Amy K. Glasmeier

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AMY K. GLASMEIER*

High-Tech Industries and the Regional Division of Labor

IN ADDITION TO CHANGING LABOR RELATIONS on the shop floor, high-tech industry is creating a spatial division of labor in which firms segment the more technical aspects of manufacturing from those of production and assembly, and seek out labor markets where the type of skill and labor relations needed to support different elements of production are found. Thus far, there have been few attempts to document the spatial division of labor; instead, most speculation about the importance of high-tech industry location is confined to comments about the shift of jobs to the Sunbelt. Although this trend is important, more troubling for labor in the long run is the fact that firms are increasingly taking advantage of the possibility of fragmenting production tasks and matching them with labor force characteristics found in different locations.

The creation of a spatial division of labor tips the balance of power in favor of employers. Increasingly, employers can shift production away from the original site of innovation soon after the product has achieved production status. This truncates the process of employment filtering where job growth historically expanded outward from the point of innovation into surrounding communities (Freeman, 1982). Thus, while states and communities may gain technical jobs, this does not necessarily mean production employment will follow. Given cost considerations and the possibility of ever cheaper production locations, even when production jobs are created, they may be short-lived.

In this paper, I present the results of a two-stage analysis of the occupational structure and spatial location of high-tech industries and employment.[1] After

*Assistant Professor of Economic Planning, Department of Community Studies, Pennsylvania State University.

[1]Although there is no standard definition of a "high-tech" industry, it has become general practice to define as "high-tech" those three-digit industries with above average proportions of engineers, engineering technicians, computer scientists, mathematicians, and life scientists (Vinson and Harrington, 1979; Glasmeier, Hall, and Markusen, 1983; Riche, Hecker, and Burgan, 1984). This definition encompasses such popular industries as semiconductors, computers, scientific instruments, and communications equipment, as well as lesser publicized industries, such as industrial inorganic chemicals, aircraft engines, missiles, and space

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a brief review of relevant theoretical and empirical work on the spatial division of labor, a model of the division of labor in high-tech industries is presented and then tested using industry occupational employment data for states registered in the U.S. Department of Labor's Occupational Employment Statistics (OES) survey program in 1977.[2] Then, states that in 1977 and 1980 had higher than average proportions of engineers and engineering technicians and low proportions of production and assembly workers in high-tech industries are identified. Factors that may have encouraged the clustering of the more technical aspects of high-tech industries in a few states, largely outside the traditional manufacturing belt, are proposed. The paper concludes with remarks about the impact of high-tech industries on the regional division of labor.[3]

Review of Relevant Theoretical and Empirical Research

Most authors suggest that the spatial division of labor has evolved as firms seek out locations where a profitable supply of appropriate labor can be found.[4] Historically, the locational decision of single-unit firms was constrained by factors such as transportation costs, access to markets and labor, and rigid, mechanically integrated methods of production (Storper and Walker, 1983). In recent years, firms' locational choices have been increased dramatically by changes in the organization of corporations from single to multi-establishment firms (Hymer, 1979); by advances in telecommunications that make possible real-time communication among far-flung production operations; by decreases in the time and cost associated with shipping materials and products among different production units and markets; and by the application of microelectronics to manufacturing processes, which makes possible more flexible and hence more divisible production.

Locational choices of high-tech firms are constrained by their need for different types of labor. For reasons of exposition and simplification, we can think of manufacturing production as consisting of three stages: conception, design, and prototype production; fabrication of component parts; and assembly

vehicles. Owing to data limitations, high-tech industries are defined using three-digit level occupational data based on the Department of Labor's OES Industry-Occupational Matrix. Most researchers conducting spatial analysis then disaggregate the three-digit industries into their four-digit counterparts. Consequently, most lists of high-tech industries include between 88 and 100 four-digit industries (Glasmeier, Hall, and Markusen, 1983; Armington, Harris, and Odle, 1983).

[2]A similar analysis was conducted for states in the OES program reporting data for the year 1980. The results of the principal components analysis of 1980 data are not reported here because they closely resemble the earlier year's results.

[3]The author would like to acknowledge the assistance of Barbara Baran for substantive and editorial comments on the first draft of this article. Additional comments by Bennett Harrison, Clair Brown, Williem Van Uliet, and anonymous reviewers are also appreciated. Portions of this research were funded by a National Science Foundation Dissertation grant from the Geography and Regional Science Division.

[4]"Appropriate" encompasses all aspects of employment—wages, working conditions, skills, and labor relations.

of fabricated components into intermediate and final products. During product conception and prototype production, firms employ high proportions of technically trained engineers and technicians. These craftsmen's skills become less important in fabrication as production and materials handling skills become more essential. During the final stage of manufacturing production, workers are engaged in tedious but exacting assembly of component parts. Although great concentration is required of assemblers, levels of technical skill are quite low.

Firms can and do operate vertically integrated production facilities with technical, production, and assembly employees working side by side, but employers are increasingly choosing to separate these operations. At least two factors are said to regulate the decision to segment production: employers' desire to minimize contact between workers with different levels of bargaining power; and certain physical characteristics of products that may either encourage or impede spatial segmentation.

Clark (1981), for example, argues that relative differences in bargaining power among workers encourage the separation of technical employees from production workers. Technical workers have considerable bargaining power because their skills are highly valuable and transferable to other employers. If engineers and technicians are dissatisfied with their existing working conditions, they can change jobs easily. Consequently, in order to limit labor turnover, high-tech firms are forced to provide incentives for technical workers, such as job security, stock options, and freedom of movement and decision making. In spite of periods of economic down turn, employers hoard technical workers because of training and proprietary knowledge accumulated on the job.

High-tech firms also want the flexibility to lay off production and assembly workers and to limit potential workplace organization. This becomes difficult when both technical and production workers are centralized and skilled and/or unskilled workers are covered by either implicit or explicit employment contracts. If production is centralized, employers may be confronted with requests for comparable working conditions for production workers, particularly with regard to issues of job security.

Employers have the option of moving technical activities outside core areas in order to restrict skilled workers' mobility between firms—and thus also limit their bargaining power—but case studies suggest that this action is unsatisfactory because employers find it difficult to attract highly trained workers to remote locations (Clark, 1981; Glasmeier, 1986). Production and assembly workers, on the other hand, lack the strong bargaining power of technicians, so employers may more successfully implement the spatial decentralization of production operations.

Another perspective on the division of labor, while acknowledging management's prerogative vis-a-vis labor, suggests that it is products and production technologies that constrain the possibility of a spatial division of labor (Glasmeier, 1986). Storper (1982) and others (Saxenian, 1981; Massey, 1984) indicate that the production of semiconductors occurs in discrete stages. Each stage requires different labor skills and hence promotes different labor relations among workers and employers. Firms maintain research and development activities in core centers of the industry, while fabrication of the wafer is spun off to satellite locations near R&D centers.[5] Historically, assembly operations have been located predominantly in the Third World, where female workers with minimal industrial experience are employed. Although there has been some tendency to automate the entire process and bring assembly back to the United States, the subsequent relocation of highly automated production has been primarily to the Sunbelt outside core centers of technical activity (Sayer, 1985; Glasmeier, 1986).

Another important insight from the literature is that technical, corporate, and administrative activities are found in close proximity to one another (Malecki, 1980a,b). Most modern corporations maintain R&D laboratories either attached to or near corporate headquarters. This pattern reflects the fact that new product development requires a high degree of interaction between corporate finance and marketing staff as well as technical workers (Hymer, 1979). Once an innovation reaches product status, planning, marketing, and production decisions become increasingly intertwined. It is also true that technical employees find it in their own best interest to be located near headquarters so that they can promote their pet projects (Ritti, 1971).

The model. In high-tech industries, where production lends itself to fragmentation, technically trained workers will be spatially separated from production and assembly operations. Past theoretical and empirical research indicates that there are three levels in the division of labor. First, the high degree of interaction between technical and professional staff during new product development suggests that technical workers will be positively associated with high proportions of professional and administrative personnel. Second, technical centers of high-tech industries will have correspondingly low proportions of production workers in the labor force relative to simple production

[5]Firms such as Motorola have also begun fabricating the wafer in other advanced industrial countries (e.g., France and Ireland). This decision is governed by the company's desire to avoid tariffs as well as to take advantage of these countries' cheaper technical labor.

locations, both because of different labor requirements and because of employers' desire to separate production workers from technical employees. Third, high concentrations of assembly occupations will be separated from both technical and production locations because of differences in skill levels needed and the desire to tap labor pools with a minimum history of industrial relations.

Data and Methodology

The test of the division of labor in high-tech industries presented here compares the occupational composition of employment in two-digit industries in states. Because a state is classified as a "production site" does not mean that it doesn't have significant *numbers* of engineers in its industry occupational profile. Rather, what is identified are differences in the *composition* of states' industry occupational employment profiles.

Five industry groups were investigated: Chemicals (SIC 28); Nonelectrical Machinery (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); and Scientific Instruments (SIC 38). These groups were selected because they include 29 three-digit industries identified as "high tech" in previous work (Glasmeier, Hall, and Markusen, 1983).[6] It should be noted that within the five groups there are a number of more disaggregated industries that do not qualify as high-tech, based on the definition used in other studies.

For each of the 41 states reporting employment in 1977,[7] in one of the five industry groups, an average of 50 occupational categories were collapsed into nine uniform ones,[8] as follows: engineers; engineering technicians; other professionals, such as accountants and lawyers; managers; assemblers; production workers; service workers; office clericals; and plant clericals.

Methodology. A principal components analysis was used to examine the occupational composition of each industry group separately. This statistical technique makes apparent the underlying data structure in a collection of variables by identifying variables which are measuring the same factor. In this case, the technique tests for statistical associations between nine occupational categories across a number of states, calculating weights for each variable so that each successive principal component contains as much information about the original variables as possible. Factor loadings are eigin values (weights)

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[6] Detailed spatially disaggregated industry occupational data are consistently available from individual states only at a two-digit level.

[7] Omitted states either did not participate in the program in 1977 or did not publish data for reasons of confidentiality.

[8] I created uniform categories in order to make the data comparable across states (see Glasmeier [1986] for details). Some states reported only 15 occupations, while others reported upwards of 50 separate occupational categories for each industry.

used in forming the weighted average of the principal component. These weights (factor loadings) are used to interpret the principal component's meaning.

For example, if the first principal component in industry X consists of high positive loadings on technical and professional occupations and high negative loadings on production occupations, it indicates that technical and professional workers are not concentrated in the same locations as production workers. Table 1 reports the first three principal components for each industry's occupational profile, along with measures of individual and cumulative component variance explained for each industry.

A Test of the Model

The results of the analysis for all five industries indicate that the hypothesized spatial division of labor is confirmed in the occupational distribution of employment in high-tech industries. Concentrations of technical, administrative, and professional workers are present in similar places, while production workers are found in different locations. In general, these results confirm the hypothesis that workers engaged in design and prototype activities are spatially associated with professional and administrative employees. With the exception of the Scientific Instruments industry (SIC 38), the first principal component represents a professional, technical, and administrative axis.

The sample high-tech industries also exhibit the tendency for assembly workers to be segmented from both production and technical workers. This is particularly true for industries that engage in complex assembly, such as Electrical Equipment (SIC 36). Included in this industry group are firms producing semiconductors and electrical components (e.g., resistors and transistors), as well as communications equipment. It is interesting to note that in the Scientific Instruments industry, production and assembly workers are negatively associated. This results partly from the fact that this industry group includes sectors that are highly spatially concentrated and which employ large numbers of machinists who make custom instruments for industrial use, along with sectors that produce medical equipment, for example, which has a large assembly component engaged in producing relatively standard products such as syringes, medical applicators, and other intravenous devices. In two of the five industries which engage in complex assembly activities (Nonelectrical Equipment and Electrical Equipment), the second principal component shows a positive association between assembly workers and plant clericals. This reflects the fact that assembly operations require careful stocking of materials and complex inventory control, hence plant clericals are relatively important.

TABLE 1

PRINCIPAL COMPONENTS ANALYSIS OF THE SPATIAL AND OCCUPATIONAL DIVISION OF LABOR IN FIVE HIGH-TECH INDUSTRIES

		The Chemicals Industry (SIC 28)			
Professional[a]		Technical[a]		Service[a]	
Occupational category[b]	Factor loading	Occupational category[b]	Factor loading	Occupational category[b]	Factor loading
3	.86	1	.67	7	.86
4	.70	2	.50		
7	.91				
6	−.97				
Var. explained	50.6%		21.8%		15.7%
Cumulative variance explained					88.10%
		The Non-Electrical Equipment Industry (SIC 35)			
Professional/Technical[a]		Assembly[a]		Service[a]	
Occupational category[b]	Factor loading	Occupational category[b]	Factor loading	Occupational category[b]	Factor loading
1	.91	5	.93	7	.72
2	.94	9	.87		
6	−.90				
Var. explained	51.3%		22.3%		8.1%
Cumulative variance explained					81.7%
		The Electrical Equipment Industry (SIC 36)			
Professional/Technical[a]		Assembly[a]		Service[a]	
Occupational category[b]	Factor loading	Occupational category[b]	Factor loading	Occupational category[b]	Factor loading
1	.91	5	.63	7	.86
4	.92	9	.62		
8	.89				
6	−.82				
Var. explained	59.3%		12.9%		11.9%
Cumulative variance explained					84.10%
		The Transportation Equipment Industry (SIC 37)			
Professional/Technical[a]		Assembly[a]		Service[a]	
Occupational category[b]	Factor loading	Occupational category[b]	Factor loading	Occupational category[b]	Factor loading
1	.83	5	.83	2	.49
3	.81			7	.50
4	.81				
8	.89				
Var. explained	50.7%		19.2%		12.9%
Cumulative variance explained					82.0%
		The Professional and Scientific Instruments Equipment Industry (SIC 38)			
Technical[a]		Assembly/Production[a]		Professional[a]	
Occupational category[b]	Factor loading	Occupational category[b]	Factor loading	Occupational category[b]	Factor loading
1	.89	5	−.82	4	.60
2	.79	6	.73	8	.60
Var. explained	39.0%		27.6%		14.2%
Cumulative variance explained					80.80%

[a]These groups were generated by principal components analysis of state industry occupational employment; I labeled them on the basis of the composition of the principal components.

[b]1 = engineers; 2 = technicians; 3 = professionals; 4 = managers; 5 = assembly; 6 = production; 7 = service; 8 = office clericals; 9 = plant clericals.

Source: Computed from published data from selected states in the Occupational Employment Statistics Program, 1977.

The third component reflects the unique relationship between service workers and other occupations. Regardless of whether the site is a production or an administrative/technical location, it appears that service workers are found in relatively constant proportions across locations.

High-technology industries clearly exhibit a spatial division of labor. States with high proportions of technical and administrative jobs have low proportions of production workers. However reassuring the growth of high-tech employment is for states and communities, it is clear from this analysis that there are very important distinctions to be made about the type of job(s) being created in various locations and the extent to which this has led to the evolution of clusters of technical versus production operations.

The Centralization of Scientific and Technical Jobs

The significance of the spatial division of labor in high-tech industries is even more powerfully understood when it is described in terms of particular states and regions. Discriminant analysis was used to provide additional confirmation that states which have industry occupational profiles with high proportions of engineers and engineering technicians also have low proportions of production workers. Discriminant analysis parallels regression in that it plots the independent variables, in this case occupations, against the dependent variable, membership in either the group of technical or nontechnical states. In the analysis, Wilks' lambda, an inverse measure of the discriminating power of variables which have not yet been removed by the discriminant function, ranged from a high of .34 to a low of .19, indicating significant discrimination between the two groups.[9]

The analytical procedure, executed for states that participated in the Occupational Employment Statistics program both in 1977 and 1980, was undertaken in three stages. States with above-average proportions of technical, professional, and administrative occupations in individual industries were classified separately from those with above-average proportions of production workers; the data were standardized for size of state industry employment base; and lastly, the groups were subjected to discriminant analysis. Each year was analyzed separately and then the results were combined to make a total of 45 states.

The results identify 26 of the 45 states as centers of technical employment on the basis of their having above-average proportions of scientific and technical jobs in any one of the sample five industry groups. Only ten states (Arizona,

[9]By definition, Wilks' lambda ranges from 0 to 1. A score of 0 means perfect discrimination. In this case, a score of zero means that the structure of occupational profiles among production and technical centers are highly different.

TABLE 2

STATES HAVING OCCUPATIONAL PROFILES WITH HIGH POSITIVE PROPORTIONS OF ENGINEERS AND ENGINEERING TECHNICIANS AND LOW PROPORTIONS OF PRODUCTION WORKERS, OES 1980[a]

	Industry groups				
State	(SIC 28)	(SIC 35)	(SIC 36)	(SIC 37)	(SIC 38)
Arizona	×	×	×	×	
California		×	×	×	
Colorado	×	×		×	×
Connecticut	×			×	×
Delaware	×				×
Florida		×	×	×	
Illinois	×				
Indiana	×				
Kentucky	×	×			
Louisiana	×				
Maryland	×		×		
Massachusetts	×	×	×		×
Minnesota		×			
Missouri	×				
New Hampshire		×			
New Jersey	×	×	×		
New Mexico				×	
New York	×	×	×	×	×
North Carolina		×			
Oregon		×			×
Pennsylvania	×	×			
Texas	×		×	×	
Vermont			×		
Virginia			×		
Washington			×	×	×
West Virginia	×				

[a]The designation of technical versus production location was derived from a discriminant function that used nine occupational categories in a linear model (see text for details).

Source: Computed from published data from selected states in the Occupational Employment Statistics Program, 1977 and 1980.

grams have encouraged the development of a few technical enclaves in the South. These factors are examined in greater detail below.

The location of engineering schools. Numerous studies indicate that high-quality postsecondary education is a key variable in attracting the technical components of high-tech industries (Dorfman, 1983; Markusen, Hall, and Glasmeier, 1986). In spite of the widespread distribution of universities and colleges across the country, only a few states, primarily in the Northeast and West, host top-ranked engineering schools that grant a majority of American graduate degrees in engineering and science.

The number of engineers and scientists graduated by New England universities and colleges is a key factor in why this region is a technical center for high-tech industries. For example, in 1975, Massachusetts, with only 3 per cent of the nation's labor force, produced 9 per cent of the nation's Ph.D.'s in mathematics, computer science, and electrical engineering. In addition, in 1981, 5.5 per cent of the nation's bachelor degrees in electrical engineering and computer science was awarded by Massachusetts institutions. In the West, California has similar strengths with regard to degree-granting universities which graduate large numbers of students with advanced training in engineering and science. The University of California at Berkeley and Stanford University together annually award more than 15 per cent of the nation's graduate degrees in engineering and science. Moreover, a large proportion of individuals who receive their graduate degrees from schools in California and Massachusetts stay in these regions after graduation and work for local high-tech firms (Dorfman, 1983).

The link between entrepreneurs and relevant services. Another factor that has reinforced the location of the technical components of high-tech industry is the link between entrepreneurs and adequate supplies of business services, banking institutions, and other urban amenities (Duetermann, 1966; Dorfman, 1983; Markusen, Hall, and Glasmeier, 1986). The Northeast has maintained its powerful position as a center of technical activities because of the significant spatial concentration of banking, corporate headquarters, and business services located there. In large part, the location of corporate headquarters explains why industry in the Northeast is technical in nature. In the West, California has been a regional center for corporate headquarters since before the twenties. And, since the creation of the micro-processor, California has become the nation's capital for semiconductor and microelectronic firms.

The industrial structure of the Midwest. The Midwest also has its share of corporate headquarters, research labs, and major universities (Malecki, 1980a; Browne, 1983), but because of the structure and composition of its labor force, the region cannot support the more technical aspects of high-tech industries to the same extent as can other regions. Workers could achieve high wages in the basic industries without college educations, so over the postwar period states in the Midwest experienced high rates of in-migration of workers lacking college degrees. According to the 1970 Census, in-migrants to the Great Lakes region, for example, had lower levels of educational attainment than in-migrants to other regions (Bureau of the Census, 1970). This was followed by a corresponding trend of more highly educated persons leaving the Great Lakes and moving to other regions. More importantly, the proportion of the Great Lakes states' population with a college degree is lower than any other region except the East North Central (Browne, 1983).[10]

Although the Midwest has a number of nationally recognized engineering schools, the region still lacks levels of engineers and professional workers comparable to those found in the Northeast. Browne's (1983) comparative study of Illinois, Indiana, Michigan, Ohio, and Wisconsin with New England shows that New England has 20 per cent more engineers and technicians, given its size, than do these Great Lakes states. Thus, relative differences in the proportion of technically trained personnel may have made states in the Midwest less attractive as technical centers.[11]

Levels of education aside, it might also be argued that high-tech firms simply choose to locate the more technical aspects of the industry in less unionized regions. The evidence, though, tends to undermine this argument. The results of a regression model of 1977 high-tech metropolitan employment levels and various metropolitan characteristics (including state-level unionization rates, manufacturing wages, business services, and the number of universities and colleges present) indicate that whereas rates of unionization and wage levels were insignificant, business services and access to universities and colleges were positively associated with high-tech employment location (Markusen, Hall, and Glasmeier, 1986). Rates of unionization may be important for the location of production jobs, while urban amenities are the more critical factor in the location of technical functions. An adequate understanding of the relationship between high-tech industry and rates of unionization requires further research.

The role of space and defense spending. In the South, the presence of technical components of high-tech industries is partly explained by the oil and chemicals industries' expansion in the Gulf Coast, and more importantly, perhaps, by the substantial growth in government space and military programs that has occurred over the postwar period. Of the nine Southern states with above-average proportions of technical occupations in one or more industries, three states can be considered technical centers because of the significant presence of the petrochemicals industry; three others have high-tech complexes

[10]In 1980, in the Great Lakes region, 14.5 per cent of the population 25 years or older had completed four or more years of college, compared with 16.3 per cent in the nation as a whole, and more than 19 per cent in New England, California, and several other Western states. Even states in the South collectively had a higher proportion of college graduates.

[11]The structure of the Midwest's labor force may also have contributed to the overall decline of manufacturing in that region. An interregional economic model developed by Data Resources Inc. for 1973-1980 indicates that a relatively low percentage of college graduates in the active working population in the Midwest states, as compared to other regions, was responsible for a loss of 86,000 jobs in manufacturing (Resek and Kosobud, 1982).

consisting largely of government and defense operations, one has high-tech roots that can be traced to private investment decisions; and one has a high-tech center of mixed origins.

In contrast to the Northeast and West, only two Southern states, Florida and Texas, can be considered as multiple-industry technical centers. Florida's high-tech history is significantly linked to a few large communications corporations and defense contractors. Although this history predates the development of the Cape Kennedy Space Complex, much of the high-tech growth that occurred between 1950 and 1970 was either directly or indirectly associated with the early space program.[12] Texas's high-tech base has older and more complex origins. The largest single high-tech industry employer in the state is petroleum-related Scientific Instruments (Goodman and Arnold, 1983). The state's high-tech base is also heavily influenced by defense spending and the national space program.[13]

One needs only to look at the proportion of the nation's engineers and technicians employed in defense-related industries to understand why defense-spending has contributed so importantly to the creation of a spatial division of labor in high-tech industries. Defense-related sectors employ 48 per cent of the nation's aerospace engineers, 38 per cent of the nation's physicists, and 18 per cent of all mathematicians (Markusen, Hall, and Glasmeier, 1986). Thus, areas whose economic base is dependent on defense activities have attracted large numbers of technical personnel working for defense contractors.

Focusing exclusively on the technical end of high tech's division of labor overlooks the importance of where production jobs are located and why. Over the 1968-1984 period, states in the Midwest lost almost a million-and-a-half jobs in the five sample industry groups, while states in the South and, secondarily, in the West, gained comparable numbers of jobs over the same period. The South has gained a considerable number of high-tech jobs over the last ten years, but a large portion of this employment is relatively low-skilled production and assembly work (Hansen, 1979). Even some of the high-tech jobs that might otherwise be considered very technical because of their connection to defense contracts, in reality involve largely low-skilled assembly. Although firms in the South have garnered a considerable share of national defense contracts, the sectoral specialization and defense-related job growth has been primarily in sectors that characterize the South's dominant industrial structure, i.e., food processing, clothing, and tobacco (Schlesinger, Gaventa, and Merrifield, 1983).

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[12]This and other insights were gained during interviews with executives of the major high-tech corporations in the Melbourne-Titusville, Florida area.

[13]In a recent study of defense dependency, Stein (1985) concluded that the Dallas-Fort Worth Standard Consolidated Statistical Area (SCSA) had the most defense-dependent manufacturing base in the country.

Conclusions

The growth of high-tech industries has resulted in the creation of a spatial division of labor where a few states host concentrations of technical occupations. This spatial pattern can be traced largely to the selective location of a few major engineering universities and the powerful impact of government spending for defense and space programs over the postwar period. Particularly disturbing is the fact that these centers of industrial innovation are primarily located outside manufacturing states in the Midwest.

High-tech industries appear drawn to a labor force which is more highly skilled than that which historically has been employed in basic industries. While there is much discussion about this issue in academic and policy circles, little empirical documentation has been undertaken. This analysis suggests that states with higher levels of education in their general population have been effective in attracting and cultivating the more technical aspects of high-tech employment and that a number of these same states have also experienced substantial gains in high-tech employment over the last several years.

If, as has been argued here, the division of labor in high-tech industries has weakened the relationship between new product development and the spatial filtering of employment, then all but the more technical jobs in manufacturing are in danger of relocation sometime in the future. America's labor organizations need to consider the fact that a majority of low-skilled production employment is mobile and hence vulnerable to relocation, and that in the long run any manufacturing that is done in the U.S. will consist of the more technical aspects of such activity, whether that means increasingly complex products or more sophisticated methods of production. Labor's long-term strategy in the face of industrial restructuring and the growing importance of high-tech manufacturing industries must address the problem of retraining on a large scale. If American manufacturing workers are to remain competitive, they will have to continually upgrade their skills to match the ever-increasing performance requirements of future production technologies. While historically it has proven difficult to regulate employers' decisions to move production activities from one location to another, if workers' skills are more valuable, then employers may be less willing—and perhaps less able—to shift production in the future.

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