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ABSTRACT

This document focuses on four community colleges--in Ireland, Denmark, California, and Mississippi--that play central economic development roles in their communities. Each has chosen to specialize in the skills and knowledge needed by local industry and the regional economy. Such technical colleges have emerged as key regional institutions, not only filling industry's labor requirements, but also serving as sources of advice and assistance in the modernization of existing industries. Thus, in many regions, community colleges are the leading source of technological expertise, and economic development has become a core mission of the college. These colleges ally themselves with businesses and draw staff from both industry and education. The benefits of such partnerships between education and business are evident: (1) colleges receive equipment, financial support, and access to industry specific knowledge; (2) businesses gain advice and employees who are more productive; and (3) the region's economy benefits from the mobility of the graduates and the flow of information among firms. Traditional college placement services are not necessary due to close ties between faculty, employers and informal labor market information networks. At each location studied, job offers at high relative wages are plentiful. Contains 26 references. (Author/AS)

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October 1998

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Regional Technology Strategies

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ABSTRACT

Four community colleges—in Ireland, Denmark, California, and Mississippi—play central economic development roles in their communities. Each has chosen to specialize in the skills and knowledge needed by local industry and the regional economy. Such technical colleges have emerged as key regional institutions, not only filling industry's labor requirements, but also serving as sources of advice and assistance in the modernization of existing industries. Thus, in many regions, community colleges are the leading source of technological expertise, and economic development has become a core mission of the college.

These colleges ally themselves with the businesses they serve through advisory or trade councils, by participating in business associations or working on regional boards and organizations. The college staffs are drawn from both industry and education, and industrial advisory boards review curricula and plans. The colleges either link themselves to technology development agencies or take on deployment as their own mission—such as supporting the adoption of new quality, inventory, and management systems.

Colleges receive equipment, financial support, and access to industry-specific knowledge; businesses gain advice and employees who are more productive; and the region's economy benefits from the mobility of the graduates and the flow of information among firms. Job offers at high relative wages are plentiful in each location studied, and the close ties between faculty and employers and informal labor market information networks make traditional college placement services superfluous. Thus, the college-industry clusters benefit the school, the industry, the region, and the students.

CONTENTS

INTRODUCTION

The two-year branch of West Virginia University in Parkersburg, West Virginia, offers special programs and faculty expertise to the locally dominant chemical processing industry. In Nelson, New Zealand, home to sixty percent of the country's seafood processing and exporting industry, a branch of the local polytechnic targeting fisheries and marine technology attracts students from all over the South Pacific. Catawba Community College in Hickory, North Carolina, a regional hub serving three-fifths of the U.S. hosiery industry, operates the only hosiery technology center in the nation. In Ayr, Scotland, the technical college has special programs and services for the region's growing electronics industry. Springfield Technical Community College in Massachusetts, a region historically dominated by the machine tool industry, helps maintain needed skill levels with programs and services designed and delivered in cooperation with the National Tooling and Machining Association. Each of these technical colleges is responding to the needs of its regional economy, and each therefore has a unique array of programs and priorities. But why have these colleges chosen to specialize, and how has specialization affected the quality of education and the local economy?

Specialization is a response to particular concentrations of needs in regional economies. A distinguishing characteristic of industrial geography the world over is that related businesses tend to cluster. Businesses form around these natural poles because they find it advantageous to be near their suppliers, customers, sources of technology, services, and even competitors. The close proximity and spatial interdependence create "collective externalities" that allow them to transact business more cheaply and easily, achieve a scale that attracts specialized services and resources, resolve problems more quickly and efficiently, and learn sooner and more directly about new technologies and practices. If businesses have the wherewithal (social capital) to take advantage of these externalities, they become increasingly interdependent.

An important—and perhaps vital— feature of successful clusters is the presence of a labor force with the skills and knowledge required by the local industries and an education and training enterprise able to continually generate new entrants and upgrade the skills of existing workers. Although educational institutions are charged mainly with addressing the needs of individuals, not economies, many of the colleges that provide postcompulsory but less-than-baccalaureate education and produce the midskilled work force have explicit

economic development missions. In some places, these technical colleges have established special programs that match their regions' economies.

This study examines cluster/college connections in order to learn (1) how regional industry clusters influence community colleges and how community colleges, in turn, influence industry clusters and thus the region's economy, and (2) what the respective benefits and costs are to students, enterprises, and economies. To illustrate the roles and impacts of technical colleges, I have chosen four clusters representing two types of industry concentrations—furniture, a relatively stable traditional sector, and electronics, a faster growing, technologically advanced industry. The colleges in the clusters are—

Galway-Mayo Institute of Technology's Furniture College at Letterfrack, Ireland, the "sparkplug" charged with igniting Ireland's largely dormant furniture industry.

Itawamba Community College in northeast Mississippi, the "lighthouse" showing a labor-intensive niche of the furniture industry a path towards modernization and global competitiveness.

California's De Anza and Mission Community Colleges, the "training partners" helping the electronics/computer industries in Silicon Valley keep pace with constantly changing technology.

EUC-Syd, the "valued supplier" of the technical labor force in the electronics industry in southern Jutland in Denmark helping to offset the region's high costs through the expertise and innovation of the work force.

COMMUNITY COLLEGES AND ECONOMIC DEVELOPMENT

Technical colleges have emerged as key institutions in technology-based development, not only for filling industry's requirements for more technically proficient workers but, somewhat surprisingly, as repositories of information and technology, sources of expertise, advice, and assistance, and nurturers of social capital.

Their most fundamental role is creating a midskilled labor force to supply the growing need for higher skill levels. Evidence of a demand for technical workers with less-than-university tertiary education is based on changes and projections in enrollment and employment patterns, surveys of employers, and anecdotal information. In a 1994 *Fortune* cover story, "The New Worker Elite: Technicians are taking on a bigger role and commanding respect

as the core employees of the Information Age," the author projected increases in demand between 1992 and 2005 of 19 percent for engineering technicians, 25 percent for science technicians, and 30 percent for computer programmers.[1] "It is not the number of robots and computers, size and technical perfection of work centres or the degree of automation which will decide upon our future success," the chairman of Volkswagon AG's Supervisory Board noted, "but our human resources."[2] Large employers such as Intel now request workers with tertiary degrees and contract with two-year colleges to offer associate degree programs inside their facilities.[3] Small employers trying to adopt new technologies, according to trade and employers' associations, are increasingly seeking workers with postcompulsory education.

All of the associated activities and services that are becoming increasingly common are due to special features of this set of institutions. Perhaps most important, economic development, long a silent partner of technical education, has become a core mission of the technical college. Colleges, which in many places have assumed some of the responsibility for attracting and expanding industry, have added to their plate the improvement and modernization of existing industries, large and small. Community colleges are particularly helpful to small and midsized enterprises (SMEs), since they are better positioned to reach them than universities, consultants, and service agencies, many of which prefer not to bother with "know-how" needs that may not be technologically challenging or of a scale that can be sufficiently profitable. In a 1995 survey of 100 U.S. colleges, 90 percent of the respondents referenced economic development or modernization services in their mission statement.[4]

The second feature is that the programs and services of technical colleges are intended for local and commuting students and nearby firms. In contrast, flagship research universities, which produce more scientific and technological innovations, are central to—and often indeed define—their local economies. But they are in effect a resource of state or national economic developers, widely disseminating their research products and knowledge. Community college faculty are encouraged to think globally but act locally. In

[1] Louis Richman, "The New Worker Elite," *Fortune*, Vol. 130, No. 4, August 22, 1994.

[2] Carl H. Hahn, *Süddeutsche Zeitung*, March 4, 1993.

[3] Stuart Rosenfeld, "College/Cluster Connections: Specialization and Competitiveness in Europe and the U.S.," Unpublished report, Community College Research Center, Teachers College, Columbia University, New York, December 1997.

[4] Stuart Rosenfeld, *New Technologies and New Skills: Two-Year Colleges at the Vanguard of Modernization* (Washington, DC: American Association of Community Colleges, 1995).

many regions, decentralized and applied community colleges are the leading source of technological expertise and know-how and the core of the regional knowledge infrastructure. Perhaps the most undervalued contribution of technical colleges to technology-based development is their nurturing of social capital through facilitating interaction and learning among people in different organizations. Faculty who are well-connected to industry become the purveyors of the "untraded transactions" that represent technology and knowledge transfer and diffusion. Proactive colleges organize business alliances that accelerate such learning and collaboration. It is this regional focus that presents these colleges with the opportunity for cluster specialization.

The third feature giving community colleges an advantage in supporting regional development is their flexibility compared to other educational institutions. In most states they are the youngest element of the state's educational system and have fewer ingrained traditions and a less rigid organizational structure, which may make them less resistant to change. This enables colleges with explicit economic development goals to respond to changes in local labor markets. In flexible systems, faculty are freer to participate in commercial activities and are likely (required in some countries) to have industrial experience and maintain industry contacts, and new programs can be introduced more easily and quickly and customized to local needs. Industrial technical committees and advisory boards are often involved in curriculum development, and industry may design final projects and exams and assess performance.

CLUSTERS AS ECONOMIC REALITIES

The special features of community colleges create opportunities to develop special expertise in those industries that are particularly important to their region, opportunities of rapidly increasing interest to agencies responsible for economic development. Firms the world over voluntarily cluster because they inherently understand the value of external economies and collective efficiencies.[5] It is no coincidence that furniture companies tend to locate near timber reserves, biotech firms near universities or federal labs with strong research programs, and metalworking firms near large original equipment manufacturers. Firms find it advantageous to be close to their suppliers, customers, services, and competitors. Close proximity stimulates webs of

[5] Edward J. Feser, "Enterprises, External Economies, and Economic Development," *Journal of Planning Literature*, Vol. 12, No.3, February 1998.

relationships that allow them to transact business more cheaply and easily, resolve their problems more quickly and efficiently, and learn sooner and more directly about innovative technologies and practices.

The most obvious manifestation of clustering is found in Europe's industrial districts and America's industry agglomerations, both of which have fascinated researchers and policy planners for much of this century.[6] Businesses can be found clustering in all sorts of regions (heavily populated areas, small cities, and rural areas) and around multiple core interests (technology, natural resources, labor market skills, markets, or products). Upholstered furniture in Tupelo, Mississippi, and High Point, North Carolina; hosiery in Hickory, North Carolina, and Castel Goffredo, Italy; carpets in Dalton, Georgia; electronics in Silicon Valley or Ayrshire, Scotland; ceramic tiles in Sassoulo, Italy; toys in Ibi and Onil, Spain; optics and imaging in Rochester, New York; seafood in Nelson, New Zealand; and automotive and machine tool industries in Stuttgart, Germany, and Detroit, Michigan—these are but a few examples.

The phenomena of clustering and economic interdependence, despite a recent surge of interest among some government agencies and private foundations, has been underrated by development practitioners, and its potential as a policy lever is only beginning to be appreciated. Economic developers typically view sector specialization as a danger to be avoided to safeguard against a regionwide economic collapse should the sector lose its advantage rather than as an economic advantage that encourages a systematic diversification of economies. Perhaps clusters have not attracted attention in policy circles because they are viewed as rare rather than common occurrences, as serendipitous results of historical accident rather than consequences of intentional policy or planned commercial activity. Yet the benefits that accrue to business are so fundamental to competitiveness that clustering is far more ordinary and frequent than exceptional and rare. Only recently have governments begun to take notice and consider demand-driven programs that are sector specific (albeit loosely defined to be as inclusive as possible). Many states and regions have analyzed industry location patterns and begun to shape modest (in terms of public investment) policies that take into account this clustering phenomenon.

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[6] See Edward Goodman and Julia Bamford (Eds.), *Small Firms and Industrial Districts in Italy*. (New York: Routledge, 1989) and Frank Pyke and Werner Sengenberger (Eds.), *Industrial Districts and Local Economic Regeneration* (Geneva: International Institute for Labour Studies, 1992).

RATIONALE FOR CONNECTING COLLEGES AND CLUSTERS

Why would a college choose to make specific industry-based choices in how it allocates its resources rather than take the less risky path of simply preparing for a broad range of economic opportunities? What benefits can the college, its students, and the region expect to realize by targeting clusters?

First, it provides an opportunity to ground education in a locally dominant industry and create a real-life context for learning that is likely to be relevant to the lives of many students. This ought to enhance the content and quality of education and training. Second, it encourages informal learning and skills that are not easily verbalized or codified, because students have closer contacts with the workplace and work force. Third, news of job or economic opportunities spreads quickly to students through faculty and social grapevines, and thus labor markets function more effectively. Fourth, colleges that choose to concentrate resources are more apt to become a true center of excellence with the expertise, knowledge, and technologies that are locally important.

How might a region benefit from a college that recognizes particular features and needs of its economy? If the skills and knowledge acquired by students and the services offered are grounded in the milieu and real problems of regional industries, businesses can realize increased productivity and reduced training costs. The special expertise and experience of the college also aids in attracting firms that fit into the cluster. Perhaps most important, industries get skilled labor pools and student workers that enable them to meet the aggregate employment needs of their businesses, access to skill upgrading, and timely information and technical assistance from the college's staff.

DEFINING THE CLUSTERS

The four industry clusters studied are furniture in the northern part of the Republic of Ireland and in northeastern Mississippi and electronics in southern Denmark and California's Silicon Valley. In each location, a community or technical college has forged a special relationship with the regional industry cluster and established itself as a key player within the cluster.

Ireland's furniture industry consists of about 600 companies that employ approximately 5,000 people. Of the four clusters, it is dispersed over the largest area, with some concentration in Counties Navan, Monaghan, and Dublin. Ireland's furniture industry lacks the interdependencies, social capital, flow of information and innovation, and sense of common purpose and vision that produces the synergy needed to meet typical benchmark measures associated

with dynamic clusters. Yet this cluster is important to Ireland and is earmarked for further development because it is indigenous, in contrast to the large number of foreign companies attracted to Ireland over the past decade.

The ten-county northeastern region of Mississippi has become the nation's foremost production center for midrange and promotional upholstered and motion furniture, (i.e., reclining sofas, love seats, and chairs). From its origins in a single manufacturer who wanted to apply mass production methods to furniture in 1948, the region now has 20,000 people producing furniture for mass marketing through retail chains such as WalMart, Sears, K-Mart, and Levitz. In addition to the 183 furniture manufacturers and 153 suppliers, an array of specialized services, including factor houses, trucking companies, and training programs, is housed in the region. Its competitive advantages are a sufficiently high concentration to attract many buyers and good quality pieces at low prices.

California's Silicon Valley is the nation's quintessential and widely acknowledged benchmark cluster. With scale, specialized expertise, experienced workers, social capital and networking, and entrepreneurial energy, it virtually defines the term cluster. Silicon Valley has 6,000 plus companies in a 50-mile corridor; a strong army of suppliers; capital equipment companies; and exporters. But the lifeblood of the industry is its social networking, which pervades business life in the community. Organizations such as Joint Venture: Silicon Valley have helped to institutionalize the regional synergy that has been achieved and to ensure a collective mechanism for meeting future challenges. Community colleges are important, but not highly prominent, because of the scale and scope of the cluster's technological infrastructure and the high visibility of the universities.

Denmark's electronics industry is quite specialized, focusing on rapidly changing subsectors, such as telecommunications, light, and acoustical equipment, where the nation's strong R&D and technology base can provide it with competitive advantages. The southern part of Jutland is home to more than thirty companies in the electronics sector and another dozen that are developing related software—all anchored by Danfoss, a homegrown success story. Since Denmark is an expensive place to do business, the cluster's advantages are its human resources—skills, knowledge, innovation, and entrepreneurship. The cluster has managed not just to survive, but also to thrive in this region because of its wits, accumulated wisdom, and innovations, and its growth depends heavily on strong educational institutions. (The defining characteristics of the four clusters are summarized in Table 1.)

Table 1:
Defining Characteristics of Clusters

Cluster	*Characteristics*
Furniture in Ireland	Lack of identity and low use of technology but the potential to be transformed into an entrepreneurial, competitive cluster
Furniture in Mississippi	Dependent on incremental production process improvements and design imitation rather than innovation
Electronics in California	Strong informal networking, high rates of information flow and new business startups, and self-identity as cluster
Electronics in Denmark	Competitiveness based on constant innovation and skills of work force, but somewhat dependent on one large employer

MAKING THE COLLEGE/CLUSTER CONNECTIONS

What led the colleges to specialize, build expertise, and link themselves to specific clusters? The nature of the clusters and local circumstances shaped the decisions. In Mississippi, the impetus for the intervention was supply side, an effort to accelerate the modernization of a low-tech industry and stave off the threat of foreign competition. But an added stimulus was the manufacturer of advanced technology for the industry, which contributed new equipment in order to demonstrate its value to local companies. Ireland's furniture college began as a rural development and youth employment strategy, but ultimately was justified as an industrial policy to revitalize the nation's stagnating furniture cluster. In the case of electronics, a more technology-driven cluster, the colleges' interventions were demand side and more education- and training-oriented responses to the rapidly changing needs of the clusters. Denmark's college focused on electronics to support the industry's growth, and the California colleges' programs were sparked by large companies that partnered with them to ensure a continuing stream of skilled workers.

THE COLLEGES AND THEIR SYSTEMS

Mississippi and California's educational systems are both part of a national enterprise that shares many features. Denmark and Ireland are representative of western European educational systems (primarily northern European).

Distinctions between the U.S. and Europe are displayed in Table 2. For example, compared to most U.S. systems, both Denmark and Ireland have better articulation with four-year engineering programs than most U.S. community colleges but place less emphasis on noncredit work force development. European colleges also serve a younger set of students who are more often full time. Most enter directly from secondary schools. U.S. community colleges have stronger work force development and continuing education missions than in Europe. Many U.S. students are returning adults re-entering the labor force, upgrading skills, or changing careers. That is in part because America's federal job retraining programs, such as the Jobs Training Partnership, fund rather than deliver training, and colleges must compete for funds in order to conduct training. In Europe, separate systems such as Denmark's AMUs and Ireland's FÁS deliver worker and adult training programs directly to adults and school leavers. In addition, in Europe credentials have greater validity and marketability among employers, perhaps because employers are more involved in the design and validation process and in the work-based portion of the curriculum. Therefore, European students are more likely to stay the course and

Table 2:
Generalized Contrasts between North American and Northern European Formal Technical Education Models*

In North America	*In Northern Europe*
Returning to school	Continuing from formal education
Part-time students, in work force	Full-time students
Most students over age 25	Most under age 25
Terminal	Articulated with higher education
Technology in school	Technology in workplace
Acquiring skills, exploring career options	Pursuing credentials
Credential has limited market value	Credentials recognized by employers
Large, comprehensive colleges	Smaller, specialized colleges
Inconsistent national standards**	Accepted national standards
Focus on improvement and the economy	Focus on design and creativity
Governed by trustees and educators	Governed by social partners

* These do not cover all systems in each area.

** Standards are being developed.

complete their programs, while larger proportions of U.S. students are either enrolled to acquire skills or explore career options.

The colleges in the clusters also have certain common characteristics regardless of their respective national systems. For example, each has the full support of its executive leadership. In each place, the cluster-based initiatives began as responses to industry—a demand, as in the case of electronics, or a need, as in the case of furniture. Each college focuses on advanced manufacturing processes that are transferable to other sectors but with the content oriented towards the problems and special needs of the local cluster.

The U.S. schools were also influenced by equipment manufacturers who viewed modernization as a way to introduce and build demand for their products. In Mississippi, the Gerben Company saw the college's program as an opportunity to demonstrate its automated fabric cutting and moving equipment to local companies, and in California, computer and semiconductor production equipment manufacturers donated goods for the same reasons. But despite the commercial goals of the companies, these links to the equipment makers greatly expand colleges' access to new technologies, which allows them to position themselves as modernizers within the cluster.

Most of the colleges view themselves as catalysts for modernization rather than as simply responding to needs. In Ireland, the college teamed up with a community-owned rural development center to respond to a study of the furniture industry by Danish consultants who concluded that the sector's future depended on modernization and improved design. And because its large furniture companies are not so advanced, students see more opportunity for change in the small young companies. In the U.S., need-driven programs tend to be slanted towards the larger companies, which are most likely to be able to use their higher skill levels, and not towards SMEs, which are slower to adopt new technology.

CLUSTER CUSTOMIZATION

The programs at EUC-Syd that most directly target the electronics industry are labeled electronics technicians, data mechanics, and automation technicians. They each concentrate on technical competencies but embed information about labor market and societal connections. Nontechnical aspects of production, such as inventory and total quality systems, which are taught in local commercial colleges, must be learned during work experience or class projects. Itawamba's curriculum, in contrast, covers a fuller scope of

manufacturing production-related skills, with less theory than Denmark's and more nontechnical content. One furniture manufacturing technology student said, "We learn to make anything work—make parts work, make mechanisms work, make a plant work [including plant layout and costing processes]....We learn to design a piece of furniture, then design the process to produce it, and then actually make it." Ireland's programs, like Denmark's, are technically rigorous and fully articulated with bachelors' degree requirements. Its curriculum is entrepreneurial, covering a broad range of craft, technical, and business industry operations, reflecting the self-employment goals of many students. California's electronics programs still carry the college transfer traditions of the school and include more liberal arts requirements. De Anza Community College responds to the needs of the industry through programs in manufacturing and design technology and computer information systems. Mission Community College serves the cluster with degree programs in semiconductor manufacturing technology, computer information systems, and design drafting/electronics plus computer/electronics, as well as with full associate degree programs for electronics technicians offered on-site at both Intel and National Semiconductor.

Workplace Transparency and Cluster Familiarity

In programs connected to clusters, students are generally either employed in the industry or in programs that have apprenticeships or co-op placements. This workplace experience results in (1) students with more intimate knowledge of the industry (and vice versa); (2) a greater scale of opportunities; (3) access for companies to low-cost labor; (4) tighter competition for workers, with companies that contract with students having an edge in hiring the graduates who have worked for them; and (5) companies viewing participation as a civic duty to the community.

Across all sites, about three in five students work while in school or have had previous work experience (see Table 3). In Denmark, all students are expected to acquire contracts with employers for the duration of their studies. Those who do not fulfill this expectation have shorter work contracts and are assigned to simulated work experiences in the school. In Ireland, 54 percent of the students already had previously worked in the furniture industry, all but one for very small firms. In Mississippi, ten of fifteen students have already worked or are now working in the furniture industry, all but one in companies with more than 250 employees. In California at De Anza, 48 percent of all students work in the electronics industry and about 25 percent in electronics-based

Table 3:
Percent of Students with Work Experience in Each Cluster, by Size of Firm

College	Students with Work Experience	Size of Firm <10	11-50	51-100	101-250	>250
California	60.9	5.3	8.8	22.8	12.3	50.9
Denmark	100	20.0	20.0	10.0	15.0	45.0
Mississippi	60.0	0.0	0.0	11.1	0.0	88.9
Ireland	62.7	65.6	25.0	0	6.3	3.1

biosciences. In the electronics programs at Mission, 67 percent of students are working or have worked in the industry.

In cluster-linked programs, significant proportions of students said they are "very familiar" with the industry, either because of family connections or through their own work experiences—29 percent in California, 20 percent in Denmark, 47 percent in Mississippi, and 14 percent in Ireland. The majority of the rest claimed some familiarity. Familial and social connections to the clusters are also important sources of knowledge. In Silicon Valley, 65 percent of the student/respondents have family members employed in the electronics industry, and at Itawamba Community College, 47 percent have family members employed in the furniture industry. A student's previous school was the most important source of familiarity in European schools, while employers are a more important source to students (many of whom are already in the work force) in California's colleges.

Customized Programs for Companies

Continuing education, evening short courses for firms in the cluster, is a major growth area in the four clusters—generating revenue, imparting new skills to the companies' employees who participate, and creating opportunities for networking and informal learning. In the U.S., customized training programs have become core elements of college programs, operating in parallel with credit programs and often funded by noneducational agencies such as those concerned with economic development. Many European countries that seek inward investment, including Ireland, now offer similar programs. The largest companies, which can afford to fill classes and pay costs, typically dominate

programs. Smaller firms, because they usually share classes with other SMEs, accept less customization.

Targeting Technology to the Cluster

In the U.S., community colleges are called upon to play a much more aggressive and proactive role in technology and economic development than European technical colleges. Itawamba's Advanced Furniture Technology Center is equipped mainly by the Gerber Corporation, which installed its latest equipment at the college for free and regularly upgrades it—with the understanding that the college will demonstrate it to potential customer-firms and conduct the training necessary for those that use it. De Anza's Center for Advanced Competitive Technologies originally set up computer-integrated manufacturing (CIM) cells to demonstrate and teach advanced methods to industry, but found too little demand among small and midsized enterprises (SMEs). Therefore, it eventually turned to what its SME customers wanted, which was workshops on topics such as environmental or quality requirements, customized training, needs assessments, technology transfer, and technical assistance. In Denmark, where technology diffusion programs have stronger traditions and more support, the college has less responsibility for being proactive in economic development and relies more on its students as technology transfer agents. Forbairt in Ireland and the Danish Technological Institute in Denmark have as their core missions "helping companies modernize." Thus, European colleges tend to act more as brokers than consultants, working hand in hand with other agencies that deliver technical services.

SIGNIFICANT OTHERS: PARTNERSHIPS, ALLIANCES, AND NETWORKS

Colleges that are effectively embedded in clusters inevitably form bonds with other organizations. They closely ally themselves with the businesses they serve and their trade and professional associations through college-managed advisory or trade councils, by participating in businesses' associations, or by jointly working on regional or community boards and organizations. Other types of cluster/college connections extend to the many local and state agencies that provide similar or related services to the same core cluster of companies. This enables the colleges to effectively function as service and technology brokers for small and midsized business enterprises, which are less likely to

have specialized departments or segmented needs and need coordinated approaches to business problems.

The cluster-focused programs are all characterized by significant employer and, in the case of Denmark, employee association involvement. In Denmark, goals and standards for education and training are set by the "social partners," government, business, and labor. All faculty members at EUC-Syd are required to have industry experience, and they constantly work directly with industry representatives to develop new courses to meet changing work requirements—which generally results in four or five new courses annually. Each of the colleges employs a mix of staff drawn from industry and education and uses local industry advisory boards that meet periodically to review and approve curricula and plans. Most have individual alliances with specific leading employers. Colleges receive equipment, support, and access to industry-specific knowledge, and businesses gain either employees who are more productive, or new sales if the partner is an equipment producer. Each college also has arrangements for its faculty to work in or consult with industry, which helps them remain up to date and helps industry ensure that the course content is relevant. Directors and key program staff regularly engage with local employers informally through professional and trade association or civic events, or by visiting companies that contract with or employ their students, or by responding to companies' calls for information.

College/cluster connections invariably involve strategic alliances with other agencies. Relationships with economic development agencies are the most common, since the quality and quantity of the work force are fundamental to their success. The U.S. and Irish colleges have industrial liaison officials who work closely with development offices in planning continuing education and customized training. To the extent that the recruited firms are tied to the cluster, this is a cluster strategy, but more often colleges are expected to respond to any potential business. The colleges also either link to technology deployment agencies or take on deployment as part of their own missions, particularly in areas where education and technology overlap, such as supporting the adoption of new quality, inventory, and management systems. U.S colleges are more likely to deliver technology services that complement education and training directly, European colleges to refer to other agencies. Irish colleges, for example, host many of the nation's new science and technology centers, with the latest, the Furniture Technology Center, co-located with the college at Letterfrack. A growing issue in the U.S. is that some technology deployment agencies are adding to their mission, creating

competitive tensions with technical colleges. Other relationships exist between colleges and programs managed by the Department or Ministry of Labor that fund or deliver prevocational training and retraining for special populations such as the disadvantaged and unemployed. In the U.S., these programs are often operated by the college.

GETTING TO THE HEART OF THE MATTER—THE STUDENTS

While the colleges studied are nestled comfortably in the industry clusters and derive much of their strength from these relationships, their highest priorities are the students who enroll in their programs and who, ultimately, represent the economic future of the cluster. They must be able to benefit from the industry connections. Most students are local, but the more specialized the program and the better the employment opportunities, the more likely it is to be known outside the region and attract students from afar. In Ireland, for example, almost 70 percent of its students come from outside of County Galway. Itawamba, however, draws almost entirely from its region of Mississippi. The Furniture College's broader appeal is its unique entrepreneurial and crafts approach to Ireland's industry, which attracts youth who want to learn, first, a craft not taught elsewhere and, secondarily, a manufacturing process. In Mississippi, although applications and equipment are specific to upholstered furniture production, they could be learned in other places in the context of other industries.

What draws students to a program? Students were asked in the survey to select the reasons that best represent their own impetus for enrolling in their programs. Personal interest ("matches interest") was more important to European students (67 and 88 percent in Denmark and Ireland, respectively), than to U.S. students (28 and 6 percent in California and Mississippi, respectively), suggesting a weaker economic and stronger personal motive in Europe. Supporting that view, both "employment opportunity" and "potential to advance" were more important to the U.S. students (63 percent in California and 94 percent in Mississippi, when combined).

What do the students intend to do immediately after completing their programs and longer term? European students, who generally come directly from compulsory education, are, on average, younger than U.S. students and more likely to look abroad for employment (about one in six). The older U.S. students are more likely to live in the region, have families and full-time jobs, and therefore seek local employment. The proportion of completers expecting

to go on to higher education ranges from one in seven in Denmark to one in four in California. Students in electronics programs, the more technical of the two industries, are less likely to want to become managers or entrepreneurs, possibly because the technical work has more potential to be fulfilling and economically rewarding than similar work in furniture. Survey results on immediate and long-term goals are displayed in Tables 4 and 5, respectively.

Ireland's furniture technology students are least likely to expect to remain in their region (3.6%), have the strongest desire to become immediate entrepreneurs (21.3%), and the second greatest inclination to go on to higher education (21.8%). Ultimately, nine in ten Irish students expect to become owners or managers.

Students in Silicon Valley are most likely to seek higher education degrees (24.8%) and most likely to expect to want local employment in this densest and largest of clusters (45.7%).

Table 4:
Immediate Postcompletion Expectations of Students

Goal	*California*	*Denmark*	*Ireland*	*Mississippi*
Local employment	45.7%	38.6%	3.6%	62.5%
Non-local employment	5.7	31.8	25.5	16.3
Job outside country/state	14.3	15.0	14.5	0.0
Own business	1.9*	n/a	21.3	n/a
Higher education	24.8	13.8	21.8	18.3
Travel/Other	2.4	1.0	16.4	0.0

* Only asked in one school and based on 63 respondents.

Table 5:
Long-Term Goals of Students

Goal	*California*	*Denmark*	*Ireland*	*Mississippi*
Advance as technician	61.8%	57.5%	10.3%	36.0%
Ownership	14.7	20.0	69.0	15.0
Management position	11.8	7.5	20.7	42.0
Enter different career	11.8	15.0	0.0	7.0

Danish students are most likely to look for employment in other parts of their country (31.8%) and, in the long term, want to advance within their technical field (57.5%) rather than management (7.5%).

Mississippi students are most likely to remain in their home region or home state (78.8%) but also the most likely to expect to enter management or own their firm (57%), which is what Itawamba's program prepares them to do.

What are the opportunities for students preparing for work in local key industries? At each site, students have economic opportunities, but regional situations shape perceptions differently.

In Ireland, students take more responsibility for creating their opportunities in the furniture industry. Their strength is their knowledge of design and modern management techniques, which are lacking in most Irish furniture companies.

In Mississippi, larger companies find that graduates of the programs, with their newly acquired knowledge of motion and time studies, inventory methods, computer-based equipment, and costing procedures, are able to fill positions formerly held by graduate engineers.

Students in Denmark are valued because of their technical abilities and experience acquired during their rotating 20-week workplace education terms. Many of the graduates accept positions in the companies in which they had their educational contracts, although a small number view this simply as a way to gain experience before establishing their own businesses.

Electronics technicians in California can pick from a wide range of employers, but most go to the largest companies first, which offer the highest salaries and most opportunities for advancement. But in this entrepreneurial culture with highly visible high-growth companies, many dream of landing a job in the next Intel or Microsoft.

BRINGING ADVANTAGES TO THE STUDENTS

Evidence from interviews of employers and educators suggests certain advantages from being tightly connected to a cluster. Job offers at high wages relative to the region and other programs are plentiful in each location, and the

close ties between faculty and employers and informal labor market information networks make traditional college placement services superfluous. With education tailored to the work of the industries and students well prepared for the jobs in the industries, employers interviewed expressed high levels of satisfaction with graduates. Their concerns were over quantity, not quality.

At the U.S. sites, a strong economy actually inhibits both enrollment and completion. Labor shortages, particularly in Silicon Valley, lead employers to hire students before they finish. Large companies encourage new hires to continue with their education and even reimburse them for the costs, but many SME employers entice promising students into jobs as soon as they acquire the minimal critical skills needed. Europe also faces labor shortages, but in Europe postsecondary, prebaccalaureate credentials have greater acceptance by industry than in the U.S. European colleges place a greater emphasis on the final skills certification process, which keeps students in school until they graduate. The main reasons for dropping out of programs at the U.S. sites, where entrants are older, is that students lack seriousness about their career paths or that they get the jobs they want; in Europe, where enrollment is generally a continuation of a youth's educational process, it is often poor academic performance.

One of the hypothesized advantages of college/cluster connections was that students gain a solid understanding of the industry as part of their educational process. California electronics students' responses indicated the highest level of knowledge, most likely because most students in Silicon Valley have worked or are working full time in the industry. But more European students believe they have a good understanding than students in Mississippi, which may be attributable to heavier emphasis on workplace education.

In Mississippi, demand for skilled technicians depends largely on the rate at which industry adopts new technologies. Currently, only the largest companies are adopting new technologies at a high rate. Graduates have employment opportunities outside of the cluster because their skills and knowledge about manufacturing processes are transferable to many other sectors facing skill shortages. Therefore, if local companies fail to create opportunities, the cluster may lose some of its best and brightest technicians and future owners.

In Ireland, students are forced to create demand for their skills, since so few firms are ready for their talents. This leaves them three choices: (1) leave Ireland to work, (2) convince a company to accept their help in modernizing (supported by the new technology center at Letterfrack), or (3) start their own company. Fifteen graduates have already taken the third option and started

companies—a few quite successfully. The first option would rob the nation of the new resources.

In California's electronics cluster, students operate in a sellers' market for skills. In this explosive economy, employers compete and recruit from each other to obtain qualified and experienced workers. Most students in electronics or computer systems programs have a wide choice of jobs. The obvious wealth in the region creates high expectations, and employers are challenged to meet them and retain their work force in a cluster characterized by highly fluid labor markets, job mobility, and little tradition of firm loyalty.

Danish students are wary of the cluster's future, in part because of its dependency on a large employer. There is still a sufficient demand—outpacing current supply—but students are watching the market carefully.

...AND TO THE CLUSTERS

Based on evidence from the four locations, what advantages have the colleges brought to the cluster? To weigh the advantages, we must make distinctions between the two clusters of the more mature furniture industries and the two of the higher growth electronics industries and between urban and rural locations. In all, a skilled work force was important. Business leaders and economic development officials alike were quick to acknowledge the importance of having a sizable pool of workers skilled in and knowledgeable about the specific cluster. Although executives may publicly express desire for employees with basic skills and an ability to learn, shop managers still prefer to hire those with industry-relevant experience. At colleges linked to clusters, faculty relationships to businesses help ensure that curricula are relevant and that new work force entrants will be well prepared.

Second, community colleges also are major sources of management training and technical assistance for smaller companies that are less able to afford the numerous consultants in the area. This is more prevalent in less urbanized areas that have fewer alternative sources of such expertise, but also within the faster growth electronics firms that are more likely to invest in such services.

Third, colleges add advantage by contributing to the region's social infrastructure through continuing education, industry seminars, and other events which provide safe havens in which businesses can mingle freely, get to know each other, build trust, and learn from one another.

Fourth, colleges are storehouses and disseminators of information about technologies, benchmark practices, market opportunities, and technical advisors for the clusters, particularly for SMEs that have limited internal capacity. This is more true of the furniture industry, whose member firms are on average older, more traditional, and slower to innovate. The new Furniture Technology Center at Letterfrack and the Advanced Furniture Technology Center at Itawamba are intended to help SMEs learn about the latest industry developments.

Fifth, well-prepared students can become catalysts for change within an industry—if given the opportunity by their employers. This is particularly true in the more traditional furniture industry. Each cluster draws both common and unique advantages from its community college, depending on what it needs, whether other entities are available to meet the needs of firms in the cluster, and public policy.

...AND TO THEIR REGIONAL ECONOMIES

The impacts of cluster/college connections on their respective regions take three forms (see Table 6). First and foremost, the colleges contribute to the synergy of the economy. As a result of the mobility of their graduates and their contributions to the flow of information among firms, the impact of the college on the regional economy is greater than the sum of its individual impacts on its customers. Second, the school as an institution is a major local employer, source of revenue, and community and cultural center. The smaller the community, the more visible is the institution and the more important is its contribution to the economy. Third, the college is marketed in industrial

Table 6:
Major Benefits to Host Regions

College	*Benefits*
EUC-Syd	Highly skilled labor force key to growth and retention Magnet for and locus of recreational cultural activities
De Anza and Mission Community Colleges	Work force development and retraining Industrial retention
Galway-Mayo Technical College at Letterfrack	College is a significant employer and source of local wealth Caused improvements in infrastructure to accommodate students
Itawamba Community College	Source of information about technology Industrial recruitment value Catalyst for modernization, aggregate impacts on industry

recruitment and is often an important consideration for businesses choosing among alternative locations. Colleges are particularly important to businesses that match those within the cluster and therefore can benefit from the expertise of the college.

CLUSTER CHALLENGES

None of the cluster successes has come easily, and each has challenges to overcome, many of which exist or are emerging at one or more of the other sites:

spiraling downward trend in Denmark's technical education caused in large part by parents encouraging their children onto academic tracks, resulting in lower enrollments in technical programs and lower ability students applying for those programs (also noted in California).

in the U.S., balancing the needs of employers in the cluster with those of their students in ways that benefit both, reconciling the needs of individuals with those of businesses. Colleges well-integrated into clusters benefit both. Denmark gives business more responsibility and authority than U.S. programs, but collectively, through their associations, not individually, thereby avoiding hints of favoritism.

high employee turnover rates, a side effect of good labor market information through which workers learn quickly about promising opportunities elsewhere. Some clustered companies accelerate this by "poaching," or encouraging workers to switch jobs.

the cyclical nature of high-tech industries, with industries seeking out lower cost regions for production as they mature, forcing a region to continually modernize its production capabilities and reinvent itself. Colleges must not just keep up with these changes but have the vision to foresee the new skills and knowledge that will be required, so that the work force will have flexibility and adaptability.

competitive advantages to customers vis-à-vis other agencies and private trainers that are hampered by FTE-based funding requirements and institutional culture, which restrict quick and full responsiveness to special industry work force development needs.

enabling small and midsized companies to employ and profitably use the skilled graduates, which may require SMEs to become more proactive in organizing the industry.

in Mississippi, keeping the industry competitive in the face of labor shortages by encouraging greater use of advanced machinery and production methods, more youth to pursue technical employment opportunities in the industry, and companies to find methods to reward and involve workers in ways that build loyalty.

SUMMARY OF STRENGTHS AND WEAKNESSES

While each of the college/cluster connections studied has achieved measurable successes and impacts, each has its own particular strengths and weaknesses from the perspectives of both the companies that comprise the cluster and the students looking to the cluster for employment and economic opportunity. These strengths and weaknesses are not all under the control of the program managers; many reflect external market conditions, state policy, and resources (see Table 7).

EUC-Syd's strengths, for example, are the quality of its technical school and workplace-based programs targeted to the cluster, the cluster-based experience of the staff, and its connections to industry. The weaknesses are a function of the academic segmentation within the system itself and demographic factors. Galway-Mayo Institute of Technology's highly regarded furniture program in Letterfrack has, in a short time, built strong community and government support. Its potential shortcomings are related to the weaknesses in the cluster itself and the remoteness of its location. California's programs have scale, industry resources, and support, but lack good connections to SMEs, despite the efforts of its technology centers to reach out to them. A barrier to greater flexibility and closer ties to industry is the staff, many of whom are career educators rather than industry experts. Itawamba Community College has the leading advanced technology center for this industry in the U.S., has established good relationships with industry, and is considered a major draw by economic developers; but it has not adequately marketed itself to young people and has not yet managed to reach the smaller firms.

Table 7:
Strengths and Weaknesses of Programs

College	*Strengths*	*Weaknesses*
Denmark EUC-Syd	Rigorous technical education Student work contracts Faculty industry experience Potential for students to continue	Limited scope of program beyond technical skills Difficulty attracting students
Ireland Galway-Mayo Institute of Technology	Creativity and entrepreneurship High demand Community development support Potential of technology center	Scale of program Limited links to industry Students' desire to leave area
California De Anza and Mission Community Colleges	Scale of investment Computer access Industry support Modernization services	Dominance by industry giants Large number of competitors offering education & training Faculty resistance to change Insufficient enrollments
Mississippi Itawamba Community College	Advanced technology center Transferability to other manufacturing Large firm support Economic development partnerships	Marketing of program and low enrollments Inability to reach SMEs Confusion with Job Training Partnership Act programs

REVIEWING THE CONNECTIONS

College/cluster connections can enhance the competitive advantages of clusters and improve opportunities for individuals through more effective acquisition of codified and tacit knowledge and more efficient labor markets and economic development.

The codified knowledge imparted through a formal educational process that is grounded in a workplace context reflecting the specialized nature of the industry appears to enhance learning. It brings real business situations into the classroom and gives students the chance to apply the theory they learn in school to problems that they may face on the job, which, according to employers, significantly adds to their value. According to students interviewed, it also enhances their own learning.

Tacit knowledge is acquired through work experiences and exposure to other workers while in school and through team projects and social circles that

include other students. The specialized environments that draw students into group social situations and the exchanges among employees from different companies in evening courses both stimulate informal learning.

Labor markets work exceedingly well in clusters, and as a result, college placement offices are rarely used by students. Most learn about available jobs from their teachers, part-time employers, other students, or friends. One unintended consequence of better information in the U.S., however, is that students are tempted out of their programs into jobs before completion. Since employment is a more common goal of U.S. students than an associate degree, completion is less important.

The effects on regional economies are through work force development, direct employment, and contribution to recruitment. Within a cluster, according to local employers, a well-prepared labor pool produced by the schools is the leading locational advantage. Other services offered by the schools reach and affect smaller numbers of businesses over time and fill important niches, but the full economic impact on smaller employers is less obvious to development agencies seeking immediate large-scale outcomes. Colleges are themselves large employers. And as an incentive for inward investment, industry cluster connections add value if the region targets the cluster. Thus, college/cluster connections in the four places studied influence curricula, attract resources, and benefit the clusters.

POLICIES TO ENCOURAGE COMMUNITY COLLEGE/CLUSTER CONNECTIONS

A number of states and European nations already have policies that encourage or, in a few instances, require various forms of industry specialization. In the United States, Alabama, California, and South Carolina and, in Europe, Denmark have policies or plans for targeting resources for clusters. But for the most part, specialization has resulted from local initiatives that occur reactively in response to concentrated demands or proactively in order to nudge certain industries ahead technologically. It is important to reiterate that the specialization linked to the industry clusters studied occurred within the context of a very broad set of programs in strong colleges. Narrowly focused efforts rarely dominate the curriculum or programs, and colleges still serve a wide range of individual and industry needs. But for a defined set of industries, targeting allows a college to develop special strengths above and beyond what

other programs at the college can offer other industries and what most other colleges can offer to businesses similar to those in the targeted cluster.

Industry specialization implies some degree of concentrating resources and focusing attention on the skills and knowledge that are clearly related to clusters of similar businesses rather than clusters of just occupations. But this is difficult for most colleges. First, since the core funding of most community colleges is tied to full-time equivalent enrollments that reflect student choices not local needs—which may not be currently popular among youth—the college may not be able to reach the critical mass needed to develop or acquire the expertise and technology needed by a set of regional industries. Students may not be making choices for careers that are regionally based, and industries may not have sufficient demand to justify special programs—particularly in less populated areas. The other barrier to specialization is support for the liberal aims of education as the unfolding of the individual's mind and the belief that this is undermined when unduly influenced by private interests. What can college governing systems do to create alternative funding sources for programs that strengthen economies and to bridge the gap between economic and social goals, thus making it easier for colleges to select a niche and address cluster needs?

To begin, the state system can analyze the industrial composition of its regional economies and examine existing strengths of the colleges to determine which clusters may require and which could benefit from special attention, what types of skills they will require, and which colleges might best serve those industries. Alternatively, they can ask each college, as part of its regular planning process, to analyze its own regional economy and determine whether specialization is warranted.

The system can allow and even offer incentives to colleges for establishing semi-autonomous centers and for employing faculty from industry, and it can reward faculty for relationships with industry and consulting as well as teaching.

The state can make it easier to justify new programs—allowing more flexibility in enrollment levels and completion rates—that take into account the dynamic nature or strategic importance of the cluster. It can also allow greater flexibility in faculty requirements and compensation in order to attract staff with experience.

It can expand the definition of "all aspects of the industry" to "all aspects of a cluster" and base it more on acquired knowledge of the cluster through a

variety of exposures and work-based experiences and less on completing units in general economics.

The state system might provide greater support for programs and services that can demonstrate industry involvement, interest, and matching resources. Developing cluster connections requires public and private resources as well as close relationships with industry, and college administrators ought to be encouraged and rewarded for building such linkages.

Finally, colleges can work more closely with high schools to attract students into the programs by helping to acquaint them with the industries as they operate today and not as they have in the past. This will give students a better appreciation of the range of opportunities industries offer and help them to understand the different kinds of skills they would use.

INDIVIDUAL CASE STUDIES

Galway-Mayo Institute of Technology and the Furniture College at Letterfrack
Industry Competitiveness, Rural Development, and Youth Opportunity

EUC-Syd Technical College
Skills to Grow the Electronics Industry

Wired to the Electronics Cluster
Two Community Colleges in Silicon Valley

Mississippi's Itawamba Community College
Bringing Technology to the Upholstered Furniture Industry

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