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DEFINING AND MEASURING HIGH TECHNOLOGY IN GEORGIA

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Table of Contents

Executive Summary

The purpose of this study is to define and measure the high technology sector in Georgia in order to assist in targeting, attracting, and retaining technology-intensive jobs for the state. A need exists for a common definition upon which to base an assessment of the state's technology standing.

To develop this definition we first consulted with an Advisory Panel of Georgians involved in economic development. In addition, we reviewed journals and government agency documents, both published and online. We then compiled and cross-referenced efforts of fifteen other states, as well as national and international agencies that have sought to measure the technology sector, and we communicated with a number of officials regarding these reports and statements.

Based on this research, the following definition of a technology intensive industry was selected. An industry is considered to be technology intensive if 1) firms in that industry spend a higher proportion of their budget on research and development than is typical of all industries, and 2) firms in that industry, relative to other industries, have a high proportion of scientific and engineering labor who spend the majority of their time engaged in research and development activities. A further distinction is made between those industries defined as "high-intensive technology," i.e., those industries whose scientific and engineering personnel and whose research and development investment are both much higher than the average industry, and the "medium-intensive technology," i.e., industries that have 1) a high level of scientific and engineering personnel, 2) a high level of research and development expenditures, or 3) processes that involve research and development intensive machinery, but who engage a less educated workforce doing more routine tasks.

We relied on the studies we reviewed that use this definition of technology intensity in order to identify technology-intensive industries, as defined by Standard Industrial Classification (SIC) codes. The size of the technology sector is measured by the level of employment in that sector. For each SIC code that we identified as being part of either the high- or medium-intensive technology sectors we used data from the Georgia Department of Labor to determine the number of establishments and the number of workers in each industry by year for the period 1979-1999.

While Georgia's strong and modernizing economy permitted an increase in employment in both the high- and medium-intensive technology sectors, the high-intensive technology sector increased more rapidly across the period 1979 to 1999 than either total state employment or technology jobs in general (Figure 1).

We ranked industries by employment level and several clear areas of strength emerge from this ordering. In addition, we identified clusters of high technology industries which can be targeted by the state for attention. Technology intensive jobs are spatially clustered in the state, with a distinct majority of high-intensive technology jobs being found in the state development regions containing metropolitan Atlanta and the coastal counties. However, the statewide distribution of technology jobs combining both high- and medium-intensive sectors reveals a picture representative of the range of jobs impacted by the "new economy" (Figure 2). The resulting measurements of Georgia's technology strengths following from the adopted definition accurately reflect the wide range of Georgia's high technology sector, permit policy formulations on a sound basis, and indicate areas for future economic development.

"*Firms that are engaged in the design, development, and introduction of new products and innovative manufacturing processes, or both, through the systematic application of scientific and technical knowledge.*"

Definition of high technology firms, Congressional Office of Technology Assessment

Introduction

The purpose of this study is to define and measure technology activity in Georgia in order assist in the targeting, attracting, and retaining of technology-intensive jobs for the state. "High technology" jobs generally receive credit for increasing the number of related jobs due their high pay, high impact multipliers from purchases of goods and services in non-high tech sectors, propensity to cluster while attracting related supply chain companies, and counter cyclical innovation push (Malecki 1998, Walcott 1999). However, there often exists limited understanding of and no agreement as to either the basis for the high technology label or the types of jobs encompassed. Exercises in defining "high technology" consistently prove less than definitive. Georgia's exploration of the definition and scope of high-tech activity in the state began with general formulations, such as J. K. Galbraith's often cited observations that "technology is the systematic application of scientific or other organized knowledge to practical tasks."

Defining the term "high technology" comprised the first and basic step for this study. The next step applied the resulting definition to a range of industries in order to identify high technology industries classified according to their Standard Industrial Classification (SIC) code, as is the generally accepted practice. Although the North American Industrial Codes (NAIC) provide more detailed divisions of technology intensive and service category industries, this system is not yet widely adopted.

The third step involved determining the number of establishments and employees in the identified high technology industries within the state of Georgia. Policy applications flow from analyzing the type of jobs involved and their growth pattern, and targeting job categories reflecting underlying Georgia technology strengths.

Methodology

A multiplicity of definitions currently exists among the various states and organizations that attempt to describe and apply technology-related measures to job or industry classifications. This study compiled and cross-referenced many of these current efforts by communicating with officials in a number of states, reviewing reports in major journals and government agencies, and documenting efforts from Europe (OECD) and Japan (MITI). The appendix provides a summary of some of the approaches used in these efforts, while Table 1 indicates the SIC codes included as high technology by the various sources we identified.

Table 1 notes the SIC codes used by the Milken Institute in their study of "High Tech America" (DeVol 1999), and by the American Electronics Association (2000), whose often cited SIC code grouping has also received frequent criticism for being too narrow in scope (particularly in omitting life science related sectors). The Bureau of Labor Statistics recently recast its definition developed earlier in the decade (Hadlock, et al. 1991, Lyons and Luker 1996, Hecker 1999). The Bureau of the Census, another arm of the government involved in compiling statistics, also weighed in with yet another list of high tech SIC codes, which is smaller than the list maintained by the Bureau of Labor Statistics. Clearly, an accepted definition at the federal level remains elusive (Luker and Lyons 1997).

Definitions used by some 15 states were also gathered, and individuals in those states were asked to supply the rationale for these choices (Appendix). Not surprisingly, SIC codes captured by the states were much broader in total than any other organizational list. Justifications for the respective lists of SIC codes largely reflected process-based explanations, or the frank admission that such activities were included because they represented a significant proportion of the state labor base. Examples of the latter include crude petroleum and natural gas operations in Texas and automobile-related codes in Michigan. Several states composed clusters of industries, and captured SIC codes involved in each cluster. Examples of states adopting this approach include Pennsylvania (particularly Pittsburgh, which worked out six "technology clusters"), New Mexico with nine clusters, and South Carolina with five clusters.

TABLE 1. SIC CODES INCLUDED AS HIGH TECH BY VARIOUS SOURCES

SIC	Category	AEA	Milken	States[a]	BLS	Census	OECD
0182	Undercover food crops			xx			
131	Crude petroleum, natural gas			x			
281	Industrial inorganic chemicals			xxxx	x		
282	Plastics materials, synthetics			xxxx	x		
2833	Medicinals, botanicals		x	xxxxx	x	x	x
2834	Pharmaceutical preparations		x	xxxxx	x	x	x
2835	Diagnostic substances		x	xxxxx	x	x	x
2836	Other biological products		x	xxxxx	x	x	x
284	Soaps, cleaners, toilet goods			xxx	x		
285	Paints, varnishes, etc			xx	x		
286	Industrial organic chemicals			xxxxx	x		
287	Agricultural chemicals			xxx	x		
289	Misc. chemical products			xxxx	x		
291	Petroleum refining			xxxx	x		
335	Nonferrous rolling, drawing			x			
348	Ordnance, accessories			x	x	x	
351	Engines & turbines			xxx	x		
353	Construction, mining machinery			xx	x		
354	Metalworking machinery			xxxx	x		
355	Specialized industrial machinery			xxx	x	x	
356	General industrial machinery			x	x		
3571	Electronic computers	x	x	xxxxxx	x	x	x
3572	Computer storage devices	x	x	xxxxx	x	x	x
3575	Computer terminals	x	x	xxxxx	x	x	x
3577	Computer peripherals	x	x	xxxxx	x	x	x
3578	Calculating, accounting equipment	x	x	xxxxx	x	x	x
3579	Office machines, nec.	x	x	xxxxx	x	x	x
358	Enviro, ecological prods, servs			x			
361	Electric transmission, distrib equip			xxxx	x	x	
362	Electrical industrial apparatus			xxx	x		
3643	Electric lighting, wiring equipment			xx			
3651	Household audio-video equipment	x		xxx	x		
3652	Prerecorded records, tapes	x		xxxx	x		
3661	Telephone, telegraph apparatus	x	x	xxxxx	x	x	x
3663	Radio, TV communications equip.			xxxx	x	x	x
3669	Communications equipment nec.	x	x	xxxx	x	x	x
3671	Electron tubes	x	x	xxxxx	x	x	x
3672	Printed circuit boards	x	x	xxxxx	x	x	x
3674	Semiconductors, related devices	x	x	xxxx	x	x	x
3675	Electronic capacitors	x	x	xxxxx	x	x	x
3676	Electronic resistors	x	x	xxxxx	x	x	x
3677	Electronic coils, transformers	x	x	xxxxx	x	x	x

3678	Electronic connectors	x	x	xxxxxx	x	x	x
3679	Electronic components, nec.	x	x	xxxxx	x	x	x
371	Motor vehicles, equipment			xxxx	x		
3721	Aircraft		x	xxxxx	x		
3724	Aircraft engines, engine parts		x	xxxxx	x		
3728	Aircraft parts, equipment nec.		x	xxxxx	x		
3761	Guided missiles, space vehicles		x	xxxxx	x	x	x
3764	Space propulsion units, parts		x	xxxxx	x	x	x
3769	Space vehicle equipment, nec.		x	xxxxx	x	x	x
3812	Search, navigation equipment	x	x	xxxx	x	x	
3821	Laboratory apparatus, furniture	x	x	xxxxx	x	x	
3822	Environmental controls	x	x	xxxxx	x	x	
3823	Process control instruments	x	x	xxxxx	x	x	
3824	Fluid meters, counting devices	x	x	xxxxx	x	x	
3825	Instruments measuring electricity	x	x	xxxxx	x	x	
3826	Analytical instruments	x	x	xxxxx	x	x	
3827	Optical instruments, lenses	x	x	xxxxx	x	x	
3829	Measuring, controlling devices	x	x	xxxxx	x	x	
3841	Surgical and medical instruments		x	xxxxx	x	x	
3842	Surgical appliances and supplies		x	xxxxx	x	x	
3843	Dental equipment and supplies		x	xxxxx	x	x	
3844	X-ray apparatus, tubes	x	x	xxxxx	x	x	
3845	Electromedical equipment	x	x	xxxxx	x	x	
385	Ophthalmic goods			xxx			
3861	Photographic equipment, supplies	x		xxxx	x		
4812	Radiotelephone communications	x	x	xx			
4813	Telephone communications	x	x	x			
4822	Telegraph, other message commun.	x		xx			
4841	Cable, other pay TV services	x		xx			
4899	Other communications services	x		xx			
504	Wholesale office, computer equip			xx			
504	Wholesale electrical equipment, parts, appliances			xx			
7371	Computer programming services	x	x	xxxxx	x	x	
7372	Prepackaged software	x	x	xxxxx	x	x	
7373	Computer integrated systems design	x	x	xxxxx	x	x	
7374	Data processing, preparation	x	x	xxxxxx	x	x	
7375	Information retrieval services	x	x	xxxx	x	x	
7376	Computer facilities management	x	x	xxxx	x	x	
7377	Computer rental, leasing	x	x	xxxx	x	x	
7378	Computer maintenance, repair	x	x	xxxxx	x	x	
7379	Computer-related services, nec.	x	x	xxxxx	x	x	
7812	Motion picture, video production		x	xx			
7819	Services allied to motion pictures		x	xx			
8062, 69, 92	Hospitals, specialty & dialysis			xx			

8071	Medical laboratories			xxx			
8711	Engineering services		x	xxxx	x	x	x
8712	Architectural services		x	xxx	x	x	x
8713	Surveying services		x	xxx	x	x	x
872	Accounting, auditing, bookkeeping			x			
8731	Commercial physical research		x	xxxxx	x	x	x
8732	Commercial nonphysical research		x	xxxx	x	x	x
8733	Noncommercial research org.		x	xxxx	x	x	x
8734	Testing laboratories		x	xxxxx	x	x	x
874	Management, PR services			xxx	x		
899	Services, nec/Environmental (8999)			xx			

[a]each “x” represents a state that selected that SIC code.

Several entities favored yet other different approaches, such as the one adopted by the Bureau of the Census based on ten products or processes considered "new or leading edge technologies." North Carolina included a set of SIC codes identified by the National Science Foundation's small business office as "fast-growing" industries, in addition to specifically technology-infused industries.

In addition to reviewing these approaches, we met with an Advisory Panel of Georgians[1] involved in economic development and interested in the issue of measuring high technology in order to understand the role of technology in Georgia's economy and the uses of a good definition for policy application. Several state agencies are involved in looking at technology employment issues. Applications of this present study may therefore provide a common definition for all state efforts, and broaden the scope of participants in arriving at the most useful definition based on real-world applications.

[1]The Panel included representatives from the Georgia Research Alliance, the State Office of Planning and Budget, Metro Atlanta Chamber of Commerce, the Economic Development Institute at the Georgia Institute of Technology, Department of Industry, Trade and Tourism, the Yamacraw Project, the Board of Regents of the University System, Technical and Adult Education, the Georgia Economic Developers Association, and the Georgia Department of Labor.

Definition

Distinctions applied to "high technology" almost universally use two particular factors. The first factor relates to the number of technology workers employed, i.e., scientists, engineers, etc. The second factor relates to the level of research and development (R&D) expenditures. The classification of high technology is thus based on the ratio of technology workers to total employment and the ratio of research and development expenditures to the size of the firm as measured by sales, profits or value-added (Hetrick 1996). The specific value of the ratio that determines when an industry should be classified as high tech is open to debate. Hadlock, et.al. (1991) classifies an industry as high tech if "an industry's proportion of R&D employment is at least equal to the average for all industries (p.26)." A further distinction employed by the Organization of European Community Development (OECD 1995) and the U.S. National Science Foundation (NSF 1998) divides occupations by their technology intensity, calculated by comparing industry research and development (R&D) expenditures and/or the number of technical people employed with the total value of an industry's shipments (value added).

Each of the studies we relied on define high technology in terms of an industry having a high proportion of its labor force comprised of scientific and engineering workers, or a high ratio of research and development expenditures relative to firm size. The various studies used different standards as to what constitutes a "high proportion" or a "high ratio." Developing our own measures of the proportion of an industry's labor force that is in research and development was not feasible. Thus, we relied on the selection of technology intensive industries in other studies that used this methodology.

Several states, such as North Carolina, also divide industries into categories based on the intensity of technology use. Our study utilizes a similar approach to distinguish between high-intensive and medium-intensive technology based industries. High-intensive technology industries are those with a very highly educated labor force and with a high ratio of research and development to firm size. Medium-intensive technology industries are those that score high on at least one of the two factors, or that have a less educated workforce but with a production process that uses research and development-intensive machinery.

To measure the size of the high-intensive technology sector, we selected those industries that are included as "high technology" by at least two out of the six non-state sources (American Electronics Association, Milken Report, Bureau of Labor Statistics, Organization of the European Community Division, and Bureau of the Census). To measure the size of the medium-intensive technology sector, we selected industries that are classified as technology intensive by other states and at least one of the six non-state sources. In addition, members of the Advisory Panel suggested other industries for inclusion. These industries were investigated to determine whether they fit the adopted criteria. As a result, two additional industries were added to the list of medium-intensive technology industries. Table 2 displays the resulting SIC codes that we identified using this approach.

For the selected technology-intensive industries, we used data (known as the ES202 data) from the Georgia Department of Labor to determine the number of establishments and the number of workers in each of the high technology SIC codes. Since these SIC codes reflect the 1987 classification, we converted the selected SIC codes to 1979 equivalent codes; lacking a one-to-one match between the two sets of codes, the pre-1987 definition of high technology occupations differs somewhat from the post-1987 definition.[2]

Ranking Georgia's top thirty SIC codes by employment (Table 3) and number of establishments (Table 4), separated into high- and medium-intensity technology categories, indicates some clear areas of strength. Computer program and engineering services, along with telephone communications, are the top three in terms of the level of employment. Six computer-related industries appear in the top group in terms of high-intensive technology jobs, along with three involving aircraft.

Industry ranking of jobs by employment level is shown in Table 5. A clear area of strength appears from this technique, without resorting to artificial pre-arranging of clustered categories. While Georgia's strong and modernizing economy (Akioka 1999, Czetli 2000) permitted an increase in both high- and medium-intensive technology categories, the proportion of high-intensive technology jobs increased

[2]The number of establishment is measured by the number of accounts in the ES202 data. Since some establishments have more than one account, our measure overstates the number of actual establishments.

more rapidly than either the growth in total state employment or technology jobs in general across the period 1979 to 1999 (Figure 1). The proportion of all jobs that are high-intensive technology jobs increased steadily, along with the increasing proportion of all high technology jobs in this time period (Figure 2).

Technology intensive jobs are spatially clustered in the state, with a distinct majority of high-intensive technology jobs in the state development region containing metropolitan Atlanta. The coastal counties contain the second highest number of high-intensive technology jobs (Figure 3). The statewide distribution of technology jobs combining both high- and medium-intensive technology categories, displayed by economic development regions, reveals a more balanced picture (Figure 4). This fuller picture of both the breadth and representativeness of “new economy” jobs confirms the wisdom of utilizing two categories to reflect infusions of advanced production processes across industries and labor force skill levels. While metropolitan Atlanta maintains its predominant position, the coastal counties are joined by Region 8, as well as technology activity in the Columbus and Macon metro areas.

TABLE 2. HIGH AND MEDIUM-INTENSIVE SECTORS BY SIC CODE

High-Intensive Technology[a]

SIC Code	Category
2833	Medicinals, botanicals
2834	Pharmaceutical preparations
2835	Diagnostic substances
2836	Other biological products
3571	Electronic computers
3572	Computer storage devices
3575	Computer terminals
3577	Computer peripherals
3578	Calculating, accounting equipment
3579	Office machines, not elsewhere classified
361	Electric transmission, distribution equip.
3651	Household audio-video equipment
3652	Pre-recorded records, tapes
3661	Telephone, telegraph apparatus
3663	Radio, TV communications equip.
3669	Communications equipment, not elsewhere classified
3671	Electronic tubes
3672	Printed circuit boards
3674	Semiconductors, related devices
3675	Electronic capacitors
3676	Electronic resistors
3677	Electronic coils, transformers
3678	Electronic connectors
3679	Electronic components, not elsewhere classified
3721	Aircraft
3724	Aircraft engines, engine parts
3728	Aircraft parts, equipment, not elsewhere classified
3761	Guided missiles, space vehicles
3764	Space propulsion units, parts
3769	Space vehicle equipment, not elsewhere classified
3812	Search, navigation equipment
3821	Laboratory apparatus, furniture
3822	Environmental controls
3823	Process control instruments
3824	Fluid meters, counting devices
3825	Instruments measuring electricity
3826	Analytical instruments
3827	Optical instruments, lenses

3829	Measuring, controlling devices
3841	Surgical and medical instruments
3842	Surgical appliances and supplies
3843	Dental equipment and supplies
3844	X-ray apparatus, tubes
3845	Electromedical equipment
3861	Photographic equipment
4812	Radiotelephone communications
4813	Telephone communications
4822	Telegraph, other message communication
4841	Cable, other pay TV services
4899	Other communications services
7371	Computer programming services
7372	Prepackaged software
7373	Computer integrated systems design
7374	Data processing, preparation
7375	Information retrieval services
7376	Computer facilities management
7377	Computer rental, leasing
7378	Computer maintenance, repair
7379	Computer-related services, not elsewhere classified
8711	Engineering services
8712	Architectural services
8713	Surveying services
8731	Commercial physical research
8732	Commercial nonphysical research
8733	Noncommercial research organization
8734	Testing laboratories

[a]"High Intensive" is defined as those industries requiring a higher than average proportion of research and development personnel and higher than average percentage of research and development investment. These industries are included as "high technology" by at least 2 out of 6 non-state sources (American Electronics Association, Milken Report, Bureau of Labor Statistics, Organization of the European Community Division, Bureau of the Census, Office of Management and Budget).

Medium-Intensive Technology[b]

SIC Code	Category
0182	Undercover food crops
131	Crude petroleum, natural gas
281	Industrial inorganic chemicals
282	Plastics materials, synthetics
284	Soaps, cleaners, toilet goods
285	Paints, varnishes, etc.
286	Industrial organic chemicals
287	Agricultural chemicals
289	Misc. chemical products
291	Petroleum refining
335	Nonferrous rolling, drawing
348	Ordnance, accessories
351	Engines and turbines
353	Construction, mining machinery
354	Metalworking machinery
355	Specialized industrial machinery
356	General industrial machinery
362	Electrical industrial apparatus
3643	Electric lighting, wiring equipment
371	Motor vehicles, equipment
7812	Motion picture, video production
7819	Services allied to motion pictures
8062, 69, 92	Hospitals, specialty and dialysis
8071	Medical laboratories
874	Management, PR services
8999	Services, not elsewhere classified/Environmental

[b]"Medium Intensive" is defined as those industries that have a high level of scientific and engineering personnel, an high level of R&D expenditures, or processes that involve R&D intensive machines, but engage a less educated workforce doing more routine tasks. They have been classified as technology intensive by other states and at least one outside classification source.

TABLE 3. TOP 30 TECHNOLOGY-INTENSIVE SIC CODES RANKED BY LEVEL OF EMPLOYMENT

High-Intensive Technology				Medium-Intensive Technology			
Employment Rank	SIC Code	Name	Number of related industries	Employment Rank	SIC Code	Name	Number of related industries
1	4813	Telephone communications	2	1	8062	Hospital, general	1
2	8711	Engineering services	5	2	874	Management, PR services	3
3	7371	Computer program services	6	3	371	Motor vehicles, equip.	4
4	3721	Aircraft	7	4	335	Nonferrous rolling	13
5	7372	Software	8	5	356	General industrial Machinery	15
6	7374	Data processing	9	6	284	Soaps, cleaners	17
7	4812	Radio/telephone communications	10	7	355	Spec. industrial machinery	18
8	7379	Computer servs., nec.	11	8	282	Plastics, synthetics	20
9	4841	Cable, pay TV servs.	12	9	8071	Medical labs	21
10	7375	Info retrieval servs.	14	10	354	Metalworking mach.	22
11	8712	Architectural servs.	16	11	353	Construction equip.	24
12	7373	Computer systems design	19	12	281	Industrial inorg. chemicals	25
13	3663	Radio/television communications equip.	23				
14	7378	Computer maintenance	26				
15	3728	Aircraft parts, equipment	27				
16	3729	Electric transmission, distribution equipment	28				
17	3672	Printed circuit boards	29				
18	3724	Aircraft engines, parts	30				

TABLE 4. TOP 30 TECHNOLOGY-INTENSIVE SIC CODES RANKED BY NUMBER OF ESTABLISHMENTS

High-Intensive Technology				Medium-Intensive Technology			
Employment Rank	SIC Code	Name	Number of related industries	Employment Rank	SIC Code	Name	Number of related industries
1	7371	Computer program servs.	2	1	874	Management, PR servs.	1
2	8711	Engineering servs.	4	2	7379	Services, nec.	3
3	4812	Telephone communications	5	3	7812	Motion picture	11
4	8712	Architectural servs.	6	4	8062	Hospital, general	13
5	8713	Surveying servs.	7	5	8999	Environmental servs.	14
6	7373	Computer systems design	8	6	8071	Medical labs	17
7	7372	Software	9	7	374	Motor vehicles	19
8	3663	Radio/television communications	10	8	355	Spec. industrial mach.	22
9	7374	Data processing	12	9	354	Metalworking mach.	23
10	4841	Cable, pay television	15	10	284	Soaps, cleaners	24
11	7375	Information retrieval servs.	16	11	8092	Hospitals, dialysis	25
12	7378	Computer maintenance	18	12	356	General industrial machinery	26
13	8734	Testing labs	20	13	289	Misc. chemical products	28
14	8732	Commercial nonphysical research	21	14	353	Construction equipment	29
15	8731	Commercial physical research	27	15	8069	Hospitals, dialysis	30

Table 5. Employment in High Technology In Georgia By SIC Code, 1999

SIC Code	Name	Employment
8062	Hospital, general	126499
4813	Telephone communications	46939
874	Management, PR services	31915
371	Motor vehicles, equipment	20320
8711	Engineering services	20020
7371	Computer program services	17426
3721	Aircraft	16363
7372	Software	13970
7374	Data processing	11554
4812	Radio/telephone communications	9699
7379	Services, nec.	9546
4841	Cable, other pay TV services	9272
335	Nonferrous rolling, drawing	4633
7375	Information retrieval services	7997
356	General industrial machinery	5741
8712	Architecture services	5339
284	Soaps, cleaners, toilet goods	5223
355	Specialized industrial machinery	4633
7373	Software systems design	4023
282	Plastics materials, synthetics	3875
8071	Medical laboratories	3660
354	Metalworking machinery	3316
3663	Radio/telephone equipment	3297
353	Construction/mining machinery	3173
281	Industrial inorganic chemicals	2951
7378	Computer maintenance, repair	2881
3728	Aircraft parts, equipment	2863
361	Electric transmission, distrib equip	2855
3672	Printed circuit boards	2819
3724	Aircraft engines, engine parts	3716
289	Misc. chemical products	3676
8713	Surveying services	2577
351	Engines & turbines	2548
3842	Surgical appliances and supplies	2408
8092	Dialysis equip. services	2243
2834	Pharmaceutical preparations	2187
8732	Commercial nonphysical research	2172
286	Industrial organic chemicals	2024
8069	Hospitals, specialty & dialysis	1900

8734	Testing laboratories	1717
362	Electric industrial apparatus	1659
3571	Electronic computers	1627
3661	Telephone, telegraph apparatus	1618
3823	Process control instruments	1600
8999	Services, nec/Environmental	1495
285	Paint, varnishes, etc.	1493
3577	Computer peripherals	1474
7812	Motion picture, video production	1433
287	Agriculture chemicals	1431
8731	Commercial physical research	1380
8733	Noncommercial research org	1331
7376	Computer facilities management	1328
3651	Household audio-video equipment	1304
3679	Electronic components, nec.	1251
3841	Surgical and medical instruments	1248
3761	Guided missiles, space vehicles	1140
3861	Photographic equipment, supplies	751
3812	Search, navigation equipment	719
7819	Services allied to motion pictures	706
3669	Communications equipment nec.	661
3822	Environmental controls	555
4822	Telegraph, other communication	514
3675	Electronic capacitors	394
3845	Electromedical equipment	386
4899	Other communications services	368
3579	Office machines, nec.	348
0182	Undercover food crops	324
7377	Computer rental, leasing	274
3643	Electric lighting, wiring equipment	240
2835	Diagnostic substances	238
3844	X-ray apparatus, tubes	167
3678	Electronic connectors	153
348	Ordnance, accessories	140
3829	Measuring, controlling devices	72
3843	Dental equipment and supplies	41
3826	Analytical instrument	12
3652	Prerecorded records, tapes	nr
3572	Computer storage devices	nr
2836	Undercover food crops	nr
3575	Computer terminals	nr
2833	Medicinals, botanicals	nr

3769	Space vehicle equipment, nec.	nr
3674	Semiconductors, related devices	nr
291	Petroleum refining	nr
3677	Electronic coils, transformers	nr
3825	Instruments measuring electricity	nr
3824	Fluid meters, counting devices	nr
3821	Laboratory apparatus, furniture	nr
3578	Calculating, accounting equipment	nr
3676	Electronic resistors	nr
3827	Optical instruments, lenses	nr
131	Crude petroleum, natural gas	nr
	TOTAL	464,872

nr: not reported for purpose of confidentiality

FIGURE 1. PERCENT GROWTH OF TECHNOLOGY EMPLOYMENT IN GEORGIA (1979-1999)

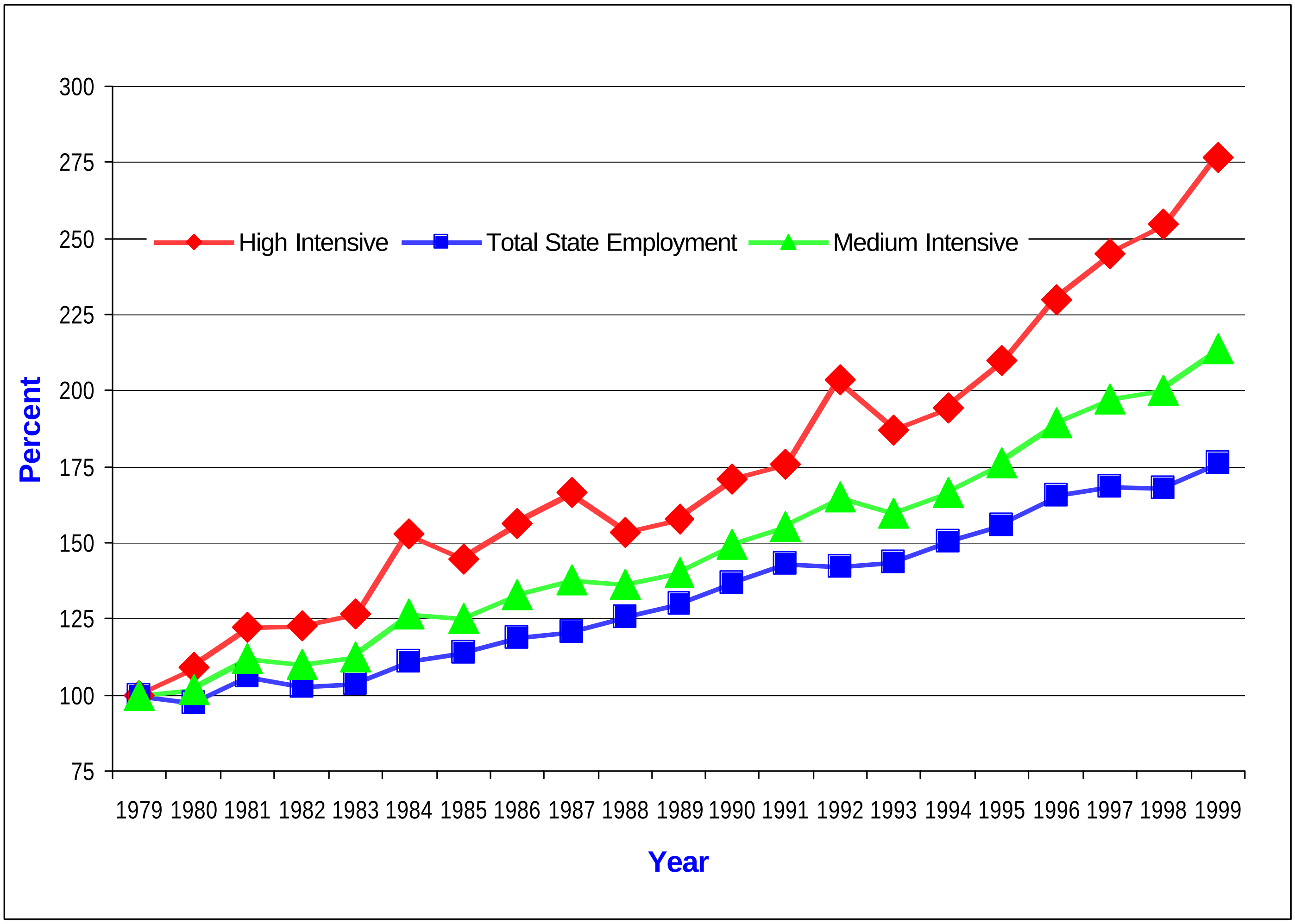


FIGURE 2. TECHNOLOGY EMPLOYMENT IN GEORGIA

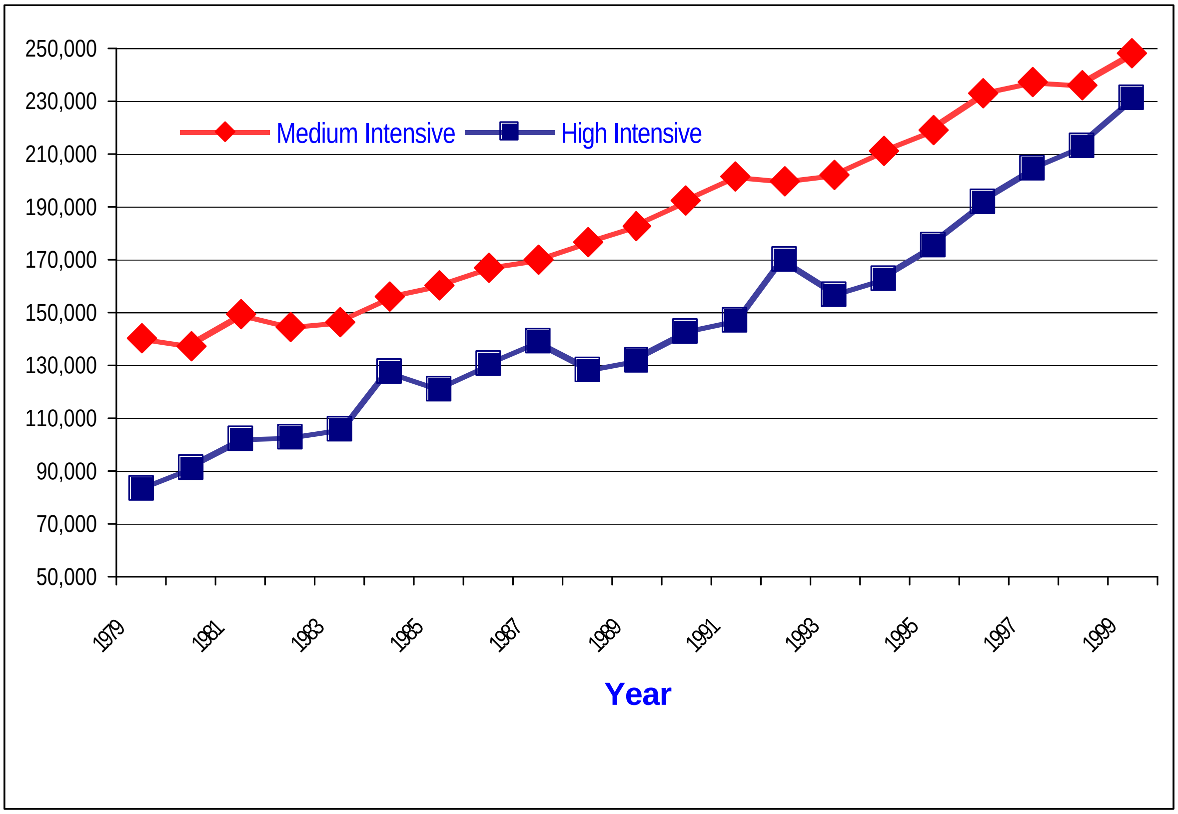


FIGURE 3. HIGH –INTENSIVE TECHNOLOGY EMPLOYMENT IN GEORGIA, 1999

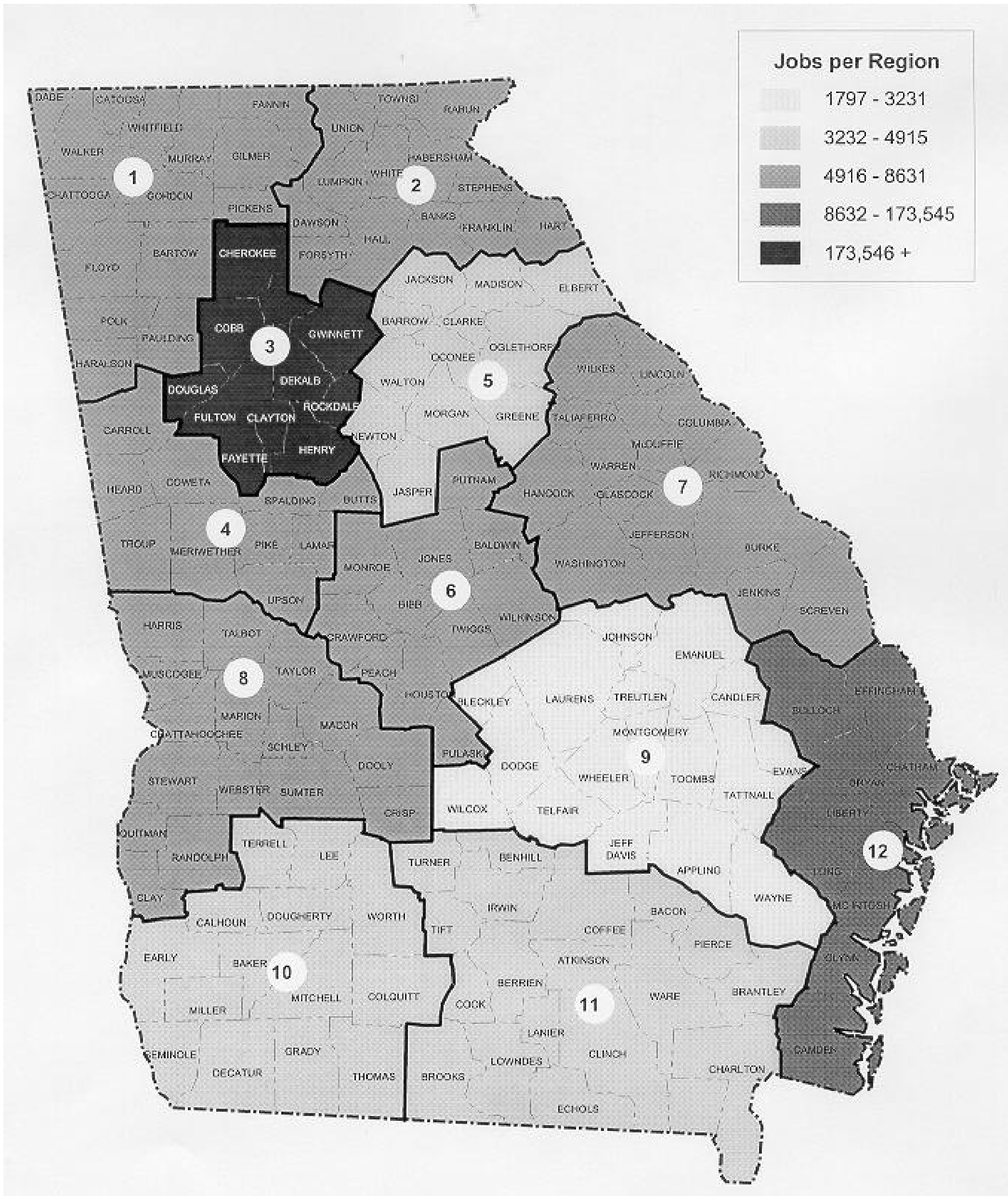
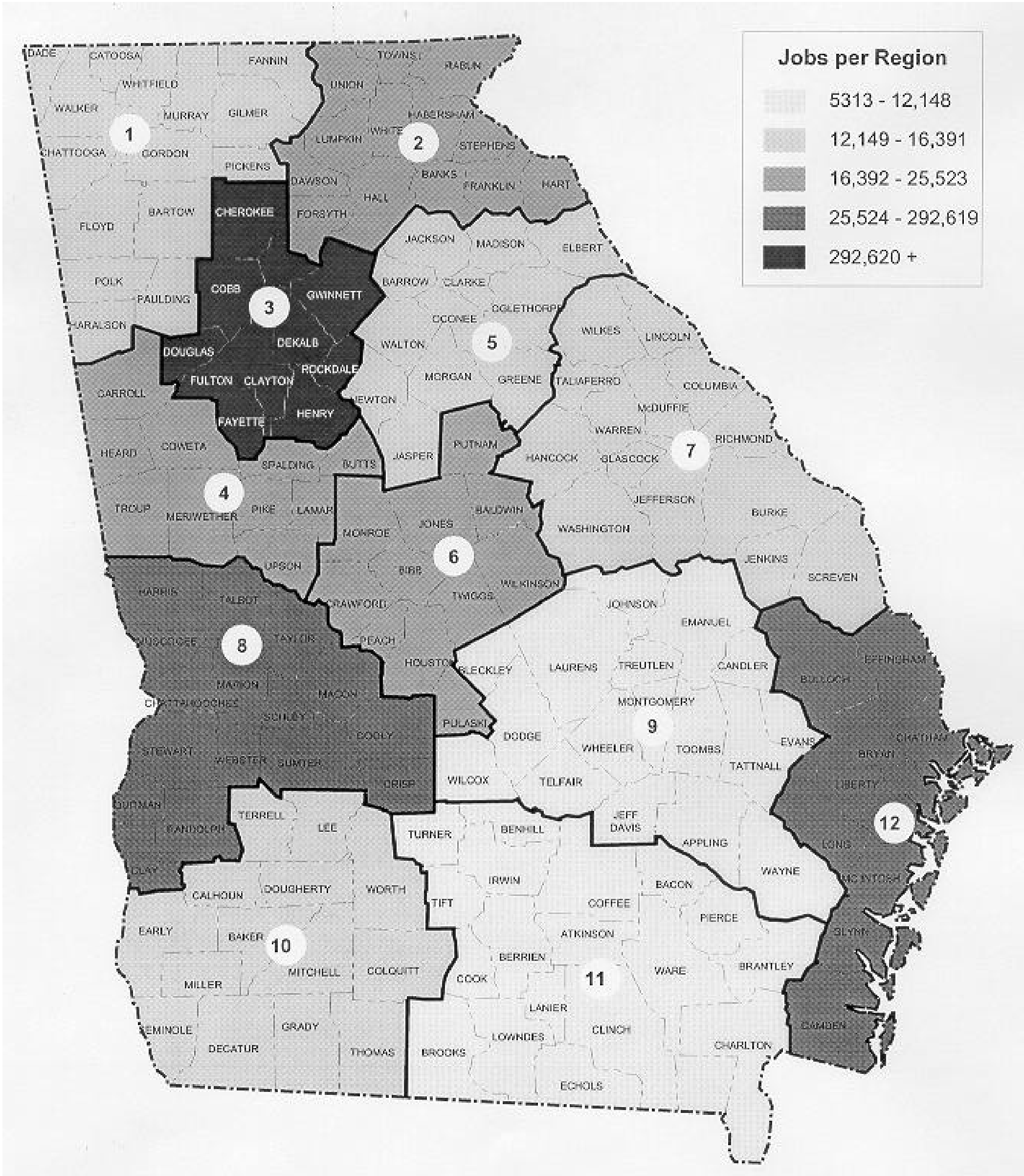


FIGURE 4. TOTAL TECHNOLOGY – INTENSIVE EMPLOYMENT IN GEORGIA, 1999



Conclusion

Several general observations regarding cluster affiliation can be made based on the two lists of high-intensive and medium-intensive technology industries. The most prominent SIC codes on the high-intensive technology list for Georgia by number of establishments are affiliated with computer services (SIC 737, at 2,143 companies), followed by engineering services (SIC 871, at 1,322 companies). Based on employment, the top high-intensive technology industries are associated with communications (SIC 48, at 47,536 jobs) followed by engineering services (SIC 8711, at 20,452 jobs) and computer program services (SIC 7371, at 17,790 jobs). Both classifications are highest in service-related occupations, reflecting a mature, skilled economy.

Our selection of SIC codes to represent technology-intensive industries draws on previous studies of high technology occupations at the national and state levels, by both government bureaus and private economic assessment groups, as well as numerous state-affiliated study groups. Including the insights of Georgia development professionals permits consideration of the pervasiveness of technology thorough production machinery and processes as well as personnel. Resulting measurements of Georgia's technology strengths following from this definition more accurately reflect the state of current technology utilization, permit policy formulations on a sound basis, and indicate areas for future development.

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Appendix. Rationale for Choice of SIC Codes

I. **American Electronics Association** (2000)**:** Used 45 SIC codes principally related to its constituency, excluding, for example, all services and medically related occupations (www.aeanet.org).

II. **Bureau Of the Census:** Ten products or processes considered "new or leading-edge technologies" (NSF 1998, p.6-12). These are not directly linked to but can be assigned SIC codes. Major areas are life science and biotechnology, opto-electronics, computers, telecommunications, electronics, computer-integrated manufacturing, material design, aerospace, weapon development, and nuclear technology.

III. **Bureau of Labor Statistics:** Used variety of expanding and contracting measures.

IV. **OECD** (1995)**:** Out of 22 industrial sectors, considers only 4 high-tech: aerospace (SIC 376), computers and office machinery (SIC 357), electronics-communications (SIC 366 and SIC 367), and pharmaceuticals (SIC 283).

V. **States**:

A. Arizona: (www.azcommerce.com/gsped/gsped_clusters.htm) identified 11 "key clusters" in the state; incongruously identified "high technology" separately from "bioindustry", "environmental technology", and "software."

B. California Office of Economic Research uses BLS' 1999 definition [see chart]

C. Georgia: GDITT 1) combined AEA and Milken categories, and 2) identified 8 "Areas of Excellence" as Georgia strengths or concentrations: Biotechnology and Health Services, Information Processing, Poultry Production, Pulp & Paper Technologies, Telecommunications, Aerospace/Aviation, Agribusiness/Agritech, and Carpet manufacturing. Suggested separating industries by process and product, industry and jobs within other industries. MACOC/IOM 1) identified jobs as high tech to target company attraction, and used seven classifications in particular.

D. Hawaii combined AEA, BLS (Hecker 1999), and Arizona's definitions. Pointed out BLS definition specified SIC included "if proportion of R & D and technology-oriented occupations exceeded twice the average proportion for all industries." Added some agricultural codes that might be useful precedent for Georgia, involving "crop and animal biotech…diagnostic substances & organic chemicals". (www.hawaii.gov/dbedt/he1-00.measure.html)

E. Kansas: Used the Pittsburgh/Cleveland clusters;

F. Michigan (MEDC 2000) added motor vehicles since they are its strength;

G. New Jersey used both the two standard definitions plus cluster approach to capture industries that fed others and only one "high-tech", similar to current Georgia approach.

H. New Mexico identified "[technology] industry clusters": advanced instruments, aerospace, biomedical products, biotechnology, microelectronics, optoelectronics, software, telecommunications equipment, and telecommunications services; (www.edd.state.nm.us/FACTBOOK/techstat.htm).

I. North Carolina eliminated SIC codes that it didn't have, added "fast-growing" industries; (www.governor.state.us/govoffice/science/projects/nc2030.html)

J. Pittsburgh identified six "technology clusters", including information tech, environmental tech, and biotech;

K. South Carolina chose SIC 7 codes for incentives; most of their tech labor is in chemicals, plastics, and textile fibers firms. Also machinery, durables and non-durables, engineering, and info services. Chose five clusters: manufacturing, information and communications, environment (monitoring equipment & services, living systems, materials (chemicals, rubber, plastic, textile).

L. Tennessee (2000) identified SIC list that corresponds to other states plus its own strengths with employment figures from DOL.

M. Texas (Lyons and Luker 1998, Prothro 1998) added "crude petroleum and natural gas operations" since they are its strength; used SIC classification of

BLS 1991; added several other categories only used by this state, a real stretch. Texas justifies including oil exploration, chemicals, and agriculture processing as "industries [that] rely heavily on technology-driven research and development activities to create new goods and services" (Prothro 1998).

N. Virginia (Stough, et al. 2000) uses AEA's SIC codes; identified a "technology sector" which it then used to rate areas in Virginia by the amount and type of technology firms predominant. Generally defined as firms "that produce technology, require a high level of dependence on technology… or use technology to examine complex problems." Combined a survey of VA tech firms, ES202 data, Bureau of the Census County Business Patterns, and Dunn & Bradstreet firm listing. Multipliers used the Minnesota IMPLAN System, 1995.

O. Washington State (Quarles and Choe 2000) used an internally computed list of industries "which employ the majority of science, engineering, and technology occupations in the state." Included "any SIC code having 7% or more of its employment in the technology occupations listed" accounting for most tech positions. Eliminated those representing "delivery of routine services based on a technology."

About The Author

Susan M. Walcott is an Assistant Professor of Geography at Georgia State University, specializing in urban and regional economic development. She has published articles on "High Tech in the Deep South," "The Three Georgias," and "Corporate Headquarters in Metropolitan Atlanta, 1960-1997" concerning the effect of high technology-induced growth in this region.

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