20,106,222	1,790,740	1,364,443	3,176,670	1,409,730	7,287,290	4,980,346
1981-82....	72,190,856	15,774,038	9,591,805	21,848,791	1,937,669	1,596,813	3,563,558	1,582,922	8,121,611	5,838,565
1982-83....	77,595,726	17,776,041	9,631,097	23,065,636	2,031,353	1,720,677	4,052,649	1,723,484	8,769,521	6,531,562
1983-84....	84,417,287	19,714,884	10,406,166	24,706,990	2,192,275	1,873,945	4,415,275	1,970,747	9,456,369	7,040,662
1984-85....	92,472,694	21,283,329	11,509,125	27,583,011	2,387,212	2,096,298	4,896,325	2,126,927	10,100,410	7,474,575
1985-86....	100,437,616	23,116,605	12,704,750	29,911,500	2,544,506	2,275,898	5,410,905	2,373,494	10,674,136	8,226,635
1986-87....	108,809,827	25,705,827	13,904,049	31,309,303	2,799,321	2,377,958	5,952,682	2,641,906	11,364,188	9,277,834
1987-88....	117,340,109	27,836,781	14,771,954	33,517,166	3,006,263	2,586,441	6,359,282	2,918,090	11,947,778	10,626,566
1988-89....	128,501,638	30,806,566	15,893,978	36,031,208	3,363,676	2,914,396	7,060,730	3,315,620	12,855,580	11,991,265
1989-90....	139,635,477	33,926,060	17,254,874	38,349,239	3,639,902	3,143,696	7,781,422	3,632,100	13,938,469	13,216,664
1990-91....	149,766,051	37,434,462	18,236,082	39,480,874	3,931,239	3,268,629	8,361,265	4,054,703	14,903,127	15,149,672
1991-92\7\.	161,395,896	41,559,037	19,833,317	40,586,907	4,159,876	3,442,009	8,977,271	4,520,890	15,758,599	17,240,338
1992-93\8\.	170,880,503	45,346,071	21,014,564	41,247,955	4,444,875	3,627,773	9,659,977	5,037,901	16,662,850	18,124,015

\1\Tuition and fees received from veterans under Public Law 550 are reported under student fees and are not under income from the federal government.
\2\Federally supported student aid that is received through students is included under tuition and auxiliary enterprises.
\3\Includes federal aid received through state channels and regional compacts, through 1959-60.
\4\Beginning in 1969-70, the private grants represent nongovernmental revenue for sponsored research, student aid, and other sponsored programs.
\5\Prior to 1959-60, data for hospitals are included under sales and services of educational activities.
\6\Income from state and local governments tabulated under "State governments."
\7\Data revised from previously published figures.
\8\Preliminary data.
---Data not available.

NOTE.--Data for years prior to 1969-70 are not entirely comparable with data for later years. Also, some details for 1969-70 are not directly comparable with data for later years. Because of rounding, details may not add to totals.

SOURCE: U.S. Department of Education, National Center for Education Statistics, "Financial Statistics of Institutions of Higher Education" surveys; and Integrated Postsecondary Education Data System (IPEDS), "Finance" surveys. (This table was prepared April 1995.)

Table 356. U.S. Department of Education outlays, by level of education and type of recipient: Fiscal years 1980 to 1995

[In millions of dollars]

Year and area of education	Total	Local education agencies	State education agencies	College students	Institutions of higher education	Federal	Multiple types of recipients	Other\1\
1	2	3	4	5	6	7	8	9
1980 total	$13,137.8	$5,313.7	$1,103.2	$2,137.4	$2,267.2	$249.8	$693.8	$1,372.7
Elementary/secondary	6,629.1	5,309.4	662.2	34.2	22.0	62.5	513.4	25.5
Postsecondary education	5,682.2	---	99.5	2,103.2	2,166.5	---	---	1,313.0
Other programs	747.7	4.3	341.5	---	---	187.3	180.4	34.2
Education research and statistics	78.7	---	---	---	78.7	---	---	---
1982 total	14,109.3	5,425.8	1,414.2	1,610.2	1,951.8	268.3	535.4	2,903.6
Elementary/secondary	6,456.3	5,420.8	593.8	48.9	21.9	2.6	340.3	27.9
Postsecondary education	6,418.8	---	196.6	1,561.3	1,847.7	---	---	2,813.2
Other programs	1,152.0	5.0	623.8	---	---	265.7	195.1	62.5
Education research and statistics	82.2	---	---	---	82.2	---	---	---
1984 total	15,534.7	5,256.5	1,879.0	2,193.4	2,167.4	330.2	516.7	3,191.4
Elementary/secondary	6,220.8	5,252.4	536.0	55.5	35.3	22.9	259.9	58.8
Postsecondary education	7,341.2	---	211.5	2,137.9	1,972.5	---	---	3,019.3
Other programs	1,813.1	4.1	1,131.5	---	---	307.3	256.8	113.3
Education research and statistics	159.6	---	---	---	159.6	---	---	---
1985 total	16,701.1	6,225.0	1,502.9	2,434.7	2,362.3	287.3	503.9	3,385.0
Elementary/secondary	7,296.7	6,220.8	636.0	58.0	25.2	2.4	322.4	31.9
Postsecondary education	8,202.5	---	228.3	2,376.7	2,308.3	---	---	3,289.2
Other programs	1,173.1	4.2	638.6	---	---	284.9	181.5	63.9
Education research and statistics	28.8	---	---	---	28.8	---	---	---
1986 total	17,740.1	6,435.1	1,823.3	2,685.9	2,637.2	265.4	625.8	3,267.5
Elementary/secondary	7,552.0	6,432.1	558.5	68.3	45.2	2.2	372.0	73.8
Postsecondary education	8,444.9	---	215.6	2,617.6	2,523.0	---	---	3,088.7
Other programs	1,674.2	3.0	1,049.2	---	---	263.2	253.8	105.0
Education research and statistics	69.0	---	---	---	69.0	---	---	---
1988 total	18,326.9	6,614.8	2,234.6	3,103.4	2,519.5	319.4	838.8	2,696.3
Elementary/secondary	8,098.4	6,606.3	717.9	66.2	39.5	23.8	616.7	28.0
Postsecondary education	8,247.1	---	184.60	3,037.2	2,437.6	---	---	2,587.7
Other programs	1,939.0	8.5	1,332.1	---	---	295.6	222.1	80.6
Education research and statistics	42.4	---	---	---	42.4	---	---	---
1990 total	23,198.5	8,000.7	2,490.3	3,859.6	3,649.8	441.4	912.2	3,844.4
Elementary/secondary	9,681.3	7,995.0	700.3	80.5	85.4	113.1	650.7	56.3
Postsecondary education	11,176.0	---	261.6	3,779.1	3,475.0	---	---	3,660.4
Other programs	2,251.8	5.7	1,528.5	---	---	328.3	261.5	127.8
Education research and statistics	89.5	---	---	---	89.5	---	---	---
1992 total	26,116.0	9,834.7	2,883.2	4,090.7	4,107.4	418.3	1,189.4	3,592.4
Elementary/secondary	12,057.7	9,830.1	1,011.0	92.9	232.7	49.8	762.3	78.8
Postsecondary education	11,323.6	---	245.5	3,997.7	3,719.9	---	---	3,360.5
Other programs	2,579.9	4.6	1,626.6	---	---	368.5	427.0	153.1
Education research and statistics	154.8	---	---	---	154.8	---	---	---
1993 total	30,478.2	10,459.3	3,123.0	5,274.8	5,264.0	404.5	1,200.2	4,752.4
Elementary/secondary	13,059.0	10,451.5	1,261.0	110.5	281.9	51.0	823.3	79.8
Postsecondary education	14,660.7	---	225.9	5,164.3	4,749.9	---	---	4,520.6
Other programs	2,526.4	7.8	1,636.1	---	---	353.5	376.9	152.0
Education research and statistics	232.2	---	---	---	232.2	---	---	---
1994 total	28,879.7	11,635.6	3,683.5	4,789.4	4,890.9	530.1	1,368.2	1,982.1
Elementary/secondary	14,825.8	11,629.2	1,580.0	170.5	295.2	60.9	1,002.1	87.9
Postsecondary education	10,699.0	---	42.2	4,618.9	4,279.3	---	---	1,758.6
Other programs	3,038.6	6.4	2,061.3	---	---	469.2	366.1	135.6
Education research and statistics	316.4	---	---	---	316.4	---	---	---
1995 total	32,947.4	11,959.9	4,150.3	4,886.0	5,020.6	535.4	1,649.2	4,745.9
Elementary/secondary	15,378.6	11,952.4	1,760.4	190.5	170.1	70.3	1,196.9	37.9
Postsecondary education	14,061.3	---	250.8	4,695.5	4,520.0	---	---	4,595.0
Other programs	3,177.1	7.4	2,139.2	---	---	465.1	452.3	113.0
Education research and statistics	330.4	---	---	---	330.4	---	---	---

\1\Other recipients include Indian tribes, private nonprofit agencies, and banks.

---Data are not available or not applicable.

NOTE.--Outlays by type of recipient are estimated based on obligation data. Because of rounding, details may not add to totals.

SOURCE: U.S. Office of Management and Budget, Budget of the U.S. Government, Fiscal Years 1982 to 1996, and Catalog of Federal Domestic Assistance; National Science Foundation, Federal Funds for Research and Development Fiscal Years 1980 to 1995; and unpublished data obtained from various federal agencies. (This table was prepared June 1995.)

U.S. Department of Education outlays (1980-1995) to college students decreased by about 35% to postsecondary educational institutions and about 20% to institutions of higher education [NCES, 1995a, Table 356]. Federal on-budget funds for postsecondary education increased rapidly up to 1975, then showed moderate declines until 1982 before experiencing sharp declines. Outlays to elementary and secondary schools showed a similar pattern except the slowdown started in 1970 with sharp declines around 1980 [NCES, 1995a, OETEC Figure 9 (Figure 21)].

Average (full) professor salaries at public institutions fell from $64,200 in 1972 to $49,500 in1981 (in constant 1993 dollars), then rose back to $58,300 by 1992. And while total revenue for higher education, with the exception of public 2-year colleges, increased between 1980 and 1992, government resources fell in public 4-year colleges from $7,600 to $6,500 per FTE student and from 67% to 55% of total revenue [NCES, 1995b].

Revenue per FTE Student (in constant 1994 dollars)

Public universities:	1980:	$15,081	1992:	$16,931
Public 2-yr colleges:		$ 5,790		$ 5,743

> A possible reason for the rise in the cost of higher education over the long term is a lack of increase in productivity in higher education. Whereas many sectors of the U.S. economy, particularly manufacturing and agriculture, have used technology and innovation to either increase the quantity or quality of goods provided with no corresponding increases in resources used, higher education is still provided in largely the same way it was when the nation was founded. When productivity growth in a particular sector of the economy lags behind that in the rest of the economy, the cost of providing that good or service increases [NCES, 1995b, p.14].

All state administrative grants are appropriated from the ESAA (Employment Security Administration Account) [Ohio Legislative Budget Office, 1997]. By law, these appropriations are limited to 95% of the account balance. But for the period 1981-1995, the average amount of administrative grants returned to the states was 84.4%. For Ohio, it averaged 66.8%. The federal unemployment compensation system consists of two taxes. One pays for the federal and state administration of the system; the other pays unemployment benefits. The federal government collects and appropriates the unemployment compensation tax, commonly referred to as FUTA. It then disburses these revenues from an account within the ESAA to the states to pay their administrative costs. The federal government opted to withhold full funding by categorizing FUTA revenues as discretionary money. Thus, in order to increase expenditures (i.e., state funding) the federal government would have to either cut other expenditures or generate additional revenue. Neither option has been completely implemented. It was found [Ohio Legislative Budget Office, 1998] that many states face funding problems, likely due to the federal government's decision to withhold disbursement of all available ESAA dollars. To adjust to this reality, each of the states contacted entered a period of transition both organizationally and technologically.

For more than three decades, Ohio's funding formula has been used to distribute state support for higher education [Inter-University Council of Ohio, 2005]. The formula assumed that an increase in enrollments would require an increase in state support. But in the early 1980's, when Ohio's unemployment rate exceeded 13% for a full year, the pressures on the state budget became unbearable. An important result was that the fee assumption was allowed to rise as much as necessary to keep the state's funding obligations to predetermined limits. The formula was no longer seen as a rational way to determine the amount of state funding required. Instead, it became simply a rationing device to allocate whatever amount the state was willing to spend on higher education. The formula has been viewed in this way ever since.

With the transformation of the formula into a rationing device, it now responds to enrollment growth only by diluting state support per student. This has particularly negative consequences for programs and institutions whose enrollments have remained relatively flat. It was much easier to adjust to a real decline in funding per student when nominal inflation rates were higher. For example, a 6% increase in funding per student in the face of a 10% inflation rate is more easily managed than a 2% reduction in funding with a 2% inflation rate. This may have been a strong contributing factor in the decline of traditional ET programs, where enrollment was already tapering off—if not outright declining—and, with this change in the funding formula, made the demise of many programs a certainty. As mentioned in the first section of this paper, it is evident in Ohio that more students have been enrolling in ET programs while fewer are becoming degree completers. The expense of completing one's degree, when the skills needed by the individual could be met with fewer classes, may be a contributing factor.

The consequences of the change in this funding formula may be a contributing factor in the woes of institutions of higher education in terms of funding. In the late 1980's and early 1990's, statewide enrollments increased by 50,000 FTE's without any increase in state funding to pay for them. As was the case in the late 1980's and throughout the 1990's—trends that can be seen in educational institutions even today in 2006—reductions in state/federal funding have forced schools to increase tuition. And, increases in tuition may have led many prospective students to postpone or even forego altogether their college plans. Currently, tuition hikes are making it ever more difficult for Ohioans to respond to the wrenching changes occurring in the state's economy.

PART III: TRENDS AMONG HIGH SCHOOL SENIORS

Changes in family structure have been evident throughout the period from 1972 to 1992 [Green, et. al., 1995]. The number of households composed of a married couple with children under the age of 18 declined slightly. At the same time, the number of single-parent households increased dramatically. In 1970, there were 2.9 million female-headed households with children under 18. In 1991, that number had more than doubled to over

6.8 million. Male-headed households with children under 18 went from 0.34 million to around 1.2 million.

And while there is no direct link between demographics/family values and enrollment in traditional ET programs, we do see notable changes in these factors during the period in question. As noted above, family demographics changed dramatically over this period. Also seen, however, were value shifts. For example, in the 1970's, seniors in high school felt that "Giving children a better opportunity", "Living close to parents", "Steady work", "Success in work", and "Money" were all either not very important or quite unimportant values. In the 1980's and 1990's, though, these same values were rated between somewhat important and very important.

Yet another coincidence lies in the fact that in 1982, only about 10% of high-school graduates earned the recommended units in core courses, regardless of whether their parents had finished high school themselves or not. However, if their parents had at least taken some college courses or perhaps had even graduated college, those high-school students were 1.5-2.0 times more likely to earn these core units. By 1992, it made virtually no difference what educational background the parents had; students were all about 46% likely to earn the recommended units in core courses [Green, et. al., 1995]. Whether or not these demographics and value shifts affected high-school students' choices or ability to do well in college is unclear, but is potentially another factor affecting the subsequent shift in student attendance rates and willingness to go on to college.

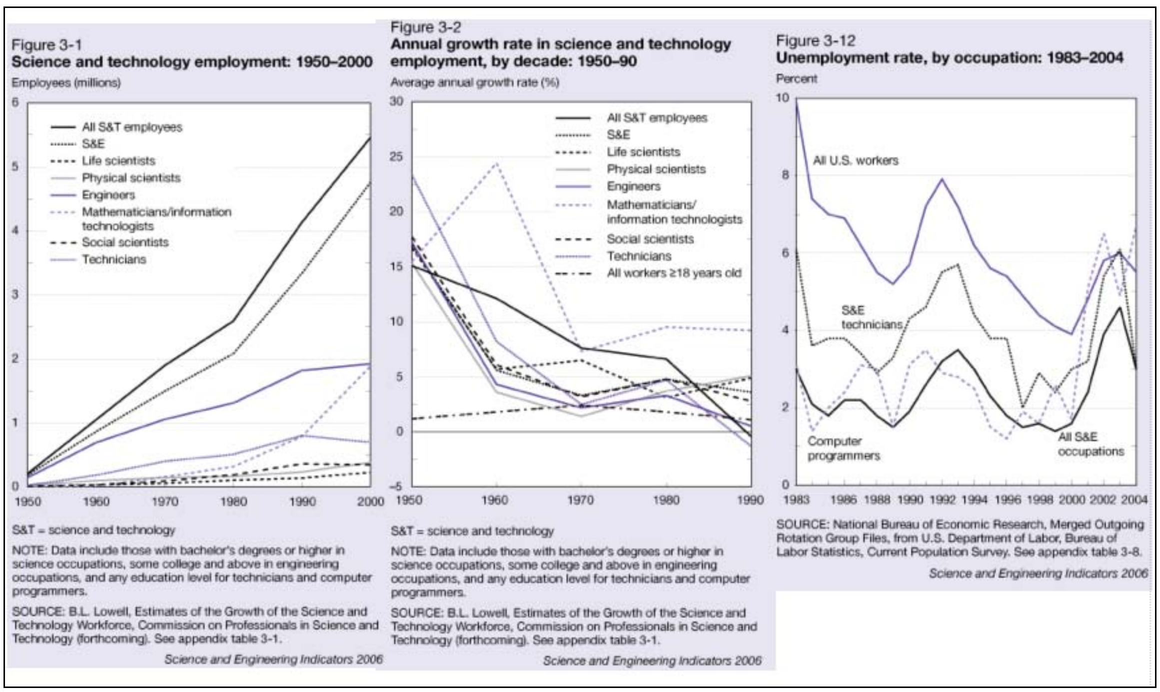
PART IV: EMPLOYMENT, EDUCATION AND THE ECONOMY

In the studies from which data have been gleaned for analysis here, it should be noted that trends stated or implied may be ambiguous because 1) data do not in every case include all schools offering these programs, and these same schools may or may not report data in every year, and 2) firm definitions of programs that should be reported as part of traditional or legacy programs versus the newer niche or specialty programs are either different for different schools or are still evolving and thus are not necessarily consistent from year to year even within particular institutions.

Another potential cause for a decrease in traditional ET enrollment might be a market shift. Coupled with a marked decline in U.S. exports in the late 1970's and early 1980's, the U.S. market shifted to focus on the PC and networking boom in business and industry. At the same time, students began to abandon electronics to ride the wave of the PC industry success [Brixen, et. al., 2006]. Jobs were plentiful and certification offered big bucks not attainable as an electronics tech. Many schools added new PC departments while others added PC's to electronics. In the end, PC's dominated to the extent that electronics departments became computer (and electronics) technology departments. Adding insult to injury, electronics programs still surviving and unwilling to adapt, end up training students for technician jobs that no longer exist.

Part of the problem may also be a shift in image related to the shift in jobs [Brixen, et. al., 2006]. A major shift in employment in science and engineering fields between 1950 and 1990 likely also had an effect on the image of technicians in all of the engineering and technology fields. Science and technology employment, starting from almost nothing in the late 1940's, increased rapidly between 1950 and 1982, likely fueled by the introduction of the US/Soviet Union space race, consumer electronics and PC's. In the period 1982-1990, however, engineers and technicians, though still experiencing employment growth, began to see a pattern of decline. After 1990, engineers managed to log slight increases but technicians were now starting a downward spiral from which they would not recover [NSF, 2006b, OETEC Figure 10 (Figure 3-1)].

Looking more closely at the growth rate of employment in science and technology, the decade 1950-1960 was most unkind to all fields except mathematicians and information technologists. From 1960-1970, the declines moderated as the economy could not sustain such a high level of growth. Most science and technology employment fields managed modest increases in the 1970's, in spite of an overall decline, but again took a downward turn in the 1980's [NSF, 2006b, OETEC Figure 10 (Figure 3-2)]. Adding science and technology fields to the unemployment rate of all U.S. workers, the roller-coaster ride is still evident. Unemployment across the nation dropped to just over 5% in the late 1980's before heading back to around 8% around 1992[NSF, 2006b, OETEC Figure 10 (Figure 3-12)].



OETEC Figure 10

It is interesting to note that annual growth for technicians exceeded that for engineers until the mid 1980's. Then, while both groups experienced a decline, technicians actually saw negative growth starting around 1988. It can be surmised then that the term "electronics technician" started to be used less and less often, being replaced by terms such as "field-service technician", "engineer", "manufacturing technician" and "maintenance technician". Combining the negative growth rate of technicians with the reduced funding to educational institutions, it could also be the case that schools stopped marketing their traditional or legacy technician programs. Now consider such a drop in program promotion at 2- and 4-year schools with the current aggressive marketing tactics of proprietary schools, and it's easy to see how the current shift is possible. In spite of employment woes for technicians and declining enrollment in college and university legacy ET programs, proprietary schools continue to attract new students.

So here we see a picture of low unemployment (in the early to mid-1980's) and declining enrollment in schools and universities. Whether or not there is a correlation, we cannot say. Regardless whether students are choosing the workforce over school due to plentiful job opportunities or choosing not to pursue an (advanced) education due to a poor image in the technology field, the end result was the same.

In a survey of employers in South Carolina [Hull, 2005, p.9], the employers stated that 85% of their jobs required education and training beyond high school, but also that only 20% required at least a 4-year college degree. Community colleges (or junior colleges as they were called) were originally designed to offer 2-year terminal degrees. Today, however, many offer programs that are designed to be similar to the first two years of 4-year programs [Commission on Engineering and Technical Systems, 1985]. In 1967, when baccalaureate institutions first started accrediting ET programs, 2-year institutions were already 20 years ahead of them with 193 accredited programs at 61 institutions. By 1983, 4-year schools were offering 271 ET programs, while 2-year programs numbered 460 [Commission on Engineering and Technical Systems, 1985, OETEC Table 2 (Table 2, p.32)].

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TABLE 2 Historical Growth of Accredited Engineering Technology Programs

	Associate		Baccalaureate		Total	
Year	Institutions	Programs	Institutions	Programs	Institutions[a]	Programs
1946	3	7	—	—	3	7
1951	22	62	—	—	22	62
1956	32	95	—	—	32	95
1961	32	116	—	—	32	116
1966	49	164	—	—	49	164
1967	61	193	1	2	61	195
1968	62	194	3	9	63	203
1969	68	222	5	12	69	234
1970	80	257	12	27	82	284
1971	85	272	17	41	92	313
1972	94	299	19	46	101	345
1973	98	315	29	81	110	396
1974	100	322	36	102	117	424
1975	103	324	45	121	128	445
1976	111	344	57	150	139	494
1977	117	377	62	155	149	532
1978	121	387	67	178	159	565
1979	123	390	70	189	166	579
1980	132	416	83	221	185	637
1981	136	434	88	242	188	676
1982	140	447	91	257	192	704
1983	142	460	91	271	195	731

[a]Some institutions have both associate and baccalaureate degree programs and are only included once in the total for any one year.
SOURCE: *Fifty-first Annual Report of the Accreditation Board for Engineering and Technology* (New York: September 30, 1983).

The preferred credential, it seems, is the associate degree [Hull, 2005]. This finding, along with those of the other studies presented in this report, points us to the country's community and technical colleges as they are uniquely and ideally positioned to provide this postsecondary education and training that is essential if the U.S. is to maintain and advance its position as an economic leader in high-tech manufacturing.

OETEC Table 2

Interpreting these results, most programs have experienced losses in their traditional or legacy programs, while at the same time many are showing promising numbers in their newer programs.

PART V: PROJECTIONS

While we have seen a number of notable trends during the period between the late 1970's and the mid 1980's, we should also look at projections for the future if we plan to make predictions relating to the continued decline in traditional ET programs and the increase in popularity for non-traditional, niche programs like power technology, electromechanical/mechatronics and construction [Hussar, 2005].

According to a 2005 report by the National Center for Education Statistics [Hussar, 2005], the U.S. can expect to see minimal growth (1%) in PK-12 enrollment in public schools through 2008. Between 2008 and 2014, the report projects an increase of 2.7%. For Ohio, after a slight decrease (0.3%) between 1996 and 2002, projections for further declines through 2008 are sharp at 3.2%, with another decline of 1.6% up through 2014.

Looking specifically at grades 9-12, the U.S. is expected to continue increasing through 2008 (6.6%), though not at the previous rate of 9.5% through 2002. Between 2008 and 2014, however, these grades are expected to show declining enrollment at about 4.5%. Ohio's numbers are in line with the national expectations with only a slight increase by 2008 (1.2%) and a sharp decline after that through 2014 (8.5%) [Hussar, 2005]. Additionally, total enrollment for all degree-granting postsecondary institutions is projected to post moderate gains by 2014 with the bulk of the increase coming from the age groups 22-24 and 25-29 (for both men and women).

In an effort to identify successful strategies and best practices to answer the concerns raised here and elsewhere, we turn our attention to efforts by other groups around the U.S. Potential answers to this and related questions come from a study on high-tech manufacturing's future by the Battelle Memorial Institute [Battelle, 2005]. And while the Battelle study focused on the greater Phoenix (Arizona) region, its suggestions are appropriate for all of us. Namely, that high-tech manufacturing continues to provide a strong economic employment base and economic diversity to the region; manufacturing wages are higher on average than total private sector wages and wages in the service industry, typically due to increased skill-set requirements for employees [Battelle, 2005].

> …high-tech manufacturing will be demanding graduates with ever-expanding skill sets, Ohio must develop a strategic plan to ensure that the state has a viable talent pool from which existing high-tech manufacturing can draw…

If, then, we may assume that high-tech manufacturing will be demanding graduates with ever-expanding skill sets, Ohio must develop a strategic plan to ensure that the state has a viable talent pool from which existing high-tech manufacturing can draw, but also to use as a draw for new companies seeking regions for building new plants and putting down roots. It is not sufficient to continue "business as usual"; this can be seen in the decline and demise of traditional or legacy ET programs that have not been willing to adapt. Rather, Ohio needs to look to the future and develop a vision for its economy, workforce and educational preparation. To this end, Ohio—taking from the recommendations of the Battelle study—must provide leadership and knowledge, not only to the schools offering ET programs, but also the public from which the future students will come.

Furthermore, Ohio must forge new outreach programs with industry and local schools to develop or update its pipelines to move students into its ET programs and successfully on to the industrial marketplace. However, beyond business as usual, we must also develop career ladders, talent clusters and mentoring programs that encourage the development of engineering technology talent. Ohio need also keep communication channels open with its legislators, such that the money and support will not dry up. And though money is important in the sustainment of educational institutions, without public support from our government, we will lose the public confidence and parents will continue to steer their children elsewhere.

"The key is not just knowledge or skill, but flexible knowledge, flexible skills—those insights and abilities that enable us to learn new material quickly, to move easily from one job to another …the most important skill a student can master is learning to learn" Gunderson, Jones & Scanland in *The Jobs Revolution: Changing How America Works*

Lastly, we must provide for lifelong learning opportunities to our dedicated workforce. The reason that there is so much talk about and studies relating to the changing skill sets of the high-tech manufacturing employee, is because technological advances are occurring at a rate never experienced before. Today, the odds are against the average college graduate to remain in one job for an entire career. Even should the graduate choose to remain at one specific job, the pace of technology will require periodic retraining. It is, then, in our best interest to provide retraining opportunities for these employees so that they can remain a useful part of the high-tech manufacturing workforce. "The key is not just knowledge or skill, but flexible knowledge, flexible skills—those insights and abilities that enable us to learn new material quickly, to move easily from one job to another" [Gunderson, Jones & Scanland, 2005, p.22]. Gunderson, Jones & Scanland also go on to state that "…the most important skill a student can master is learning to learn" [p.59].

This, most certainly, is the brunt of the argument—possessing the ability to be easily retrained. Options for retraining typically fall into two categories: employer-initiated and employee-initiated. Employer-initiated means that the employee will be retrained "in-house" for another job within the company; employee-initiated means that the person likely is unemployed and must go back to school for additional training in order to obtain a new position. In either case, individuals requiring the least amount of training—or who are best able to learn on the job with a minimal amount of investment of time and resources from others—are going to have the greatest longevity and mobility throughout their careers.

Looking again at the Battelle study [Battelle, 2005] and work done by Frenzel and McGlew [Frenzel, 2006a; Frenzel, 2006b] and Brown, Gear and Kinkley [2004], we can summarize the findings from interviews with local industry. The industrial perspective focused on three keys areas: 1) strategic directions, 2) operational requirements, and 3) workforce development.

1) Strategic directions:
   - Most companies expect increased sales over the next few years;
   - Engineering requirements are growing more complex, and technicians need more experience in system performance instead of so much of the component-level knowledge as before;
   - In light of global competition, a competitive advantage can be gained through products with higher engineering content that are quick to market—thereby reducing labor costs, while retaining or increasing quality, product features and service;
   - According to the Battelle study [Battelle, 2005, p.63], a key issue observation was that finding and retaining key employees with appropriate talent and technical skills is becoming a critical challenge. In spite of a tightening labor market, business volume is in many cases increasing, thereby challenging them to hire and retain workers. Methods used by a majority of the companies surveyed (in the Battelle study) use tuition-reimbursement plans and in-house training, both cited as aiding in student retention.

2) Operational requirements:
   - Battelle [Battelle, 2005] and others found that technicians increasingly need more training on a full-systems perspective. Here, the technician would be expected to diagnose and repair a complex system of both hardware and software as well as deal with component-level troubleshooting as needed.

3) Workforce development:
   - High-tech manufacturing firms are looking for technicians with broad and well-rounded skill sets—including “soft skills’, and with broader skill sets, employers are better able to cross-train their employees.

Council Recommendations

Strategies to Strengthen Ohio

Based on the data presented in this paper, OETEC proposes the following policy changes or organizational commitments from Ohio and individual college administrations throughout the state.

1.) Incorporation of Structured Pathway Programs

- Create Structured Career Pathways, which have community, industry, government and education collaboration. All of the parts must work in concert to provide access to and preparation for participants in a modern workforce. These are more than passive articulation agreements or memorandums of understanding; instead, they are strong active relationships that purposely funnel emerging and incumbent workforce participants into greater opportunities for them individually and the community as a whole.
- This recommendation requires a more structured use of Ohio's government agencies engaged in workforce enhancement. Thomas [2007] recommended a redesign of the Governor's Workforce Policy Board to make it a more nimble, responsive and cross-functional agent for Ohio. At present, there exists a dizzying array of services intended to assist workforce development for employers, employees and perspective employees that come from the Ohio Department of Education, Ohio Board of Regents, Ohio Department of Job and Family Services, and various other state and federal councils, boards or commissions. Employers generally acquire an exasperated sense of disillusionment with government's workforce development initiatives. A recent Ohio workforce survey of manufacturers listed public recruiting mechanisms, specifically One-Stop Career Centers and SCOTI online jobs database, as one of the least useful tools for recruitment of new employees [Vosler, 2005]. This must change.
- Governor Strickland has made this a priority in his Turnaround Ohio vision. One of his three implementation features is to "set the leadership agenda of increased coordination among education and workforce and economic development, providing a cohesive and synergistic talent development system" [Office of Workforce Development, 2007]. This cannot happen soon enough.
- Associate Degree ET education should not be seen as an alternative to, but rather an inclusion in the successful path of tomorrow's technology employees.
- Strengthen Access to Bachelor's Completion Programs – graduates of associate degree programs are often place bound and require flexibility in attainment of advanced ET degrees. Miami's interactive distance program in Electro-Mechanical Engineering Technology is an excellent benchmark for bachelor completion programs.

2.) Focus on Consolidation of Emerging and Legacy Engineering Technology Programs
- Create Degrees and Certificates with Contemporary Content and Names – students and industry must be convinced that the investments made in higher education will generate exceptional returns for the future. In many cases, "traditional" ET programs are declining in enrollment while emerging technology degrees are increasing. Majors with cross-functional content and capacity, such as mechatronics and electro-mechanical engineering technologies, have more appeal to industry and prospective students alike.
- Funding for Emerging Technology equipment and training will be a key: investment in capital equipment and professional development related to instruction of emerging technologies must be secured.

3.) Focus on Short to Medium Length Certificates in Flexible Format
- Modern industry is calling for highly trained technicians with specific skill sets. These skill sets are sometimes a moving target due to the pace of technological change in the workplace. Therefore, colleges must be prepared to train both an incumbent and emerging workforce with delivery of courses in less than a full 2-year cycle.
- Flexible delivery formats will become necessary to meet the multi-faceted work schedules and busy lives of today's workforce and incorporate on-line instruction and accelerated course schedules (e.g., one-night-a-week, linked learning).

4.) Targeted Marketing and Recruiting for Engineering Technology
- Statewide efforts at marketing advanced technology and manufacturing occupations should become a priority. Public institutions are often reluctant to allocate marketing dollars for programs that have stagnant or moderately increasing enrollments. Efforts such as the national *Dream It Do It!* campaign hold much promise to attract new talent to high-tech fields and should be explored for purchase at a statewide level.
- Thomas [2007] described one strategic action as "Customer Usage and Satisfaction" and detailed a recommendation to launch a multi-faceted, multi-year statewide marketing campaign aimed at increasing employers' and employees' use of the state's talent development system. OETEC approves of this initiative.
- Thomas [2007] also mentioned the support of apprenticeships, student internships, faculty externships and mentoring/coaching initiatives with businesses. OETEC supports this initiative and believes it could be a great tool to attract young people to exciting high-technology careers.

5.) Targeted Collaboration with 2-yr Colleges on State Grant Opportunities
- Ohio's Third Frontier projects typically emphasize job retention or creation as a desired outcome. Of the 23 Third Frontier Wright Projects funded to date, two have 2-yr colleges as leads (Rhodes State College & Stark State College of Technology) and an additional three have 2-yr college collaborators (Sinclair Community College [x 2] & Lorain County Community College). The state should start including language in the RFPs that encourages 2-yr college ET department or division involvement.

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Acknowledgements

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Funded by:
Ohio Engineering Technology Educators Council (OETEC)