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ABSTRACT

Two paths may be followed to project training needs for high technology: concentration on the employment composition of high technology industries or focus on high technology occupations. The pervasiveness of high technology occupations appears to verify the wisdom of considering total industry employment in manpower planning for high technology occupations. While there has been interest in expanding the supply of engineers and computer personnel, less has been said about manpower needs at the technician level. An adequate supply of engineering and science technicians who are trained primarily in postsecondary institutions below the baccalaureate level will be equally important to the revitalization of industry. While the state employment agency projections of the occupational demand for engineering and science technicians in several southern states indicate a balance between supply and demand, these projections may not reflect the dynamic changes taking place. When demand for engineering and science technicians is measured on the basis of more dynamic projections--on the basis of what the demand would be if southern states were to employ the same proportion in their industries as is projected for the nation in 1990--need for expansion of training programs below the baccalaureate level for engineering and science technicians exists. (YLB)

Technician Manpower in the South:

High Tech Industries or High Tech Occupations?

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SREB

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Foreword

This brief analysis is of interest to educational and economic development planners in the Southern region, and elsewhere, for several reasons.

The author presents evidence that industrial development prospects in many Southern states require substantial expansion of their labor force supply at the technician level, which is trained largely in community colleges and vocational schools.

The assumptions about the nature of future economic development which underly these manpower projections are provocative. The contention that technological modernization is actually taking place over a wide range of industrial settings runs counter to a popular current conception that a select number of somewhat narrowly defined "high tech" industries will prove to be the key to invigoration of the entire economic activity in a given state or region.

Thus, the proposition that expanded preparation of manpower for "high tech" occupations is a crucial prerequisite for advancement of economic well-being is here maintained and supported—but with one proviso. Two-year postsecondary institutions are strongly advised to provide broad-based generic programs in the basic technologies, allowing for an individual's adaptation across a wide range of occupational applications, rather than aiming at a proliferation of inordinately specialized programs.

Winfred L. Godwin
President

High Tech Industries or High Tech Occupations?

What specific education and training strategies should the South pursue to successfully compete for high technology? This is the question that is being asked on all fronts. There is general agreement that the climate for promotion of high technology includes the availability of professional talent and research facilities in engineering and science, and a work force at all occupational levels that is well educated and able to respond to change. But more specific objectives are needed by states so they can mobilize their education and training resources to compete for high technology.

Two paths may be followed to project training needs for high technology: (1) concentration on high technology industries, and examination of their employment composition, or (2) focus on high technology occupations, regardless of the industries in which they are found.

The two approaches to identification of manpower needs serve two fundamentally different economic development strategies. A strategy based on securing as large a share as possible of new or developing high technology industries would focus primarily on the occupational patterns of these industries, and then seek to provide a labor force with specialized skills for such industries. The appropriateness of this economic development plan for any state or local area depends upon its competitive potential versus all other entities now pursuing this approach. The success of California's Silicon Valley, Route 128 around Boston, and the North Carolina Research Triangle has prompted many states to seek similar developments. It is highly unlikely, however, that all who are now mounting such efforts will succeed.

An economic development strategy, on the other hand, that focuses on existing industries proceeds on the assumption that to compete in national and world trade more and increasingly sophisticated technology will need to be applied throughout many sectors of the economy. Such a strategy emphasizes "high technology" *occupations,* regardless of the industry in which they predominate, rather than specific "high tech" *industries.* To the extent that microprocessors, numerically-controlled tools, lasers, and even robots are introduced into a variety of industries, the real issue becomes one of training a work force that will be able to function in that environment throughout the whole gamut of modernized industry, rather than in selected "high tech" industries.

According to the U. S. Bureau of Labor Statistics (BLS), total employment in "high technology industries"* in 1980 comprised only 4.6 percent of total wage and salary worker employment nationally. With the definition broadened to include "technologically intensive" industries, nine percent of total employment was found in these sectors in 1980.[1]

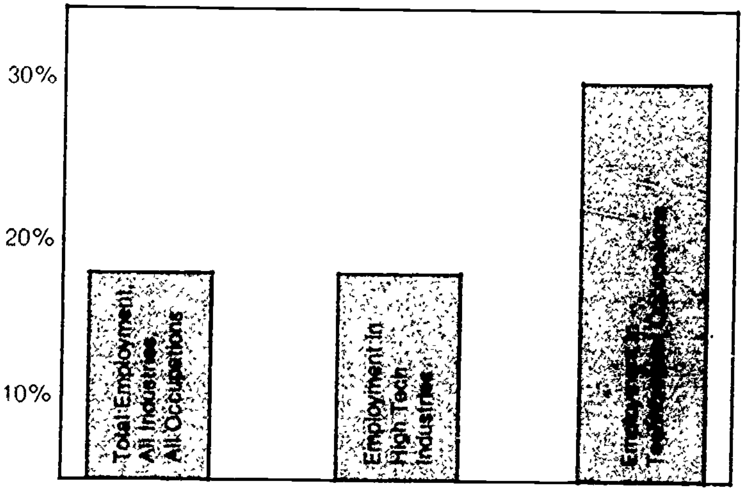
According to BLS, the projected growth rate of total employment in high tech industries for the next decade (18 percent) will not exceed the growth rate for all industries. Employment in technological occupations, however, is projected to grow by 30 percent in the ensuing decade, or at a considerably faster rate than (1) total employment in all occupations and (2) total employment in high tech industries (see Figure 1).

Pervasiveness of High Tech Occupations

The diversity of industries in which high technology occupations are found is illustrated by the BLS finding that only one-fifth of persons employed in high tech *occupations* in 1980 worked in high tech *industries.* Even the expanded definition of "technologically intensive" industries accounts for less than one-third of all persons in high tech

*According to U.S. Bureau of Labor Statistics working definitions, a "high tech" industry is one where research and development expenditures, relative to sales, and employment in high technology occupations each represents at least 10 percent. A technologically intensive industry is one where research and development and employment of high technology occupations represent at least five percent. High technology industries include drugs and medicine, office, computing and accounting equipment, electrical and electronic equipment, aircraft and missiles, and instruments and related products. Technologically intensive industries include the above plus all other chemicals, machinery, and transportation equipment.

Figure 1
Projected Employment Growth
United States, 1980—1990



Source U S Bureau of Labor Statistics, unpublished preliminary report to the Joint Economic Committee, August 2, 1982.

occupations. This appears to verify the wisdom of considering total industry employment in manpower planning for high tech occupations, rather than focusing on specific occupational needs of so-called high tech industries.

The relevance of high technology to a variety of existing industries, and not just to high tech firms, is illustrated in the South by the textile and apparel groups, which in 1980 accounted for 1.2 million jobs in the region.

In the Carolinas, where some 46,000 jobs in these industries have been lost in the last two years, textiles and apparel still represented 41 percent of total manufacturing employment in 1980. The survival of these industries depends on the application of sophisticated technology to offset lower labor costs in other countries.

As stated by Robert F. Anthony, a vice-president of Burlington Industries, America's largest textile company, "The ability to make this shift will spell the difference between competing in world markets, getting left behind, or not even surviving."[2]

Electronic knitting machines, electronically-controlled looms, and robots that eliminate the old "push-pull" operations between work stations have greatly increased productivity in some modernized textile plants in the region. New technology is being introduced into the apparel industry too, although at a slower rate than in textiles. For example, operators at Cluett Peabody plants now tend several sewing machines simultaneously, with stitching controlled by microcomputers, while a "clue-picker," or robot-like arm, separates and moves a single ply from a stack of fabric. Such automation depends on an adequate supply of well-trained technicians who can program and maintain the new equipment, and the availability of such manpower is critical. As one manager explains, "It did not make much difference when one of our operators who produced 30 dozen pockets in one day was absent. But, when a machine that produces 180 dozen pockets per day is down, we're in real trouble."[3]

The application of more technology also affects assemblers or operators. For example, in the apparel industry, more manual dexterity was needed by the traditional sewing machine operator, but the person dealt with only one major switch—the on or off position. Today, the operator monitors a much greater variety of controls. The least this implies is a level of literacy sufficient to read instructions.

The application of technology also has implications for the training of craft workers, for example, repairers and maintenance personnel. Even in the concrete products industry—which is certainly not considered "high tech"—larger plants are installing electronically-controlled automatic batchers that select, weigh, and proportion required amounts of components. Craft personnel now become responsible for the maintenance of control panels, instruments, and machinery.

Similarly, changes of method in underground mining—another industry that lacks the glamor of "high tech"—have modified workers' skill requirements. The introduction of continuous mining machines has eliminated hand loaders, and increased the need for electrical and mechanical maintenance workers to service the machines. While such equipment already prevails in underground mining in Illinois and Pennsylvania, there is considerable potential for widespread application in Kentucky and Alabama mining.

The relative distribution of workers by occupational categories, depending on the degree of technology, is illustrated in Table 1. While engineering technicians constitute 16 percent of total employment in robot manufacturing, they represent only 2.2 percent of total employment in all manufacturing. However, the proportion of skilled craft workers in "all manufacturing" is much greater than in the robotics industry. Indeed, the availability of craftsmen, such as skilled machinists, is often crucial to the production process.

Table 1
Current U.S. Occupational Profiles
Robot Manufacturing, All Manufacturing, and All Industries

	Employment Distribution (percent)		
	Robot Manufacturing	All Manufacturing	All Industries
Engineers	23 7%	2 8%	1 2%
Engineering technicians	15 7	2 2	1 4
All other professional and technical workers	4 2	4 0	13 5
Managers officials, proprietors	6 8	5 9	8 1
Sales workers	3 4	2 2	6 3
Clerical workers	13 9	11 3	19 9
Skilled craft and related workers	8 4	18 5	11 8
Semi-skilled metalworking operatives	4 2	7 2	1 7
Assemblers and all other operatives	19 0	36 2	13 1
Service workers	—	2 0	15 8
Laborers	0 7	7 7	6 0
Farmers and farm workers	—	–	1 0
Total	100 0	100 0	100 0

Source: H. Allan Hunt and Timothy L. Hunt, *Robotics Human Resource Implications for Michigan*, Upjohn Institute for Employment Research, Kalamazoo, Michigan, 1982, p. 7

Supply and Demand for Machinists

Machinists often turn up on lists of occupations perceived by employers to be in short supply. Since the absence of such workers is more likely to produce production bottlenecks than is the case with some other occupations, real or perceived supply deficits in these fields tend to be anticipated with particular concern.

Skilled machinists are included among priority occupations in several recent Southern statewide studies of training needs.

According to the U.S. Bureau of Labor Statistics (BLS), some 568,000 skilled machinists were employed in the U.S. in 1980. This includes job and die setters, machinists, and tool and die makers. Another 223,000 were employed as "machine tool operators, combination" and in numerically controlled machine tool operative occupations that are closely akin to skilled machining. The BLS projects the addition of 119,000 jobs by 1990 for skilled machinists, on its low economic growth assumption.

The machine tool industry, which is concentrated in the Midwest, is dependent on an adequate supply of skilled machinists. The industry has suffered severe employment declines in the recent recession. If it recovers to the levels of the late 1970s, a severe short fall of 250,000 skilled machinists is expected.

Although BLS agrees that there is a general shortage of skilled machinists, it does not concur with the machine tool industry on the magnitude of the problem. The BLS projection model suggests from 11,900 to 23,000 new jobs annually in the next decade, not counting at least that many more openings as workers exit from the labor force. Yet, registered apprenticeship programs, where skilled machinists are trained, in the late 1970s produced annual completions not exceeding 5,400. Since apprentices do work in the trade, *additions* to apprenticeship programs represent a better measure of available new entrants. Such additions, approximately 12,000 per year, do not come close to meeting the projected openings for skilled machinists. How many more are trained in unregistered programs is not known.

The Southern region employed approximately 119,000 skilled machinists at the end of the last decade. The state employment security agencies' projections of average annual openings for skilled machinists indicate an average of some 6,400 annual openings. For the 11 states in the region for which Bureau of Apprenticeship and Training data are available, average annual openings total 4,664. The journeyman completions and training in 1982 in these states were 694, while the total number of apprentices was 2,907, with Virginia accounting for more than one-third of this total.

Skilled machinists traditionally have been trained within industry through apprenticeship programs. Preparation in secondary and even postsecondary vocational programs does not approach the training of three- to four-year apprenticeship programs. The machine tool industry complains that fewer large companies are offering these programs, and that small companies cannot afford to do so during slump periods, if they do so during peak periods, their trainees are lured away by the larger firms. The industry suggests that closer ties are needed with technical schools to develop appropriate vocational programs.

Sources. Neal Rosenthal, "Shortages of Machinists. An Evaluation of the Information," *Monthly Labor Review*, July 1982, p. 31-36, and Machine Tool Panel, *The Competitive Status of the U S Machine Tool Industry*, National Academy Press, Washington, D. C., 1983, p. 23 and 65.

Occupations Classified as High Technology Occupations

What occupations are counted as high technology ones? BLS classifies the following major categories:[4]

Distribution of U.S. High Tech Occupations—All Industries, 1980

Engineers	36.7%
Life and physical scientists	7.7
Mathematical specialists	1.6
Engineering and science technicians	40.2
Computer specialists	13.7
Total High Tech Occupations	100%

The relative magnitude of the above occupations (and of operatives) to total employment is shown below for 1980, and projected for 1990 under the BLS "slow growth" assumption for the total economy:[5]

	For Each 1,000 Workers	
	1980	1990
Engineers	11.5	12.5
Life and physical scientists	2.4	2.5
Engineering and science technicians	12.4	13.1
Mathematical specialists	.5	.5
Computer specialists	12.4	13.1
Operatives	139	136

The above projections indicate that highly trained persons will comprise a somewhat larger proportion of employment in 1990. Operatives or assemblers in manufacturing plants, while still greatly outnumbering all high technology occupations, will decline on a relative basis.

The three largest groups among the high tech occupations are engineers, engineering and science technicians, and computer specialists. A previous SREB report dealt with training needs in the

South for engineers. Much attention has been given to the demand for computer specialists, and enrollments in that field have escalated considerably.

In recent years the regional growth rate of academic awards below the baccalaureate level (associate degrees and certificates) in data processing technologies (including programming) has been double the growth rate for academic awards in technologies that relate to engineering and science technicians (see Appendix A).

At the baccalaureate level, degrees in computer sciences in the SREB region have escalated sixfold in the past decade. This production does not reflect the acquisition of programming skills by many young people through short courses, other majors, or proprietary schools. The proliferation of training in programming has led to some reports that the market for beginning programmers is becoming saturated.[6] While there may no longer be a scarcity of entry-level programmers, there is a scarcity of persons with advanced programming skills at the systems analyst level. The National Science Foundation (NSF) projects a shortage for computer specialists (which combines programmers and systems analysts) for the Eighties.[7]

The remainder of this report focuses on engineering and science technicians, who are trained primarily in postsecondary institutions below the baccalaureate level.

Engineering and Science Technicians

The Occupational Employment Surveys (OES), used by the state employment security agencies in developing their occupational projections, define engineering and science technicians as follows:

Engineering technicians are concerned with the practical application of physical laws and principles of engineering for the development and utilization of machines, materials, instruments, structures, processes, and services.

Science technicians (excluding medical and dental) assist physical and life scientists in both laboratory and production types of activities. Normally, these technicians work under the supervision of a scientist and assist in those functions usually described as routine at the professional level.

The prevailing differentiation between engineering technicians and engineers is that the former are engaged in the application of engineering principles, while the latter have design responsibilities for new processes and products. A technician tends to function with existing equipment and technology, while the engineer designs new apparatus.

The major subgroups for engineering and science technicians, in terms of occupational openings produced for each, are shown below:

Engineering Technicians	*Science Technicians* (except medical and dental)
Drafters	Biologic science technicians
Electrical and electronic technicians	Physical science technicians
Surveyors	Timber cruisers
Mechanical engineering technicians	Chemical technicians
Industrial engineering technicians	
Civil engineering technicians	

Industries have a wide variety of occupational titles, sometimes specific to their own plants, which fall under the above categories. For example, what may be called test technicians in one plant or instrumentation technicians in another, are subsumed in the above classification system under electronic technicians. Work settings for science technicians may be as diverse as high tech gene-splitting or chicken disease control in the poultry industry.

There are no neat separations in industry that firmly differentiate between professionals, technicians, and craft workers. Entry into many occupations is fluid, with competencies developed through formal or on-the-job training. A recent survey of manufacturing engineers, for example, showed that an associate degree was the highest level of education for at least half who were aged 40 or older. Even among the youngest group, two-fifths had that level of education.[8]

On the other hand, according to BLS, one-half of those who took jobs as engineering and science technicians in 1980 had some postsecondary education. One-third had a high school education or less, and one-fifth were college graduates—most often science graduates.[9]

Thus, it is difficult to obtain precise measures of job openings for technicians trained at less than the baccalaureate level, and to project training needs for the future.

Employer Projections

Training needs are generally projected either through employer estimates or by statistical techniques. Employers in Tennessee recently participated in an effort to predict occupations for which there would be rapid expansion. Technicians of various types predominate on their list (see Table 2).

The 37 occupations projected to account for half of the new jobs to be generated in the United States in the 1980s include many that do not require technical training, ranging from secretaries to janitors. The list does include electrical and electronic technicians, as well as maintenance repairers.[10]

A recent study of vocational education in Texas developed a list of 40 priority occupations for training needs.[11] The list was culled from one developed by statistical methods, which identified over 1,000 occupations below the baccalaureate level with the highest number of openings. Employers assisted in identifying the 40 priority occupations. The two top occupations among these are drafters and electrical and electronic technicians, both of which are subsumed under engineering and science technicians.

The growing application of computers to all manner of products—from kitchen appliances to office equipment—and to production processes means that there will be a growing demand for electronic technicians. The shortage of electrical engineers projected by the American Electronic Association indicates that, where technicians are available, they may be employed in lieu of scarce engineers.

A comparison of salaries for engineers and engineering technicians with a two-year degree and with zero years of experience shows salaries for the latter rising more rapidly than for engineers. This indicates the possibility that engineering technicians may be in greater demand relative to supply than full-fledged engineers.

Table 2
New or Rapidly Expanding Job Opportunities Identified in Tennessee Regional Job Skills Task Force Meeting July 1982

Instrumentation control technicians
Computer maintenance technicians
Computer programmers and machine control specialists
Computer operators
Office communication control equipment sales and service workers
Quality control engineers with expanded statistical skills
CAD/CAM computer augmented designers/technicians
Multi-skilled craftsmen and machinists with computer skills and broad machine knowledge
Computer aided designers and draftsmen
Electronic technicians and maintenance workers
Tool and die makers
Machine repair technicians for high technology equipment
Health care and related medical service occupations at all levels, including RNs, LPNs, lab technicians
Biological research technicians for biogenetic research/engineering jobs
Food service workers and managers
Service industry jobs in insurance, banking, and finance
Recreation industry workers
Child care professionals
Teachers of mathematics, science, business statistics, economics, computer science, and technical skills
Telecommunications/information workers with computer skills
Business administrators and foremen with knowledge of management information systems and data processing
Engineers and engineering technicians of all types
Skilled computer trades of all types
Systems analysts with both computer and business skills
Word processing machine operators
Managers with computer skills

Note Not listed in order of importance nor ranked by speed of occupational expansion

Source Job Skills Task Force, *Meeting Future Job Skills Requirements in Tennessee*. Department of Economic and Community Development, Nashville, Tennessee. December 1982, p 8

Median Salaries—Zero Years of Experience
Percent Increase, 1971-1981

Engineers	*Engineering Technicians* (2-year degree)
114%	179%

Source. American Association of Engineering Societies, Inc., *Engineering Manpower Bulletin*, No. 62, October 1982, and No. 60, March 1982.

The heightened importance of technicians relative to engineers is highlighted in a recent National Science Foundation analysis of manufacturing employment. From 1977 to 1980, the study shows a nine percent annual growth rate of electrical/electronic technicians, versus a four percent rate for the corresponding classification of engineers.[12]

A Georgia analysis of vocational-technical training needs for high tech industries indicates that these firms will require a mixture of electronic, electromechanical, and mechanical skills in their technical labor force. The Georgia report states,

> Industry need for highly trained technicians is so great that in many states, including Georgia, companies are hiring high technology students before they finish their programs. Intense competition among firms for the limited number of technicians presently available has led to high salary offers. In turn, career opportunities in high technology are attracting ever greater numbers of students, many of whom are experienced in the work place, and quick to recognize the potential advantages of high technology training provided by the vocational technical system.[13]

A major question confronting educational planners is whether, and how far, to expand training for high technology occupations at the subbaccalaureate level beyond what is presently available in each state.

Statistical Demand and Supply Projections

The United States

National projections for average annual openings for engineering and science technicians for the 1980s total from 168,000 to 183,000; the range reflects low and high economic growth assumptions. This total represents 21,000 to 29,000 annual openings due to new jobs, and 147,000 to 154,000 openings due to replacements.[14] The latter include not only openings because of deaths or retirements, but also transfers out of the occupation, as technicians are promoted or make other occupational moves.

The total average number of projected openings vastly exceeds the 83,000 certificates and associate degrees earned in 1981 in mechanical and engineering technologies and natural science technologies. Additionally, 54,000 persons completed postsecondary vocational training in related public and private programs in 1980. Although demand vastly exceeds supply, this projected imbalance is inaccurate for the following reasons:

1. Some of the technology programs included in the overall supply data are not closely related to the occupations for which demand is specified.

2. Program completers may include individuals already employed as technicians who are upgrading their skills; thus, they are not "new entrants."

3. Some individuals, on which there are no statistics, qualify to become technicians through on-the-job training and in the armed services. Indeed, approximately one-half of the job openings for engineering and science technicians in 1980 were filled by transfers from other occupations, many of whom presumably acquired the requisite skills while working in related occupations.

4. Persons with a baccalaureate degree in the sciences may qualify for technicians' openings and, therefore, augment the supply trained below that level for entry into technicians' openings.

A recent National Science Foundation analysis of needs for technicians for the next five years concludes that 1982-1987 annual employment growth for electrical/electronic and mechanical engineering technicians will exceed the growth rate for these occupations in the late 1970s. The NSF cautions, however, that due to inadequate supply data for these occupations, it is difficult to determine whether these growth rates will translate into shortages.[15]

The SREB Region

Demand for engineering and science technicians in the South is presented on the basis of two sets of projections: (1) those prepared by the state employment security agencies under the national Occupational Employment Survey (OES) program, and (2) the SREB projection.

Occupational Employment Survey Projections

The OES projections are based on surveys that determine the occupational mix in each state within each industry. Openings for each occupation are then projected on the basis of those surveys, and according to expected changes in the occupational mix and growth of industries. The OES projections are for varying base years, depending on how recent the projection is in each state.

The percentage of total wage and salary employment that engineering and science technicians comprise in each state in the OES base year is shown in Table 3, Column 1. The percentages in the region vary from .8 to 1.74. These variations reflect the differences in the industrial mix of states, and in the utilization of technical manpower across all industries. A state that has a high concentration of electrical machinery manufacturing, for example, would tend to have a higher percentage of engineering and science technicians than a state where manufacturing employment is concentrated in textiles and apparel—industries that use fewer technical personnel, regardless of where they are located.

However, the variations of the percentages also reflect the speed with which industries across the region move to incorporate new technology, and the resulting requirements for more technicians. Thus, states with equal employment shares of any one industry might have varying

Table 3
Engineering and Science Technicians

		Projections of Average Annual Openings for the Eighties	
	Current* Percent of Total Employment	State "OES" Projections	SREB Projections
Alabama	1 25%	515	1,410
Arkansas	80	230	1,100
Florida	1 10	2,764	3,050
Georgia	1 18	869	1,700
Kentucky	92	530	1,440
Louisiana	1 39	1,011	1,310
Maryland	1 65	1,223	1,120
Mississippi	95	300	1,210
North Carolina	92	1,115	2,390
South Carolina	1 09	.550	1,250
Tennessee	1 33	1 150	1,500
Texas	1 74	6 955	4,570
Virginia	1 51	1,150	1,950
West Virginia	1 17	225	670
SREB Region	1 31	18,587	24,670
United States	1 35		

* Current refers to the base year of each state s OES projection 1980 for U S , Alabama, Arkansas, Florida Mississippi 1979 for West Virginia 1978 for Louisiana North Carolina South Carolina, Texas and 1976 for Georgia, Kentucky, Maryland, Tennessee, Virginia

representations of engineering and science technicians, depending upon rates of application of technology in that industry. The higher percentage that engineering and science technicians represent in Texas, as compared to other Southern states, presumably reflects an industrial mix that combines to relatively higher use of this occupation and of technical personnel across all industries.

The average annual openings indicated by the OES projections in each state, shown in Table 3, Column 2, total 18,600 for the region.

This includes openings for newly created jobs, as industries grow and as they add technicians' jobs, and for replacements due to deaths and retirements. The state projections do not include replacement needs produced by those who "move out of the occupation" into other jobs. As was shown in the national projections, the magnitude of replacements that do include transfers is at least five times the number of new jobs. The state projections, which do not take this into account, include replacement openings at the much lower rate of less than one-half a replacement opening for every newly created job. If openings due to transfers are included at the national rate in the state projections, a total of 39,400 annual openings for engineering and science technicians is projected for the South.

The total number of certificates and associate degrees awarded in the region in the relevant mechanical and engineering and natural science technologies in 1981 was 15,610. In addition, there were 1,815 completions in relevant vocational education programs. (See Appendix A for a definition of programs included as relevant in this analysis.)

The SREB Projection

The SREB Projection of average annual openings is constructed on the supposition that the occupational mix in each SREB state by 1990 will reach the national average. In other words, if in the nation by 1990 the percentage of engineering and science technicians in the communications and utilities industries is expected to rise from 3.6 percent of total employment to 3.8 percent, the assumption is made that each state in the region will reach this same proportion at the end of the decade. Thus, this projection is a dynamic one which pictures what average annual demand for engineering and science technicians would be if the South were to incorporate technical personnel across its mix of industries to equal the national average by 1990. (See Appendix B for details of the projection method.)

The national average representation of engineering and science technicians to total wage and salary employment in all industries was 1.35 percent in 1980 and is projected to rise to 1.42 percent by 1990 under the assumption of low economic growth.[16] Even this small percentage change in the representation of engineering and science technicians, coupled with the low economic growth projection for industrial employment, is expected to generate 308,000 new jobs for these technicians during the decade—or close to 31,000 per year, exclusive of replacement needs.

The average annual openings under the SREB projections, shown in Table 3, Column 3, reflect openings due to growth, as industries expand and as they increase their representation of technical personnel to match the projected national average, as well as the same number of replacement openings included in the OES projections. The total number of annual openings under this projection is 24,670 for the region, or approximately one-third more than the total under the state OES projections.

Adequacy of the Supply

In 1981, the region's postsecondary institutions reported approximately 17,450 completers of technical programs relevant to openings for engineering and science technicians (see Table 4). This includes one- and two-year degrees and certificates awarded by community colleges and technical institutes, as well as completions of vocational education programs in institutions that are not already included in the national data system for degrees and other formal awards. It does not include those proprietary colleges which do not report to the Higher Education General Information System (HEGIS). Devry Institute, for example, does report to HEGIS, but Control Data Corporation, which also trains electrical and electronic technicians, is an example of an institution that is not included.

In addition to the formal training route, there are some entrants into technicians' jobs who obtained the requisite skills through a combination of on-the-job training and sporadic coursework. Thus, the supply data do not represent the total available supply of new entrants. It should also be noted that the available demand projections for the region do not reflect openings created by those who transfer out of an occupation.

Since the current regional production of formally trained technicians is slightly below the OES projections, and considerably below the

Table 4

Postsecondary Completions (Below the Baccalaureate) in Programs Related to Engineering and Science Technicians, 1980-81

	Degree and Certificate Programs	Vocational Programs	Total	Supply is Below Demand for both Projections	Supply Exceeds OES Projections and Approaches SREB Projections	Supply Exceeds OES Projections but not SREB Projections
Alabama	1,298	62	1,360		X	
Arkansas	274	0	274			X
Florida	2,085	334	2,419	X		
Georgia	590	514	1,104			X
Kentucky	881	94	905			X
Louisiana	287	130	417	X		
Maryland	544	—	544	X		
Mississippi	811	—	811		X	
North Carolina	2,235	—	2,235			X
South Carolina	1,262	—	1,262			X
Tennessee	880	—	880	X		
Texas	2,947	586	3,533	X		
Virginia	1 063	—	1,063	X		
West Virginia	523	95	618		X	
SREB Region	15,610	1,815	17,425			

Source National Center for Education Statistics data in columns 1 and 2

forecasted openings if the South were to approach the expected national occupational structure, expansion of programs (below the baccalaureate level) for technicians appears to be in order. It is interesting to note that two Southern states often pointed to as models of training for technical personnel—North Carolina and South Carolina—produce more graduates annually than would seem indicated by their state OES demand projections. Production, however, does not exceed demand, calculated on the more dynamic assumptions of the SREB projection. There are no current indications of overproduction of technical personnel in these two states. Indeed, the availability of technicians is one of the advantages these states tout in their economic development strategies.

State-by-state comparisons of supply and demand, as shown in Table 4, indicate that Florida, Louisiana, Maryland, Tennessee, Texas, and Virginia could well expand their programs to train technicians according to both the more conservative OES projection and the SREB projection.

Alabama, Mississippi, and West Virginia are states where current supply exceeds the OES projections and also approaches the higher SREB demand projection. The remaining states (Arkansas, Georgia, Kentucky, North Carolina, and South Carolina) will probably not err by producing more technicians than the demand indicated by the OES projections, since the SREB projection indicates there is a potential for absorption of these people, as industry modernizes and adopts technological improvements.

Summary

Much attention has been lavished on the desirability of attracting high tech industries to the Southern states. While some states may succeed in this economic development strategy, an alternative policy that might be more realistic is to focus on modernization of existing industries to make them more efficient and competitive in national and world markets. This strategy will depend upon the availability of manpower with skills in "high tech occupations."

While there has been great interest in expanding the supply of engineers and computer personnel, less has been said about manpower needs at the technician level. An adequate supply of engineering and science technicians will be equally as important to the revitalization of industry—and the installation of new technology in many sectors of the economy—as is an expanded supply of technical graduates at or above the baccalaureate level.

While the state employment agency projections of occupational demand for engineering and science technicians in several Southern states indicate a balance between supply and demand, these projections may not reflect the dynamic changes that are taking place, or that should take place, if the economic base of the region is to prosper. When demand for engineering and science technicians is measured on the basis of more dynamic projections—on the basis of what demand would be if the South were to employ the same proportion of such technicians in its industries as is projected for the nation in 1990—then there is need for expansion of training programs below the baccalaureate level for engineering and science technicians.

It is impossible, at the regional level, to be precise as to whether these training programs should be expanded for specialties such as robotics or bioengineering. Such decisions can be made only through detailed analysis of local labor markets and their prospects. Generic training programs, as for electronic engineering technicians, prepare persons with sufficient flexibility to function in a variety of settings. The expansion of generic programs may be a safer strategy, given the uncertainties of labor market needs, than the development of numerous specialty programs at this time.

Footnotes

1. U. S. Bureau of Labor Statistics, "Current Employment and Projected Growth in High Technology Occupations and Industries," unpublished preliminary report for the Joint Economic Committee, August 2, 1982.
2. "Modernizing To Survive," *Context,* E. I. du Pont de Nemours Corp., Vol 12, No. 1, 1983, p. 17.
3. Interview with Richard Treaster, Manager, Training Center, Cluett Peabody & Co., Inc., Atlanta, Georgia.
4. U. S. Bureau of Labor Statistics, *op. cit.,* Table 3.

5. U. S. Bureau of Labor Statistics, *Occupational Projections and Training Data*, U. S. Government Printing Office, Washington, D.C., 1982, p. 77.

6. Scientific Manpower Commission, *Manpower Comments*, September 1982, p. 3.

7. National Science Foundation, *Highlights*, 83-307, February 1983, p. 4.

8. Battelle Columbus Laboratories, *The Engineer—Past, Present and Future*, Society of Manufacturing Engineers, Dearborn, Michigan, 1979, p. 24.

9. U. S. Bureau of Labor Statistics, *Occupational Projections and Training Data*, U. S. Government Printing Office, Washington, D. C., 1982, p. 40.

10. *The Information Society*, Educational Commission of the States, Denver, Colorado, September 1982, p. 26.

11. *A Study to Make Recommendations Regarding A Comprehensive State Occupational Education Program*, Research Triangle Institute, Research Triangle Park, North Carolina, October 1982, p. 48.

12. National Science Foundation, *Highlights*, 83-303, Washington, D. C. March 10, 1983, p. 4.

13. *An Advanced Technology Study for Post-Secondary Area Vocational-Technical Schools*, Georgia Institute of Technology, Atlanta, Georgia, August 1982, p. 1.

14. U. S. Bureau of Labor Statistics, *op. cit.*, p. 41. A more recent unpublished BLS projection shows 31,000 to 34,000 "growth" average annual openings for the Eighties for the "low" to "high" assumptions of economic growth.

15. National Science Foundation, *Highlights*, 83-307, Washington, D. C. February 23, 1983, p. 5.

16. U. S. Bureau of Labor Statistics, unpublished matrices for occupational employment by industry, based on OES surveys of the late Seventies.

Appendix A

Postsecondary Training Programs Related to the Preparation of Engineering and Science Technicians

Vocational Education Programs*	Collegiate Programs (HEGIS Data)
Architectural Technology, General	Mechanical and Engineering Technology, General
Civil Technology	Engineering Graphics
Chemical Technology	Architectural Drafting Technology
Electrical Technology	Chemical Technologies
Electronic Technology	Civil Technologies
Industrial Technology	Electronics/Machine Technologies
Instrumentation Technology	Electromechanical Technologies
Mechanical Technology	Industrial Technologies
Metallurgical Technology	Textile Technologies
Nuclear Technology	Instrumentation Technologies
	Mechanical Technologies
	Nuclear Technologies
	Other Mechanical and Engineering Technologies
	Natural Science Technologies, General
	Marine/Oceanographic Technologies
	Other Natural Science Technologies

*Completions for these program areas for 1980-81 were supplied by the National Center for Education Statistics, and are preliminary. Completions in "regionally accredited" schools were subtracted, since they are already counted by such institutions in degree and other formal awards data they submit under the HEGIS data. Thus, the remainder of vocational program completions represents postsecondary institutions other than colleges.

Appendix B

Methodology for SREB Projection of Engineering and Science Technicians

1. Obtain employment by industry for each two-digit Standard Industrial Classification (SIC) in each state from *County Business Patterns 1980,* U.S. Bureau of Census, and for the government sector from *Supplement to Employment and Earnings, States and Areas, Data for 1977-81,* U.S. Bureau of Labor Statistics.

2. Combine employment in "educational services" and "total government.

3. Multiply employment in each industry obtained in (1) and (2) by the percentages that engineering and science technicians are projected to represent nationally for each industry in 1990 under the "low growth" total employment projection. These percentages were supplied by the U.S. Bureau of Labor Statistics and are projected from those obtained by the Occupational Employment Surveys of 1977, 1978, and 1979.

   The projected BLS percentages for "educational services" and for "total government" were combined, weighted on the basis of U.S. employment in the two sectors. This had to be done since the employment projections for 1990 for each state, by the major divisions, (see step 5) subsume education within the projection for the government sector.

4. Obtain weighted average percentages that engineering and science technicians comprise, in each state, of major divisions of industries from the data obtained in (3). For example, add the numbers of engineering and science technicians obtained in (3) for each two-digit SIC in nondurable manufacturing, and divide this by total employment in nondurables in that state in 1980. This gives a weighted average of the 1990 percentage for that occupational group for the major industry division.

5. Obtain employment projections, by major divisions, for 1990 in each state from the National Planning Association (Martin K. Holdrich, *U.S. Regional Projections 1981-2000,* National Planning Association, Washington, D. C., 1981). Multiply these employment projections by weighted percentages for the major divisions obtained in (4). This yields the projected numbers of engineering and science technicians in each state if total employment follows the National Planning Association patterns, and if, *with* the 1980 relative distribution of employment *between two-digit SIC industries* in each state, the occupational mix for engineering and science technicians will meet the 1990 average occupational mix projected for the U.S. (Military employment was excluded from these calculations.)