ATE Regional Centers:
CCRC Final Report

Monica Reid
Jim Jacobs
Analía Ivanier
Vanessa Smith Morest

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Community College Research Center
Teachers College, Columbia University

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EXECUTIVE SUMMARY

Background and Study Design

The purpose of this research study was to determine the role of regional centers in the Advanced Technical Education (ATE) program of the National Science Foundation (NSF). Conducted by the Community College Research Center (CCRC), the researchers began by asking whether the concept of a regional center was unique and useful to NSF's goals of increasing both the number and the quality of science, technology, engineering, and mathematics (STEM) workers. We asked questions about the following: (a) the quantity and quality of the students, (b) the changes in structure and organization of the participating community colleges, (c) the capacity of the "system" of technical education, and (d) the conceptualization of sustainability within the regional centers. In the end, the report presented here documents the unique role of the regional center as well as suggests areas to pursue.

The regional centers differ from other ATE programs in their focus on manufacturing or information technology, their focus on a "logically defined region," and their challenge to meet ATE's goals through academic program reform. Our research indicates that the regional focus on the centers is an important one, and that it plays out differently at each center because the regions differ in size, heterogeneity of labor markets, and economy.

Our study's sample comprised eight sites that were initially funded as regional centers between 2001 and 2003. Between February 2004 and March 2005, a team of CCRC researchers conducted field visits at each center for the first phase of the project. Research for the second phase was conducted between December 2005 and August 2006. During this period a team of CCRC researchers conducted a total of 65 telephone interviews with faculty affiliated with the partnering community colleges, business contacts working with each center, and the principal investigators themselves.

Regional Center Goals and Activities

Our site visits and follow-up interviews with participants at eight sample centers indicate that the ATE regional center is a valid concept for meeting a particular need for institutional innovation and change within a given geographical area. Despite differences in the parameters of "region," virtually all the centers had a defined concept of place and the institutions to be served. It was different from the mission of the ATE national centers or individual project. In addition, as opposed to emphasizing new curriculum materials and national staff development seminars and/or technical support services, as do the national centers, the regional centers appeared to concentrate their staff development and introduction of new programs within their self-defined area. In that way, they were far more focused on specific institutional change than their national counterparts. That is not to say that a few centers that we studied did not have a national impact, rather that they we able to have a greater local impact than most national centers. Frequently staffs were integrated into the institutions where they were housed, yet many of the centers were independent enough to play a local/regional role in economic and workforce development

strategies. In this regard, regional centers are distinct and useful to both the ATE program and the community colleges.

In our conception of the *workforce expansion* and *program development* foci of the academic program reform, we saw differences in the impacts by quantity and quality of students. The workforce expansion focus undoubtedly has the widest impact, by providing training to large numbers of faculty who in turn could teach courses and content to students that would otherwise not have been available. Feedback from faculty involved in the program development approach suggests that this structure had a less widespread impact, but that those students who were reached were impacted in significant ways: they were able to attain an associate degree and a well-paying job with future opportunities. Our conception of these two approaches represent two extremes, and in fact most centers were engaged in each activity to some extent. Nevertheless, this issue of breadth and depth compels our suggestion that NSF should encourage the deliberate and simultaneous pursuit of workforce expansion and program development by the ATE regional centers. It is only in doing both that the centers can have the kind of widespread substantive impact on the technical workforce that the program hopes to achieve.

The role that the ATE regional centers play in building and maintaining strong connections to industry is critical for meeting the centers' goal of workforce development. Without these connections, they would be unable to respond to local industry's needs or create job opportunities for their students. Thus, we highlight the role of industry on the regional center advisory boards and propose that the centers are acting as *workforce intermediaries*.

While the ATE regional centers emerged to meet the specific needs of the ATE program leadership for a new organizational form to undertake the mission of the program, they resemble workforce intermediaries in form and mission by serving as brokers between employers and community colleges. As such, they can benefit from existing research on workforce intermediaries by using it to inform the development of the concept to support the sustainability of such organizations.

A number of the centers we studied displayed multiple relationships with local industry. It must be noted that such relationships were cultivated and developed through extensive efforts on the part of the principal investigators (PIs) and some advisory board members. Thus, centers should be aware of the attention they need to pay to developing such relationships. In addition, we saw a range of activities that centers need their industry partners to engage in. First, they need partners who are willing to be active participants in their center's advisory boards by providing substantial input on the direction of their industry, their hiring needs and forecasts, skill requirements, and curriculum development. There should also be a group of advisory board members and others who provide substantive assistance by offering internships at their businesses for students, enabling faculty to visit in order to better understand the skills their students need upon graduation, and hiring the center's graduates. Therefore, advisory board should be made up of a mixture of employers (including for-profit companies, not-for-profit organizations and government groups – large and small, local, national and international). The unifying characteristic should be a presence in the region and, thus, influence on the region. While we saw excellent examples of such partnerships, it would be appropriate to make this approach to industry explicit.

Finally, we identified a series of factors that contribute to *sustainability*, another key area of our research, investigating whether NSF's notion of sustainability needs to be reconsidered. We asked, for example, whether the goal of a regional center should be sustainability, especially if its priorities change, and if the labor market or the population of students on which it focuses changes. Further, if sustainability is to continue to be a priority for the centers and for NSF, then a more explicit emphasis should be placed on developing plans for it from the onset so that the center can adjust to changes.

<center>**The Regional Centers and Workforce Development**</center>

We now situate the ATE regional centers within the larger context of reform in the American educational system and workforce development. In doing so, we propose areas for further study and new ways to understand the unique role of these centers.

One of the major reasons for the development of the regional centers was to support the goal of the community colleges to respond to their local economic development base. In some cases, such as the Center for Nanofabrication Manufacturing Education (CNME) and the Kentucky Information Technology Center (KIT), the projects utilized state grant funds to create the center. In other instances, such as Boston area Advanced Technological Education Connections (BATEC), the approach was more local: how would this regional center develop the specific information technology skills needed in Boston and its surrounding area. While in the past this motivation may have resulted in the development of short-term, often non-credit "training programs," more recently the tendency has been to offer for-credit programs leading to a degree and, many times, toward a four-year degree. Further, part of these programs combined foundation mathematics and science skills with the specific technical skills of the industry.

An important concern for the future development of ATE regional centers is whether they will provide a new opportunity for NSF to serve as a federal complement to regional, state, and local economic development and workforce development efforts. The centers could strengthen the ATE program in many ways. First, a center's partnership with state workforce agencies would bring more local credibility to the ATE efforts and, probably, aid in bringing more private sector and other partner educational institutions into their initiatives. It would make the regional center connect with the local labor markets in a more systematic way. Second, a relationship to the local workforce or economic development agencies might result in some additional resources from these entities for the regional center. Such a relationship would contribute to a center's becoming more embedded in the local labor market and increase the likelihood that real career pathways would be successfully established by the regional centers for students in these programs.

The partnership would also have significant benefits for state and local workforce development agencies. First, the participation of an ATE regional center would help create a much needed corrective to the agencies' short-term "work first" mentality which often takes precedent in its activities. Such a mentality results in an agency's securing for clients dead-end low-paying jobs but failing to increase clients' skill sets or job-related credentials, thereby leaving clients in poverty. The NSF emphasis on STEM and the creative linking of foundation skills to long-term

occupational growth would aid in the development of long-term sustainable training programs; they would not only promote individuals' continued attendance in college but could lead to sustainable careers. Second, the NSF emphasis on increasing the number of minorities and women in technologies work would reinforce the efforts of workforce development agencies to ensure universal economic opportunity. Third, the credibility of ATE program involvement with this constituency would be extremely beneficial for obtaining employer interest in hiring individuals from these programs.

There are some important factors to consider in the pursuit of these partnerships. First, many of the workforce development and economic development agencies emphasize short-term training and tend to respond to the immediate concerns of the local political establishment. Since community colleges are really products of the state, they perhaps would be more responsive to the demands of local agencies than to NSF, and there is a danger that regional and national centers might move away from their main mission to become appendages to the local workforce efforts. Second, the programmatic resources of the local agencies could overwhelm the ATE centers and make it difficult for them to achieve their mission of innovation. Therefore, the initiatives need to be undertaken with some caution and should focus on emerging and new technology within the information technology and manufacturing sectors. Third, the emphasis of the workforce agency on the workplace and the need to meet employer demands might shift the focus of local activities away from the ATE concern with student success and program innovation, making it difficult for the NSF programs to meet their objectives.

These factors pose significant challenges for the regional centers. However, through careful planning and development, projects developed by a regional center could be easily disseminated and supported through statewide contacts throughout the state. Therefore, in future grant application instructions, the NSF leadership of ATE might want to encourage partnerships with existing state and local workforce development initiatives, and perhaps launch some pilot sites. At a minimum, there needs to be more appreciation by the state workforce agencies of the significance of the ATE programs to their own work, and steps could be taken to begin that process with organizations such as the National Governors Association and the National Association of Workforce Development Boards.

The Regional Centers and Community College Reform

The second area of potential linkage for ATE regional centers is with the newly emerging community college reform activities which private foundations are sponsoring. These activities share with ATE the goal of internal community college reform to promote greater student success. While NSF's goal was to increase the number of STEM technicians for the workforce, the ATE projects – and the regional centers in particular – were faced with a number of specific challenges related to the way that the colleges function internally. Over the years, through rich experiences, the foundation-supported initiatives are increasing general reform efforts within the institution.

Further, in the past five years private foundations have shown considerable interest in the development of community colleges as new gateways to opportunity for low-income students

and adults. The Ford Foundation's Bridges to Opportunity initiative in 2002 and Lumina Foundation's Achieving the Dream initiative represent two dramatic new commitments by major foundations to improve community colleges' efforts to serve new populations of students. In addition, the Jack Kent Cooke Foundation is developing a program which links community colleges with four-year selective colleges and universities. The Hewlett Foundation is supporting efforts to reform career and technical education at the postsecondary 1evel in California. The Gates Foundation has targeted efforts to develop high schools on community college campuses. The Charles Stewart Mott Foundation supports a community college initiative linking adult basic education to credit technical training programs to gain sustainable jobs for working adults. Not only are these individual efforts by many foundations impressive, but the foundations have made a concerted effort to co-ordinate their initiatives through a community college funding consortium that meets regularly to discuss ways to develop a more responsive community college system.

These foundation initiatives have begun to systematically alter some of the operating principles of the community colleges. While their specific activities differ from those of the ATE regional centers, many have similar goals. Both stress the completion of credit degree programs. Both are directed at encouraging individuals to obtain an advanced degree and to transfer from community college to a four-year institution. While many of the foundation programs now deal with the process within the colleges, they often lack the substantive contact that the ATE centers have. For many colleges, success for low-income students will not be the completion of any degree at all, but the completion of a degree in a science and technology field that will guarantee jobs with greater sustainability. Therefore, the regional centers can, as appropriate, help refine the goals of the initiatives of private foundations.

It would be useful for NSF leaders to explore how the ATE regional center program and the centers themselves can aid in the development of foundation-created programs. Unlike the activities with workforce development agencies, these foundation initiatives are far more modestly funded, making it unlikely that the goals of the ATE project will be subsumed or overwhelmed. Indeed, the focus on content and student substantive knowledge is a nice complement to many of the foundation projects which concentrate on process reform issues.

Recommendations

In the end, the ATE regional center is a valid concept that meets a need for institutional innovation and change tied to a particular geographical area. Given our conception of centers as workforce intermediaries, we propose two areas that the regional centers should develop in order to increase their impact and improve their chances of sustainability. First, the centers should be tied to state regional economic and workforce development strategies. Second, they should be involved in broader issues of community college focus and integration with other community college initiatives and reform efforts. By maintaining these connections, the regional centers will provide a new opportunity for NSF as a federal complement to the regional, state, and local community economic development and workforce development efforts; and, also, to local reform efforts sponsored by private foundations. The ATE program has in place the structures to

systematically support the integration of all these efforts at a regional level to bring about substantive change in the educational and professional success of students.

INTRODUCTION

Since 1994, the National Science Foundation's (NSF) Advanced Technological Education (ATE) program has had the primary goal of improving the education of the nation's science, technology, engineering, and mathematics (STEM) technicians. ATE seeks to do this by focusing on two-year colleges and expecting them to take the lead on the activities funded by the program. Public two-year colleges are particularly well positioned to prepare mid-skilled technicians for several reasons. First, they represent a large educational sector, enrolling nearly half of all postsecondary students. Second, community colleges are multi-mission institutions; they are oriented both towards four-year transfer and preparing students in specific occupational areas. Third, community colleges enroll many of the nation's adult students who seek training or retraining for jobs in the new economy. Finally, many community colleges explicitly seek to maintain strong connections to local economies. This final point is particularly relevant to the focus of this study on regional centers.

ATE and the Regional Center Concept

The Centers

The ATE program consists of three tracks: ATE projects, ATE centers, and articulation partnerships. Within the center track, there are national centers of excellence, regional centers, and resource centers. The research described in this report focuses on the regional centers, the first of which were funded in 2001 (see Table 1). One of the goals of this study is to provide feedback to the National Science Foundation and to the centers themselves on the implementation of this newly-created program. Our research sought to understand the effect of these regional centers on the goals of the ATE program and on the structure and organization of the participating community colleges. In effect, we sought to understand whether the new regional centers fulfilled a new function for ATE program.

Table 1:
Participating ATE Regional Centers

Center	Service Region	Technology Focus
The California Regional Consortium for Engineering Advances in Technological Education (CREATE)	California (Statewide)	Engineering Technology
Boston Area Advanced Technological Education Connections (BATEC)	Boston, Massachusetts (Citywide)	Information Technology
The Midwest Center for Information Technology (MCIT)	Iowa, Nebraska, North & South Dakota (Multiple States)	Information Technology
Center for Nanofabrication Manufacturing Education (CNME)	Pennsylvania (Statewide)	Manufacturing Technology
Information Technology Education Center (ITEC)	Florida (Cities)	Information Technology
Kentucky Information Technology Center (KIT)	Kentucky (Statewide)	Information Technology
Center for Information Technology Education (CITE)	Nashville, Tennessee (Citywide)	Information Technology
South Carolina Advanced Technological Education Center of Excellence (SCATE)	South Carolina (Area within State)	Manufacturing Technology

The regional centers are distinct from other programs in several important ways. First, when they began, the centers were required to deal with a particular field of technology: manufacturing or information technology. Second, they must work in a "logically defined region" (RFP 2005, p. 9). Each regional center, therefore, is responding to specific needs of a particular industry in a particular region. Within its region, the center works to coordinate multiple levels of the educational system with local business and community leaders, thereby strengthening the connections among disparate components of the technical education system. Third, the focus of the regional centers is on reforming academic programs, departments, and systems to meet ATE's goals as they pertain to a given region. This focus is in contrast with the original national center concept which was to create entities responsible for serving a national market instead of a region. This set of distinguishing features constructs ATE regional centers uniquely as

organizations functioning as "workforce intermediaries." Preliminary research on such workforce intermediaries suggests that this is a powerful organizational type for NSF to promote. We will discuss this concept in greater detail later in the report.

In order to encourage structural changes promoting workforce development, the RFP for the regional centers emphasized three components: academic program reform, professional development of college faculty, and capacity building, stating that "these [regional] centers are expected to focus mainly on reforming academic programs, departments, and systems to produce highly qualified workers" (RFP 2005, p. 10). This explicit focus on the institutional level differs from ATE national centers, which incorporate curriculum development and nationwide dissemination into their goals. The focus also differs from the ATE project track in that the regional centers are involved in a broader scope of activities and their work is replicated in multiple institutions within the defined region.

The CCRC Study of the Regional Centers

Description of the Study

Within the ATE program, the regional centers have very specific workforce development goals: to increase the quantity of technicians and improve employer satisfaction with those technicians. This study began by looking at the ATE regional center and considering whether it is a unique and useful tool in workforce development efforts. Specifically, this study, conducted by the Community College Research Center (CCRC), investigated eight regional centers that varied by geography, longevity, and technology focus. Our overarching research question concerned the effectiveness of the ATE regional center concept in achieving the goals established by NSF. In particular, because the regional centers were a new creation, we sought to understand whether they play a unique role in comparison with the existing national centers and projects. We began our study with a basic question of regional center scope and how effectively the centers have increased the number of technicians in their region. We then followed with a series of questions designed to understand a regional center's impact on curricula; the organizational location of the programs; the relationships between community colleges, four-year colleges, and high schools; and the relationship with industry. Finally, we asked about how the regional centers conceptualize sustainability and how they planned to achieve it. The conception of sustainability as understood by NSF was in the development of a self-sustaining relationship between the community colleges and industry. This is a different understanding of sustainability than as it was conceived of by us and the centers: sustainability as an issue of the viability of the center and its work, and not specific to the relationship between the colleges and industry. In some cases the two understandings overlap, but that is not always the case.

Following this introduction, we next discuss the study's methodology. Then we examine how the centers have approached reform in support of workforce development. We borrow the tripartite framework of ATE Center goals as laid out by NSF, and discuss our research and findings with respect to the following: (a) the context of each center, including its relationship to its region and the specific technology area on which it focuses; (b) the way that the centers have pursued

academic program reform; (c) their relationship with other educational sectors and industry and (d) evidence of sustainability. Finally, in our conclusion we return to two fundamental concepts: state regional economic development and workforce development strategies. We consider the role of these federally-funded regional centers in regional, state, and local economic and workforce development efforts and possible partnerships with other funding sources, such as foundations. Our research suggests that the regional centers do indeed have a unique role to play in the ATE program as a new form of workforce intermediary, stemming more from their regional focus than from their technology focus, and that this role must be carefully attended to. Our findings have implications for future regional centers and community colleges in general as well as for research on workforce development and the role of workforce intermediaries.

Limitations of the Study

While our findings have emerged from cross-case comparisons, it should be noted that the local contexts surrounding the creation and operation of these eight centers are quite distinct. Significant differences include these: (a) the basis for defining the regional scope of the center's efforts, (b) the economic landscape of each region, (c) the structure and politics of each region's system of higher education, and (d) the organizational composition of the center itself. Furthermore, the work that each center has accomplished is directly related to the time frame of its development. BATEC and MCIT have the shortest funding histories, complicating comparisons of their efforts to the work undertaken at the more established centers.

Consequently, the cross-case comparisons clarify how the work of each center is shaped by certain environmental conditions, and how the strengths of each center have emerged in interaction with its regional context. While a common set of issues emerges across the eight sites, each center's approach is shaped by unique constellation of external conditions. This means that it was not always possible to compare all eight centers across each topic of investigation.

Another limitation was the accessibility of the centers' business partners. Given the critical nature of their substantive participation in the centers, and the demands placed on them by the centers themselves, as well as by affiliated work such as the center evaluations, principal investigators (PIs) were duly cautious of overtaxing their center's business and industry partners. As a result, we sought to speak to two to four business contacts at each center. We believe that the outcomes of our business interviews, supported by our attendance at center advisory board meetings, do give a fairly accurate picture of the role and perception of industry. Nonetheless, we do not have a representative sample of business partners.

METHODOLOGY

The purpose of the CCRC study was to determine the role of the regional centers in NSF's efforts to achieve the goals of its ATE program. Our research was guided by a set of questions which examined the following: (a) the quantity and quality of the students; (b) the changes in structure and organization of the participating community colleges, specifically in the development of curricula and programs; (c) the capacity of the "system" of technical training and all its various components including the community colleges, the high schools, and the four-year colleges; and (d) the conceptualization of sustainability within the regional centers.

Our sample consisted of eight sites that were funded as regional centers between 2001 and 2003. Most of them had conducted work previously as ATE projects or national centers. The California Regional Consortium for Engineering Advances in Technological Education (CREATE), the Kentucky Information Technology Center (KIT), and the Center for Information Technology Education (CITE) emerged from work that had initially received funding as ATE projects. The South Carolina Advanced Technological Education Center of Excellence (SCATE) was funded as a national center in the late 1990s before the ATE Program developed the concept of regional centers. The work of SCATE while funded as a national center, however, was focused on a statewide initiative. For this reason, the profile for SCATE fit well with this study of regional centers. The Center for Nanofabrication Manufacturing Education (CNME) and the Information Technology Education Center in Florida (ITEC) also adopted regionally-focused approaches, making their work compatible with the "regional" designation. Only two centers, Boston Area Advanced Technological Education Connections (BATEC) and The Midwest Center for Information Technology (MCIT), received their initial funding under the regional center designation.

In selecting the eight sites, we considered several factors. First, we sought a national distribution of sites. Second, we intentionally included sites that were at different stages of development, ranging from the well-established SCATE, which originally started as a national center but evolved into a regional center, to the newly developed BATEC. The majority of centers have targeted the information technologies (IT) industry, so while we included sites focused on other technical fields, over half of our sample is IT-focused.

This report draws from data collected and synthesized over the past 30 months. Between February 2004 and March 2005 a team of CCRC researchers conducted field visits at each of the eight centers for the first phase of this project. In preparation for the site visit, researchers conducted telephone interviews with at least one of the center's principal investigators (PIs), undertook comprehensive web searches of the center and its affiliated partners, and created a pre-visit portfolio from the preliminary data collected. Next, a team of two or three researchers conducted a four-day field visit. Each visit, planned in consultation with the center's director, consisted of interviews with a range of participants at several participating colleges and with individuals at the lead organization (see Table 2).

Table 2:
CCRC Fieldwork

Center	# of Participating CCs	Site Visit	Faculty Interviews
CREATE	7	Visit to 3 CCs	Faculty interviews at 7 CCs
BATEC	3	Visit to 3 CCs	Faculty interviews at 3 CCs
MCIT	10	Visit to 3 CCs	Faculty interviews at 7 CCs
CNME	14	Visit to 1 CC	Faculty interviews at 6 CCs
ITEC	3	Visit to 3 CCs	Faculty interviews at 4 CCs
KIT	8	Visit to 2 CCs	Faculty interviews at 4 CCs
CITE	2	Visit to 2 CCs	Faculty interviews at 2 CCs
SCATE	2	Visit to 2 CCs	Faculty interviews at 3 CCs

During each Phase One site visit, the team conducted interviews with the following: (a) the PIs and key coordinators of the ATE center; (b) two-year college administrators, faculty members, and students involved in the ATE program; (c) participating business and industry representatives; and (d) any additional participants who could shed light on the linkages emerging between the colleges and their local high schools, and between the community colleges and four-year partner institutions. We wrote detailed site summaries for each site, using interview transcripts, observation notes, and other documentation.

While writing the site summaries, we refined a thematic coding scheme for the interview transcripts and field notes. Then, using the thematic categories, we began constructing basic cross-case analytical matrices. This work generated a growing body of descriptive text regarding each center, the colleges visited, and our categories of analysis.

Research for the second phase of the project was conducted between December 2005 and August 2006. During this period a team of CCRC researchers conducted a total of 65 telephone interviews with faculty affiliated with the partnering community colleges, business contacts working with each center, and with the PIs themselves.

Prior to the phone interviews, we developed a list of all faculty involved with the regional center based on our earlier research. Those lists were then distributed to the PIs to confirm their accuracy; the PIs updated them, indicating faculty who were no longer participating and those who were new. It should be noted that the fact that a faculty member was no longer participating did not eliminate the individual from our potential interview list; we felt that such faculty still had experiences from which we could learn and could provide some insight into why faculty no longer participated in the program. Once we had a complete list for the center, we randomly selected half of the list to interview. Our response rate ranged between 19 percent and 63 percent for each regional center, with an average of 40 percent.

In preparation for the telephone interviews, we developed interview protocols based on the model of program improvement that we had identified in the regional center during the first phase of the study. Particular attention was also paid to the involvement of business and industry. Each phone interview was tape recorded, transcribed, and subsequently analyzed using qualitative software.

In addition, site visits during ATE regional center advisory board meetings occurred between December 2005 and May 2006. These visits were coordinated with the principal investigator (PI) for each center. Prior to this set of site visits, a separate protocol was developed focusing specifically on the role of business in the center. The advisory board meetings for CREATE, MCIT, and SCATE were structured such that the meeting convened for two to four hours, and was specifically designed to bring together businesspeople who sat on the advisory board, faculty, and staff from the affiliated community colleges, and students. The purpose of these meetings was to gain input from the businesses on the curriculum, ascertain the extent to which the programs were meeting the needs of local industry, inform business about the activities of the center, and highlight the successes of the students.

The CITE meeting was a much smaller meeting involving only those who were actively involved in CITE activities. Interestingly, the meeting at CITE also included individuals representing efforts to 'spin off' components of CITE's work, such as the efforts of Alignment Nashville and other community organizations. This was a chance to hear about such initiatives and other ways in which CITE has impacted the community.

The BATEC and CNME meetings were of a different nature. They were more like conferences and professional development opportunities designed to bring together faculty. Attendees could take workshops and attend meetings about various technologies while providing a chance to discuss common challenges, such as creating internship opportunities for students, understanding what businesses want in terms of soft skills for their new hires, and so on.

Instead of attending an advisory board meeting for ITEC, we attended one college's IT program advisory committee meeting. This meeting was insightful because it illustrated the ways in which businesses are providing input to their local community colleges at a program level. There was extensive discussion about course content and course sequencing. In addition, attention was paid to new technologies and skills that potential employers saw as increasingly important.

We did not attend the advisory board meeting of KIT. However, at our site visit in May 2006, one week after the meeting, we received an extensive briefing on it by some of the participants and were able to review the documents from that meeting.

Field notes of these visits were written subsequent to the visits. The data gathered from Phases One and Two provided the basis for the following report. Further, simultaneous to this research project, CCRC researchers were working on other projects whose geographical areas overlapped. Thus, in some cases, we were able to draw upon data from these other projects to provide a greater context for understanding our findings from the ATE project.

REFORM AND WORKFORCE DEVELOPMENT

The RFP made clear that regional centers were to have a unique focus in their approach to workforce development: academic reform in support of regional needs for highly qualified manufacturing and information technology workers. Thus we consider this the center's the most basic feature: their technology focus. We continue with the regional focus and the economic role of the centers as well as the centers' role in promoting academic reform at the institutional level through the development of new programs and the modification of existing programs; through professional development for faculty; and through capacity building efforts, such as recruitment of students from high schools, promotion of seamless transitions from high school to community or four-year colleges, and increased placement of students upon completion of their program. However, the success of regional centers is larger than their direct impact on the partnering community colleges. This investigation leads to the development of a framework through which we can understand the sustainability of certain centers compared with others. That framework described in detail later in the report.

The Centers, Their Regions, and Workforce Needs

The definition of "region" for each regional center varies considerably. Some are areas within a state, others are entire states, and still others are parts of several states. For example, BATEC and ITEC operate within tightly defined regions, each clustered around a specific metropolitan area. Defining the region served in geographical terms has many advantages with respect to focusing a center's efforts. However, when the definition of region is as broad as a state or multiple states, this regional designation may encompass many sub-regional labor markets and workforce needs which can produce contradictory pressures upon a center. This is especially true within the information technology sector where firms have diverse needs depending on the labor market they face. In addition, it becomes difficult to determine what are the specific set of firms to be served within that region. Within regions, there can be vast differences in the size and focus of IT businesses and considerable variation in the average levels of experience and education found in the local labor force.

Our interviews revealed that the economic contexts and concerns of the colleges located in metropolitan areas are fundamentally different from those of the smaller, more rural colleges. This rural-metro division is illustrated by contrasts in appropriate strategies to promote workforce development and differing educational needs of a city compared with a rural area located within the same state.

In the case of Nebraska, for example, research studies have been conducted on Omaha since 1992 in order to inform the city's approach to economic development. The research evidence indicated that IT investment would be good way for the city to sustain and continue its growth. In addition, recent industry surveys have shown that employers in the metropolitan area value bachelor's degree holders as potential employees. In contrast, at the rural college we were told that there are definite job opportunities for AA/AS holders.

Differences within a region are seen with MCIT. According to faculty with whom we spoke, some felt that there are currently too many jobs and as a result students do not need to go to school to learn a trade to be hired. Others in the region, however, thought that there is a mistrust of the IT industry based on layoffs at a local computer company a few years earlier.

CREATE provides another example. It serves an area including both large metropolitan areas and some fairly rural areas with small companies that cannot absorb all their graduating students. A faculty member at one college servicing a rural area noted that about half the students leave the immediate area to go to the cities. In this case, the participation of CREATE's advisory board has been critical to its college by promoting contacts with employers outside of the local area. As one interviewee said, "We do have an advisory committee and they do help us on the development of the curriculum; however – and this is where CREATE is really helped – we can get employers from other cities that actually have better industry. We're not training the student to just work [locally]; we're training them to work anywhere."

ATE centers are generally predicated on a need for workforce development in the area, but, clearly, the nature of that need is shaped by the economic outlook of their region as a whole, the outlook of the industry on which the center is focused, and the specific make-up of the local industry. These factors also shape industry involvement in the ATE centers. In fact, the role of industry involvement in the ATE centers is more complex than perhaps anticipated by the original design of the program. While the ATE program is premised on the need for skilled technical workers, we found that some of our interviewees suggested that other factors driving industry participation were at play. These other factors, such as retraining displaced workers and creating a pool of skilled workers in anticipation of the need, are discussed in greater detail below. In a few cases, there was a need for skilled workers in the area. Certain regions are dealing with a pending loss of workers with the baby boom generation beginning to reach retirement age. This is true in parts of SCATE's state, South Carolina, where a local need for trained workers in manufacturing is driving industry participation in the SCATE program. Similarly, a concern about losing hundreds of trained electricians in CREATE's region in California, combined with new state certification requirements, has compelled the local energy company to say that it will hire CREATE's graduates for the next few years. According to one program director, the local electrical company has said it will hire between six and 10 a year from its program for the next 10 years.

In other cases, the regional centers were involved in training workers displaced by company downsizing, or workers needing to change fields. ITEC's pilot training program allowed a major corporation with offices in the area to offer retraining to employees whose jobs were being eliminated. MCIT's work through one of its rural colleges provided retraining for railroad employees injured on the job and looking for work that would not require physical labor.

Others were anticipating, and, in the case of CNME, actually trying to create, the need for skilled technical workers. In those regional centers that were trying to create a demand, the issue could be one of regional identity. For example, one interviewee working with CNME in Pennsylvania commented, "I don't think a lot of companies…think of us as a technology state. I think we need to change their mindset on that. There's a lot of technology here but they don't see it." In the

case of BATEC, a great demand for forensics technicians does not yet exist, but two schools are pursuing forensic technology because they anticipate that with advances in forensics technology combined with the interest generated by television shows such as CSI, there will be a demand for forensics programs.

This effort suggests the relationship between employer occupational demand and educational institutions is more complex, especially around newly emerging occupations. In many instances, industry is reacting to short-term perceived needs by assigning highly skilled employees to a particular task, and not recognizing that their needs could be met though a definition of new occupational classification or skill set. It becomes necessary for the educational institution to create "a demand" within industry for this new occupation. In some instances it may be the joint collaboration between business and education that a new employment classification is created with the appropriate skill sets determined by business and industry.

An example of this interactive process in the area of information technology occurred in the development of an important part of software production: the software testing. Originally, companies utilized engineers and computer scientists to perform their software tests, because they were unsure of the specific skills needed and wanted highly skilled individuals involved. However, as software production became more routine, and educational institutions demonstrated they could produce individuals with less than a four-year degree, companies began to hire individuals specifically for this task, i.e., software testing. The occupation required some college, normally an associate degree. It was the recognition by the company of the existing tasks, coupled with the availability of training individuals that produced this change.

For some sites, the decrease in the immediate need for trained labor has created a very different context for ATE center activities. This situation has certainly been evident in certain cities, such as Nashville and Omaha. Interestingly, a business representative in Nashville described this as an advantage. "This whole thing got started during the IT boom in Tennessee, but it's almost a good thing that the pressure to deliver qualified IT workers is gone, because the results of this work are going slowly." That is to be expected in educational reform, she explained, but, from a business perspective, incremental changes would most likely appear ineffective and not worth continuing to support. Business generally responds to market conditions for immediate employment needs and finds solutions even if they are inefficient.

At many of the colleges we visited, and particularly at the smaller, more rural colleges, industry partnerships had developed from personal relationships within the community – often between technical instructors and their former students. At these sites, the relationships between local employers and ATE instructors had existed prior to ATE funding, and while instructors may have started asking for more assistance from their industry contacts, the essential basis for and nature of those partnerships had not been altered by ATE program participation. In other cases, active Workforce Investment Boards (WIBs) have included ATE projects under their purview, examples include the WIB's working with CITE and CNME, but the ATE project specifically has not significantly changed the existing relationship between the WIB, the local businesses, and the community colleges. Given the goals of the ATE regional centers and the possibility of leveraging the existing connections of the WIBs, it seems that there is an opportunity for the

regional centers to further enhance the relationship between the WIBs, the local business and the community colleges.

Consequently, the private sector firms that participate in NSF projects may not be motivated by short-term employment needs. Indeed, initial discussions with employers in this study indicated that some are motivated by a "general interest" in the technology or the field rather than seeing the programs as sources of potential employees. For example, the partnership that CITE has fostered with representatives from two large international companies was never intended to provide employees for either of the two companies. An interviewee from one of the firms asserted that the company rarely hires locally educated personnel. He explained that the partner schools for the company are "pretty much set" while naming a few large competitive state universities. The respondent from the other company noted, "Well, we're not hiring right now, but if we were, we *would* be hiring local people…we just haven't been hiring for five years, maybe more." Continuing, she clarified that hiring local people would entail hiring the local university's graduates, not the community college graduates.

One final point regarding the centers and their workforce development is that it was assumed that with the exception of CNME, which was trying to anticipate the need for manufacturing expertise while broadly improving STEM preparation, most regional centers were pursuing an explicit regional need for people with particular STEM skill sets and knowledge. In fact, we found little documented evidence of a need predating the emergence of a regional center. This issue may point to a distinction raised by The Evaluation Center in its brief on workforce needs: "[M]any PIs perceive that workforce needs assessment is not essential to their efforts" (Ritchie, Gullickson, & Coryn, 2006, p. 1). Yet, many of the regional centers are led by people with longstanding familiarity with the region and the centers are often in extensive contact with area employers through the advisory committees we discussed earlier, so they may in fact be drawing upon what The Evaluation Center terms as "weak" assessment.

Academic Program Reform

NSF identifies academic program reform as the mechanism through which the ATE regional centers should meet the workforce needs of their self-identified regions. Since NSF did not define the concept except to say that the reform should be applied at the level of the department, program, and curriculum, the idea was interpreted differently by the centers. Our research suggests that this notion of academic program reform was approached through two separate strategies. In the first group, regional workforce needs were framed as an issue of quantity and content. This group, wanting to create a large pool of highly trained workers and ensure their skill levels, relied on industry-vetted curricula. We consider this group as beginning with a *workforce expansion* focus. Note that this orientation is not synonymous with workforce development. All regional centers are pursuing the goal of workforce development. Instead, workforce expansion is a particular approach to workforce development. This group tended to include members whose technology focus was on information technology, probably because the need for IT professionals was significant when many of these grants were first written in 2000. Thus, the workforce expansion focused centers sought to expand technical course or program

offerings in an attempt to reach more students with industry relevant content. They accomplished this goal by training faculty who could then reach a large number of students. The focus was to have a cascade effect: the presence of more highly trained and certified instructors would enable more students to be reached.

Centers that concentrated on program development through new approaches to teaching or new curricula to relieve attrition and/or improve the preparation of students entering STEM fields comprise the second group.. A number of centers we studied were particularly interested in approaches that relied on problem-based learning. CITE and SCATE both sought to provide students with educational experiences that would better prepare them for the challenges they would find in the workplace. CITE used problem-based case studies as the foundation for teaching the skills students would need in the workplace while collaborating with a local business partner. In doing so they sought to emphasize higher order skills such as investigating, hypothesizing, and troubleshooting to better mirror the challenges the students will face in their workplace. SCATE sought to integrate the first-year experience of engineering students so that the engineering and sciences content was addressed not only in their STEM courses but also in their communications and general education courses. The idea was to make the coursework immediately relevant to students. CNME sought to improve STEM students by creating a program that would strengthen their preparation through stringent and broad coursework, culminating in a hands-on capstone semester at the university. Although focused on a specific specialty, the techniques learned in the program are widely applicable. Finally, BATEC has sought to strengthen relationships between high schools and community colleges, and between community colleges and universities. Its program development has focused on modifying existing programs to ease movement between these educational sectors and on developing new programs to meet new workplace demands. We refer to the approach of the centers in this group as those with a *program development* focus.

Workforce Expansion Focus

In the regional centers that were focused on workforce expansion there was often a conscious attempt to align the center's priorities with the state economic and workforce development strategies. These state strategies were attempts to build a new workforce that could relate to the skill demands of the knowledge-based economy. CNME, ITEC, and KIT were initiated as part of larger workforce and economic development strategies. CNME was part of the state's economic development attempt to initiate nanotechnology as a new growth industry for the state. ITEC was created as a response to the need for 15,000 new information technology workers in the state. KIT was part of an effort by Kentucky's community college system to develop the capacity of the system for companies investing resources. Although these approaches played out differently across the participating colleges, the centers that adopted this approach have used similar approaches, including the following: they (a) researched a specific labor market, (b) developed training with an eye to employer preferences and potential needs, and (c) targeted the community colleges as the engine of workforce development.

KIT provides an excellent example of the workforce expansion focus, having had 2,344 participants since it began. Over the course of the past decade, Kentucky has enacted legislation

focused on formulating a long-term and coherent economic development plan. Higher education has played several roles in the state's larger economic planning. At the four-year level, the research universities are expected to increase the state's research and development infrastructure (the state is forty-seventh in the nation in per capita R&D spending). At the same time, the two-year sector has received greater recognition. In 1998, two-year and technical institutions were consolidated into a single, autonomous system of technical and community colleges, under the leadership of two chancellors – one academic and one workforce.

Within this larger context, KIT has been able to integrate its goals into state-led economic initiatives for the state. It has defined its primary goal as positioning the state's community college system as the educational provider of IT technicians, which will be needed across the larger career clusters on which the state is trying to base its revised/enhanced economy. As one PI explained: KIT's goal is not designed to produce students from the community college system who are "IT purists," i.e., employees of companies involved in the development, production, or distribution of information technology hardware or software companies. Instead, the objective is to train IT workers to perform the information technology functions for the companies within the industry clusters that the state has targeted for expansion, such as the automotive industry and the medicine/biotech cluster.

Thus, of all the regional centers in our study, KIT is the most closely aligned with the workforce and educational policies of one individual state. Indeed, the KIT co-PIs include people in the community college system, a unit of state government (the governing board is appointed by the governor), and a local community college. The expressed goal of the project was to increase the capacity of the community college system to offer information technology courses and thus be able to respond to the needs of business and industry for trained information technology students.

Despite the explicit connection to the state's workforce development efforts, KIT does not appear to play a major role in many of the new initiatives of the community college system in areas of workforce development. For example, in cooperation with a local auto manufacturer, the system is building a new training and technology center which will be part of a local campus. KIT is not playing a role in the plans for this center. The community and technical college system has also pursued a vigorous application of career pathways yet despite this formal involvement with the system KIT has not been actively involved in the development of these programs either. There is a significant demand for information technology workers within the automobile industry, both in administrative and production functions. In addition, many conventional automobile related jobs, especially at the technician and skilled trades level, require significant information technology skills. The ATE center could be an important asset in the development of greater ties between the college and the newly emerging automotive sector within the state. Finally, the state programs in the coal industry and the development of a new emphasis on the equine programs proceed without direct participation of the KIT. Both of them could profit from courses and programs of the center.

CNME, based at Pennsylvania State University, has also framed its work as advancing the state's economic development interests. It was funded in 1994 and again in 2001 with a focus on manufacturing and nanotechnology. Through Pennsylvania's search for ways to align its economy with the "knowledge economy" and to decrease its dependence on its traditional

industries (steel making, metal fabrication, and coal mining), the state has supported the growth of a new manufacturing technology. Specifically, it contributed $26 million in 2002 to one of the labs at the state university. This investment was based on the premise that the new technology, with many potential applications in the manufacturing of industrial and consumer goods, can build on the state's existing industrial economy, adapt manufacturing skill sets to new production processes, and draw, at least in part, from the current industrial workforce in training new technicians.

In order to foster an industrial presence in nanotechnology, the Penn State facility has extended its use beyond the academic research community to serve commercial industry purposes. To reach its goal of increasing the supply and preparation of STEM workers, the center has initiated its own capstone course sequence; its work with college and high school faculty; and its outreach workshops for middle and high school students. At the same time, CNME is also trying to increase industry awareness, through informative workshops designed specifically for industry representatives.

In the case of this newer technology, industry certification does not exist, and, in fact, the industry itself does not yet exist locally in the region. Nevertheless, CNME's approach has been analogous to that of the other workforce-oriented centers in that it has made cutting-edge technical training available to community college students. Experts at the university designed the six-course curricular sequence which serves as the capstone experience and is taught at the manufacturing facility. In addition, the university offers faculty development institutes to provide two-year college instructors with knowledge of the nanofabrication equipment and processes. These efforts have, in turn, shaped program design at the two-year colleges, where each of the participating colleges has designated already existing courses as components of the nanotechnology program and integrated nanofabrication information into at least one of the required courses in that sequence. At a local community college, the course is a one-unit "nanofabrication seminar"; at another, the course is a two-unit statistics course using nanofabrication examples. Fundamentally, these programs serve as the prelude to the bulk of the nanofabrication instruction, which occurs at the university's facility.

The center provides community college students with a one-semester capstone course on nanofabrication through partnerships with more than 30 postsecondary institutions. It promotes the development of associate degree programs in nanotechnology at community colleges across the state and serves as a national resource center for nanotechnology education and outreach (Patton, 2006). As a result of the partnerships leading up to the capstone course, most community colleges adapted an existing program to provide the core science courses and math prerequisites that the program requires. CNME reinforces the priority placed on nanofabrication technologies by the state, which has invested significant resources into promoting the technology and framing it as a successor to state's traditional manufacturing industries.

At ITEC, respondents spoke of positioning its state's community colleges as the central trainer and retrainer of IT workers. Thus, understanding IT workforce needs and maintaining the currency of its IT offerings are top concerns for ITEC. Significantly, and unlike the situation in Kentucky, KIT's state, a foundation of IT-related industry already existed in the Florida I-4 corridor, drawn in part by the existing industry presence. In addition, by the late 1990s, the

community college system launched a highly coordinated public relations campaign to position themselves as the center of economic development for the state. The campaign has yielded results; initiatives at the state and regional levels have provided support for further development of this high-tech economy, and directed resources towards the community colleges.

ITEC was funded in 2000 and extended in 2003 with a focus on information technology. The center works through two local community colleges to enhance the workforce by providing professional development opportunities to community college faculty in IT areas with industry-standard curriculum. It has delivered more than 120 workshops to over 1,000 faculty. In addition, the center developed a project management curriculum to provide area businesses training opportunities in support of Project Management Professional certifications. ITEC's efforts have paralleled the state's efforts to promote the region as a technology center in the state and to encourage community college students to transfer to four-year colleges upon graduation.

Similar to ITEC, MCIT enabled faculty to attend training and obtain certifications, which then enabled the colleges to offer courses and programs for which they previously did not have faculty expertise. MCIT enhances the workforce by "identifying the information technology skills for the highest-demand careers in the region, promoting the use of MCIT-developed best practices, expanding participation in emerging IT frontiers, and increasing the recruitment and retention of IT students, especially women and minorities" (Patton, 2006, p. 23). This consortium of 10 community colleges in four states was funded in 2001 with a focus on information technology. It has supported the development of articulation agreements with area colleges and dual enrollment programs with local high schools; and has sponsored a number of workshops, including hands-on build-a-computer days for high school students and a workshop specifically designed to support girls in technology.

This distributed model, the only one of its kind, in which a region is defined not as a geographical area within a state or even an entire state but rather multiple states, seems to have been problematic in some ways. First, the area was so large that bringing everyone together for meetings and professional development opportunities was challenging, as was getting participating businesses together because of the significant travel time required. In addition, while not unique to a multi-state initiative, we heard more about the discrepancy between rural and urban regions, differences in the states of the economy between various participants, etc., in this center than the others. Nonetheless, it is that very distance and number of small colleges that compel a broader conception of region if the faculty are to benefit from the networking and collaborative opportunities available to faculty in other regions.

Program Development Focus

In contrast to centers like ITEC and KIT, program-focused centers have, for the most part, framed the problem as the need to revise existing technical programs or create new programs at the two-year colleges based on innovations within the teaching of this subject matter. In our interim report, we cited SCATE as an example of a program-focused center that had targeted the first year of colleges' engineering curriculum, on the premise that students who succeeded in the 1st year of an engineering program would most likely complete the degree. Thus, the program revision – integrating a problem-based approach across linked courses – was intended to engage students with a more relevant and participatory experience and to decrease the number of

students who drop out during their first year. SCATE also modified its curriculum in an effort to integrate core competencies across science and communication courses, which would lead to a more realistic problem-based learning.

SCATE was funded in 1994 and then renewed in 2002. Its technical focus is on engineering technology, with a goal of improving the high school to college transition by focusing attention on the first year of college for students in manufacturing technology fields. It serves the city of Florence and the surrounding area, though its efforts have occasionally stretched into neighboring states as those states' community colleges have expressed interest in its program. The center is very deliberate in its attempts to address regional workforce needs by reaching out to area employers and illustrating how its program can address labor shortages and the need for new skill sets. To supply the technicians needed for these jobs, SCATE has developed an approach to the first year of college education which focuses specifically on problem solving, teamwork, and making the course content directly relevant to the workplace. Because its focus is on the first-year experience, it has not made transfer programs a priority. Nonetheless, the sense is that if students succeed in their first year and learn the fundamentals, then one of their most significant hurdles will have been overcome.

SCATE began by working with a number of colleges in the technical college system. Because the model involves team teaching across the sciences, technology, and communication departments, it had a significant impact on the schools overall in terms of scheduling and the need for faculty to fundamentally change how they teach. Curricula also changed as the teams of faculty sought to tie the coursework together in such a way that what was learned in each class was immediately relevant and reinforced in the next class. For example, communications courses emphasized writing and presenting what had been learned in the physics class. However, the magnitude of these changes, combined with a fairly small population of participating students, made the change hard to sustain at all the colleges that had begun the project, and today the model's success is really seen only at Florence-Darlington Technical College, Tri-County Technical College, and Piedmont Technical College. At Florence-Darlington Technical College the most comprehensive model exists which includes scholarships and internships. In addition, other grant-funded projects are leveraged to provide students with a laptop loan-to-own program and opportunities to serve as Ambassadors.

Similarly, in the case of CREATE, the participating community colleges originally came together to address the declining enrollments and likely elimination of their electronics programs. The small size of the colleges (and their technical departments) meant that program development for some of the departments was the work of one full-time instructor. At each of the colleges, these individual instructors faced the same task: to design a new engineering-related technical program. Accordingly, CREATE was developed from the collaborative efforts of these seven colleges to formulate and implement new curricula. While different colleges in the consortium pursued slightly different strategies for replacing the electronics program (one college started a robotics and automation program and another created a manufacturing engineering program, for example), the collaboration was productive and continued as the colleges began putting together new programs in IT, such as computer networking. Therefore, the first priority of the consortium was to replace a dying technical program. As one of the college deans told us, the faculty "threw out the old electronics program" and brought in a whole

new one. In the first couple years they had students in the pipeline in three different programs. Through this process of program development, the college created new links to industry. According to the dean, however, this was a secondary effect of CREATE's efforts.

Fundamentally, CREATE seeks to address regional workforce development needs through training and education in engineering fields such as mechatronics, manufacturing, computer services, computer networking, electronic technologies, and robotics through a joint effort among seven regional community colleges and a group of 30+ large high tech engineering/technology employers. CREATE's programs are focused in California's mid-state and lower state region, drawing its industry and government partners from that area. It was first funded in 1996 and then renewed in 2002 with a focus on engineering technology.

CREATE specifically seeks to improve the expertise of existing faculty in electronics, IT, and manufacturing; train new faculty from industry; develop 2+2 programs; and create and adapt new curricula in electronics, information technology, and manufacturing (Patton, 2006). CREATE's efforts to address workforce development have included program reform efforts that directly touch the students, rather than function solely through the faculty. For example, it offers 2+2 BS degrees in industrial technology with California State University Fresno and a BS degree in IT with CSU Channel Islands, and has created more than 200 new curricula and courses. The new curricula appear to be closely aligned with regional business needs, one example being the creation of a new electrical engineering technology program that meets the needs of local businesses that are concerned about an aging workforce and a new certification requirement imposed by the state. It is worth noting that more than 75 percent of those courses have been approved by the state for transfer to a BS program within the university system, thereby providing students with the option to continue their education and complete a bachelor's degree.

CREATE's influence on technology curricula and programs is significant, but its impact on occupational or transfer programs outside of its focus is unclear. The center maintains close ties to regional industry, business, and government partners, which provide regular input on industry needs.

Also program-focused, CITE has encouraged faculty members to work directly with business representatives in order to integrate authentic work problems into technical courses, using them as the context to encourage higher order learning. Working with industry thereby serves a particular pedagogical approach that CITE participants hope to infuse throughout the ATE program. Less focused on short-term industry demands, CITE's focus is the quality of technical training in the context of students' long range career and educational goals.

CITE was first funded in 2002. It is a consortium of two-year colleges, universities, schools, businesses, and government organizations in Tennessee that seeks to reform IT education and create a pipeline of students to create a skilled IT workforce. The center has focused particularly on city schools partnering with the local technology council on numerous activities. Problem-based case learning is at the core of its workforce and educational efforts. The method is used to provide professional development workshops in which faculty are taught using the same methods that they can use to teach students. CITE has developed the Corporate Scholar Solutions program which partners community college courses with businesses to provide a real problem-based case

that students work on during the course of the semester. It has also created information technology academies at three high schools in the area, and in spring 2006 began an after-school pilot program for the city's public schools. Finally, in 2005/2006 CITE undertook an IT career pathways initiative to connect what occurs in the classroom with the practical needs of the workplace. These multiple projects are manifestations of CITE's "advocacy of case-based, problem oriented learning [that] is an expression of educational reform for IT education and engineering and technology generally" (Patton, p. 16).

CITE also represents a new model of program development and workforce expansion. Although originally funded to develop problem-based case studies in a program designed for college students, its connections to other local initiatives in the state, and in the capital city specifically, have led to the development of collaborations with the public schools. According to its mission statement, CITE sought to "develop and sustain a Community of Practice of academic, industry, professional and ATE Center partners dedicated to the continuous improvement of curriculum, skill standards, faculty skills, and student outcomes through the use of authentic contextual learning experiences." The center has a vision of "a more adaptable IT workforce that is aligned with industry needs and is better-positioned to realize the next level of national industrial productivity." These quotations make clear the extent to which program development and workforce expansion have been integrated in CITE.

Dual-Focus Programs

As was noted earlier, the centers have evolved since we first spoke with them in 2004. What this means is that in many cases sites which we preliminarily identified as focused on program development also took on significant workforce expansion initiatives and vice versa. For example, CREATE, which we noted above for its program development, has also taken a leadership role in creating business-education connections in an effort to address a local concern of the region: the cost of living and the preference of local industry for hiring locally as a way of reducing job turnover due to the cost of living. Local employers believe that hiring skilled workers locally, who already know what it costs to live in the area and have personal ties to it, will be less likely to accept another job and relocate elsewhere in the country.

Although we have presented these two approaches as distinct, they are not mutually exclusive and, in fact, some of the centers are actively engaged in both. For example, although we discussed CNME above in the workforce expansion section, its efforts can also be labeled as program development. A focus on curricular changes is clear in CNME, where a new program leading to a capstone semester at the state university in nanotechnology had to be developed at each of the participating colleges. Most of the colleges chose to modify an existing technology program to meet the new science and math requirements.

Funded in 2003 with a focus in information technology, BATEC can also be viewed as a dual focused program. It prioritizes a lifelong learning curriculum, the development of a regionally relevant IT curricula, promotion of opportunities for students, provision of professional development opportunities for faculty, and the development of cost effective training options for its area businesses (Patton, 2006). It is focused on Boston and its surrounding communities.

BATEC benefits from its location at one of the University of Massachusetts' campuses; it is easily able to draw on resources available to it and better situated to encourage collaboration by the universities. The collaboration between university and community college faculty has resulted in modified curricula to better ensure that students who transfer in computer science arrive with the courses they need. This means that students are better prepared and the transfer process is a smoother one. New programs have also emerged – for example, in the forensic sciences – in an effort to be readily adaptive to local industry.

BATEC has also played a key role in providing professional development opportunities to faculty through its winter forum and as an active sponsor of conferences. It is clear from the preceding discussion that these approaches must have an impact on the type of faculty professional development opportunities provided by the regional center. This issue will be further discussed below.

Professional Development of Faculty

Regardless of orientation (workforce expansion or programmatic), every ATE center has consciously located faculty development at the heart of its efforts. Accordingly, resources channeled through the centers have enhanced or created professional development programs at participating colleges. Opportunities at the college level are therefore shaped by the center's efforts, but are also dependent on the college's pre-existing approach to faculty development.

There were two general approaches to faculty training which stem from the centers' conceptions of program reform strategies. Centers that primarily saw their initiative as an effort to create a supply of trained or retrained workers to the local economy tended to offer the kinds of technical courses that would keep students current in the marketplace. In contrast, centers that were considering the revision or implementation of new curricula and programs tended to focus their faculty development more on curriculum development and pedagogy.

Technical content and certification workshops. The clearest examples of this approach are the standardized courses offered through ITEC and KIT. At both centers, college faculty members were able to participate in one-day workshops that addressed specific topics, such as Adobe Web and Visual BASIC, relying on vendors such as Microsoft, Cisco, and Novell for curricula, as well as vendor-neutral organizations, such as Comp TIA (Computing Technology Industry Association). This training covered the industry-vetted content and tended to operate by transmitting information. According to a respondent from KIT, such workshops tend not to address actual teaching, but focus instead on features of the software product itself. These regional centers made an effort to provide technical training, often leading to certification, to faculty so that the course offerings at the partnering community colleges could increase. Thus, there was a particular interest in offering networking courses, such as Cisco certification courses, to community college faculty since industry certification is required before a college can offer the course.

A number of the faculties have used these workshops to gain certification which subsequently allowed the colleges to expand their course or program offerings. One faculty member with MCIT explained: "There are numerous advantages [to the faculty's getting certification through this kind of program]. With the Cisco, unless the faculty is certified, we are unable as an institution to provide the coursework and the train-the-trainer program…[also] it does keep the faculty current with industry and that's been extremely important for us. As an institution, we've been extremely fortunate with the equipment dollars we have available, but the staff development opportunities are somewhat limited. So by combining this with our equipment it really does position the departments to meet the needs of local industry." Another faculty member at KIT echoed those sentiments, saying, "[I]n order to teach those classes, I have to have certification. It is not required by the college, but it is required by the program that I teach. It also goes to student credibility. How could I teach the students a course that leads to certification if I haven't passed that exam?"

In the case of KIT, community and technical college faculty members who attended its workshops report that they have begun teaching almost two additional IT courses per workshop participant as a result of their own workshop participation. IT programs have increased from an estimated six to10 in 2001, and to 33 in 2005, within KIT's Department of Technical Education. More than 100 high schools now offer IT programs, compared with 12 in 2001. The number of students served by high school IT programs has increased four-fold, from fewer than 400 in 2000-01 to more than 4,000 in 2004-05. In 2005, 727 high school students completed an IT career cluster. This represents a modest decrease from 2004, but a 24 percent increase from 2003. High school students identified as focusing on IT are outscoring their peers on science and mathematics exams mandated by the Education Reform Act. Moreover, through its own research, CITE found that establishing an IT academy in a comprehensive high school increased enrollment in AP and honors courses and make the school more appealing to students (Gray, 2006).

Workshops with a focus on content do not preclude attendees from paying attention to how the subject is taught and incorporating such observations into their own classes. Thus, even those who took content workshops often benefited from seeing how material was taught and being exposed to another teaching method. One faculty member, who took advantage of technical training to gain certification and teach a course that was previously not offered, said: "[I now have] a better understanding of the content and am able to do a better job of teaching that and passing that on to the students." When asked about the impact of the professional development workshops, a BATEC professor replied, "This is my ninth or tenth year of university teaching, I wasn't trained as an educator, I just always figured I'm a good teacher because, well, I'm charming and funny...what I've realized is that there really are things I can do to be more effective." Thus, content workshops exposed faculty to new ways of teaching, even when they were not designed with that specific purpose. Below we consider those workshops that were designed with such a purpose.

Pedagogy and curriculum development workshops. Those centers that saw reform as an issue of program development tended to focus faculty development workshops less on technical content and more on pedagogy and curriculum development. The centers that have made the most

advances in this area (e.g., CREATE and CITE) illustrate the importance of nurturing the process over a substantial period of time. For example, CREATE's faculty development process emerged from cross-college faculty discussion starting in 1997, and was founded on a faculty program established in 1989. Similarly, CITE's faculty development emerged from an earlier NSF-funded faculty development project, and has been informed by cognitive research on learning.

Underlying CITE's approach is the principle that student learning experiences and faculty learning experiences should be aligned with each other, and with the research on teaching and learning. Drawing from research presented in *How People Learn* (Bransford, Brown, & Cocking, 2000), CITE has been promoting case-based experiences that direct students to solve a set of practical problems. Accordingly, CITE also provided faculty with case-based learning experiences focused around practical classroom-level problems. In the end, increasing teachers' capacity to reshape their students' learning requires that faculty members undergo an analogous learning experience. According to one PI at CITE, this approach evolved from an earlier, less sophisticated theory of faculty learning. Initially, participating instructors created less elaborated cases for use in their own classrooms and in professional development workshops. From that initial work, the PIs realized that the professional development comprised both the construction and the use of cases. The underlying theory is that co-developing a case is what promotes changes in teaching philosophy and, in turn, changes in teaching practice (i.e., faculty learning). CITE's constructivist approach to learning was modeled within the workshops that the faculty attended, an approach that appears to have been very meaningful to faculty: "Before, we have always done projects, but we did some kind of fictional project, like we made up problems and it wasn't something that was going to be used by anybody. So that's what made the difference in this. It was really something that was to be used."

CREATE has pursued a different strategy for supporting faculty learning. Full-time faculty members from the participating CREATE colleges have met for monthly meetings and, more recently, for four-day summer institutes facilitated by experienced trainers. Like the faculty development process at CITE, CREATE's approach fosters collaborative and active engagement around problems of teaching and learning; for CREATE, the problem solving revolves around improving pedagogical practice among the colleges' adjunct instructors. As several faculty explained, a practice of part-time faculty employment means that technical programs can find instructors who are current in the technological field. However, technological expertise does not guarantee good teaching.

Therefore, the original objective of CREATE's program of professional development was to increase the full-time faculty members' capacities to offer pedagogical training to the adjunct members of their departments. The design of the development process immersed the participants in the set of teaching topics, which they discussed and took turns demonstrating for peer critique. As they engaged with these topics – which united theories of learning and motivation with concrete teaching strategies – the participants also prepared to take on the role of facilitator, practicing the art of providing instructional feedback. After completing the institute, the full-time faculty then returned to their respective colleges and facilitated the same activities over six weeks for other members of the department – mostly adjuncts. Ultimately, the institute participants have learned a training process, which they can incorporate into the department's operating procedures.

According to faculty respondents, this form of development offered several significant benefits. Participation offers the full-time faculty the opportunity to discuss and reflect on pedagogical practices: "We come away from it with something just for us as well." Several instructors commented on the value – even for competent instructors – of learning material that is supported by research findings. In addition, they reported that the effect on adjunct instruction has been dramatic. Full-time department members feel more confident that adjunct instructors are practicing good pedagogy in their classrooms. Furthermore, the departmental culture has changed as more adjunct instructors undergo the training: "It has changed the environment. Now [adjuncts] know we are supportive so they are open to asking questions; there is an open communication channel between us and them. We feel more like a team." Another spoke of the increased engagement in teaching and commitment to the program.

Like CREATE, SCATE's emphasis on professional development has also declined over the life of the grant, although it does seem to have had lasting effects on some of the faculty who participated early in the project. At SCATE, the focus on problem-based case studies compelled some faculty to reconsider what they have been doing in the classroom despite years of teaching experience. One faculty member spoke about her exposure to the idea of multiple intelligences in a workshop: "…that was back in '95 or '96 and I've been using it ever since." Another faculty member noted that what had the greatest impact on him was not the individual methods, but how SCATE had pulled it all together: "I've certainly done team teaching, I think the problem-based learning has been available for 20 or 30 years, and integrated curricula has been around before that. I think what was unique about this particular program was the scope and how much of that was drawn together. So that you had team teaching, and problem-based learning, integrated curricula, and student teaming. By the time you got done adding it all up, I think it was the breadth and scope of the initiative rather than how original it was." Clearly, one of the most significant potential impacts of an ATE regional center is to pull together a comprehensive approach to reform rather than just implementing a series of unrelated projects.

Networking opportunities. Professional development was critical to efforts of the ATE centers, and the networking component emerged as critically important to faculty participation. Across the board, faculty was appreciative not just of the opportunity to improve their skills or learn new ones, but also of the chance to meet other faculty who were familiar with their field and could serve as resources. Many teach at small colleges where they are possibly the only person in a given specialty, thereby necessitating that they be the local expert. The professional development opportunities enabled faculty to meet others from whom they could learn and with whom they could collaborate.

Regardless of the focus of the workshops, whether technical or pedagogical, faculty across the board felt very positively about their workshop experiences, in large part because of the networking opportunities they provided. In some cases, the workshops enabled faculty to meet faculty from other educational sectors. For example, one interviewee commented, "I've gotten exposed to people at the other levels. I really appreciate meeting the community college and the high school teachers, because in the normal course of my life I don't get to encounter these

people. They have very different perspectives and very different experiences in education and I really feel like I can learn a lot from them, so I enjoy that very much."

Even those faculty who simply met other community college faculty were often very pleased because the contact provided opportunities to collaborate with faculty from their field. One faculty member we spoke with said that he does not collaborate with faculty at his college, in part because "the faculty here are pressed to do a lot of things. And I don't do those things. So when I do [collaborate] I might be connecting with some of the teachers I met through the seminar or that were teaching in the seminars."

One faculty member spoke of getting other professional development opportunities out of the contacts she made through workshops and conferences that resulted in her working with faculty from other participating colleges on a new conference for the region. Professional development connected faculty from multiple colleges and gave them the chance to talk about the programs that they have and those that they don't have, resulting in a program articulation at the institutional level and, thereby, greater opportunities for their students.

The networking opportunities afforded to the businesspeople involved are also noteworthy. One business contact said, "We have meetings with them [other CREATE businesses] and it is very beneficial because we get to find out what other companies in the area are doing and what their needs are, how they intersect with ours, and discuss those issues."

In addition to the subject matter covered by the workshops, simply being in the presence of other teachers made a difference to the workshop attendees. One MCIT faculty member described her preference for the center-sponsored workshops over industry classes as follows: "By going to [to these workshops] I am attending classes with other instructors at the same level; we have the same focus as far as community college students and that whole environment." Going to a technical training center means taking classes with businesspeople who "want to use it in their business versus us wanting to teach it."

Funding. A basic issue related to professional development was simply the additional funds that the ATE centers were able to provide. Despite the positive impact of professional development, the tight budgets of many community colleges means that the funding offered by the regional center or the courses themselves provided the only opportunities that some faculty had for development and training. Without such funding, many of the faculty we spoke with would not have been able to attend training, in part because IT training classes are often prohibitively expensive, but also because there is simply very little left over in the budgets of their respective colleges. Thus, the faculty generally felt fortunate to be able to benefit from the funding provided by the centers. For one faculty member and program, the opportunity to go for training that was funded by the regional center meant the difference between the college having a networking program and not having one: "The training was useful in just getting set up; I had no idea how to do network training until I went to some of the training that was provided. So that gave me the basis to build the lab. It was quite interesting. I went to a couple different trainings. The first one was just to get certified. The next week I went back and used all that information and purchased

all the equipment to piece together my own training facility and we built a mock cable pulling facility inside our lab." Thus, while funds for professional development are often minimal, our research suggests that such funds can have a very positive impact on faculty individually but also on the college because of the opportunities that can emerge for developing new programs. In this manner, the ATE Regional Centers serve a critical function of providing an inexpensive and accessible method for professional development of faculty and program development of new courses.

Center Connections

Reform efforts to increase the pool of educated technical workers concern not only the success of community college students, but also the pipeline of students graduating from high school and the opportunities available after completing a community college degree or certificate. Thus, it is critical to look at the connections between high schools, community colleges, and four-year universities, as well as connections between the educational sector and industry.

Connections to Other Educational Sectors

As we tried to learn about how the community colleges interacted with secondary and other postsecondary schools, we wanted to understand how the centers influenced the relationship between the community college and the other institutions. Specifically, we wanted to understand the goal of the program with respect to high schools and how the high schools changed their curriculum and professional development with respect to the regional center's activities. With respect to the four-year connections, we wanted to see if there is evidence that students are able to transfer from a community college to a four-year college after enrolling in the programs created by the regional center. To that point, does the ATE program increase the willingness of the four-year schools to accept community college graduates? Are the ATE courses and degrees/certificates transferable, and how often do students actually transfer to a college or university? Has the ATE program influenced transfer rates? Fundamentally, has the center had any impact on the relationship between the community colleges and four-year colleges?

We found that the regional centers generally tended to promote the development of connections between their partnering community colleges and the local feeder high schools or the area four-year colleges. Thus, a number of centers deliberately reached out to the high schools in the region and created opportunities for high school teachers to work with community college faculty, provided summer workshops for high schools students, and developed their dual enrollment options. Others focused more on the success of their students as they left community college and thus sought to strengthen their articulation agreements with area four-year colleges. In general, the centers seemed to focus on one or the other, perhaps signaling the challenges of creating and maintaining these connection and the differences in culture between the public K-12 systems and public colleges and universities. The questions raised in this section concerning the nature of the partnerships are discussed in detail below.

High school partnerships. The colleges have employed two main strategies for strengthening the articulation with high schools: dual enrollment programs and conventional outreach/recruitment activities. Generally, these strategies were in place prior to ATE center involvement, so ATE resources have been used to expand and organize efforts already in existence. While this work has tended to focus on reaching the students, the centers have also tried to reach high school faculty through the professional development offered by the two-year college faculty. The hope is that the professional development will influence high school teachers' curricular content in ways that foster student interest in ATE fields of study. In some cases outreach to high school faculty has been successful as seen in BATEC, CITE and MCIT. Providing professional development opportunities to high school faculty with college faculty can ease articulation efforts and can lead to greater understanding on the part of the faculty at both institutions.

Dual enrollment. When respondents across the eight sites described strategies for connecting to nearby high schools, they tended to mention dual enrollment first. The most common dual enrollment agreements across the sites involved students at IT academies, particularly for courses leading to Cisco certification. The structure of these dual enrollment programs (including location of courses, qualifications of instructors, admission requirements) varied among the colleges and across the eight sites, reflecting the broader landscape of dual enrollment programs (Karp, Bailey, Hughes, & Fermin, 2005). Recent research on high school-to-college transition programs indicates the strength of factors beyond colleges' control, including state-level policies and funding streams, as well as mandates from the K-12 system (see Karp et al., 2005). Consequently, the ATE centers' ability to forge formal linking mechanisms with local high schools is very limited.

Moreover, the effectiveness of dual enrollment or other articulation agreements in recruiting students into colleges' ATE programs is unclear. For example, a CREATE respondent noted that although the goal has been to get students from the local Cisco academies to transfer to the community colleges, it has been difficult for the community colleges to obtain information about which students came from the high schools with the Cisco academies. She concluded, "We have to get some type of systematic way to measure and validate the success of this objective." Likewise, in KIT's state, a few high schools offered dual credit to students who took Cisco courses at the community college, allowing them to earn high school and college credit simultaneously. However, KIT has not been able to track those students once they graduated from high school, and thus did not know whether the program increased matriculation at the college.

These are all good activities and programs but our experience in other areas begs the question of whether they work. We have found evidence that such programs are implemented, but appear to have little or no impact on student progress (see Hughes et al, 2005)

Outreach/recruitment. Respondents at the community colleges described the objectives of their outreach activities as two-fold: encouraging students' interest in IT or engineering fields and

increasing high school students' matriculation at their college. Outreach activities have included the following: (a) summer technology camps for secondary students, (b) career fairs and open houses hosted at high school or community college campuses, (c) formal presentations at local high schools, (d) joint work with high school counselors, (e) distribution of materials describing the colleges' technical programs, and (f) joint activities or competitions involving both high school and community college students.

In SCATE, for instance, industry representatives have visited high schools, made presentations, and created advertisements for popular teen destinations (e.g., movie theatres) in connection with their SCATE partnership. While these more traditional outreach activities seem to be very successful for SCATE, the center is also working with high schools in a very different capacity. Because of its proximity to the National Dropout Prevention Center, located at nearby Clemson University, SCATE has been trying to contribute to the body of knowledge about dropouts and is doing some faculty training for high school teachers. Although originally it had some challenges working with the high schools, the center has subsequently changed its approach to use the curriculum to teach high school teachers problem-based learning, and then ask them to consider how it might fit in their curriculum. Given the multiple pressures on K12 administrators and teachers these days, as one interviewee said, "We've got to find a need and we've got to help them [public school teachers] fill that need." In this case SCATE began by working with the school district rather than working with individuals schools to make sure their efforts were congruent with those of the district.

As the result of CITE's work in creating model IT Academies, a national business (EDS) has established a scholarship program for students entering the community college from a local high school's IT Academy. According to the academy's web site, students can receive up to 22 credits upon transferring to a postsecondary institution in the state. The program was established in 2003 with a goal of providing both rigorous academic and IT courses. The goal is for students, upon graduation, to be well prepared to continue on to college or to enter the IT profession directly, possessing certification in CCNA, A+, NET+, or web design.

While our respondents expressed a general interest in increasing enrollment, they also mentioned efforts to target particular groups of students, including underrepresented groups such as Latinos and African Americans. In addition, respondents at every center spoke of strategies for encouraging female students to enroll in ATE programs; MCIT's cyber camp for girls has been very popular.

As was true for colleges' dual enrollment strategies, respondents suggested that the high school outreach activities were not making much of a difference. In some cases, faculty members and outreach coordinators spoke of the need to reach students early – preferably no later than ninth grade. In SCATE's state, for instance, two community colleges have offered a technology gateway course for dual credit to high school students since summer 2003. They have also begun targeting middle school students through summer technology camps in the belief that initiating contact at the high school level is too late. It is difficult to judge the effectiveness of outreach efforts without data indicating that students have decided to attend the community college and/or pursue a technical career because of these specific outreach efforts.

Similarly, despite having reached over 1,500 students through presentations and summer science camps, CNME did not believe that those efforts had increased colleges' enrollment numbers. A respondent there attributed students' lack of interest to the field of study: "It takes a special kind of student to go into nanotechnology. They have to be good math and science students, they have to be willing to move, they have to take a leap of faith in the new technology, and, lastly, they have to be comfortable being in a lab setting, wearing suit and goggle gear." The center is currently sponsored by 13 school districts in the county; however, it is the choice of the high schools to partner with the college, the center must make its offerings available to all the districts schools in its service area.

BATEC's work in this area, while in its early stages, may produce different results. BATEC is unique within our sample of centers in that it is working with an already established organization whose mission is congruent with that of the center. That organization is funded by the city and by various foundations and corporations. It seeks to provide resources and opportunities to city students in the IT field with the purpose of advancing their "academic and career aspirations." It does this by creating awareness about technology in students, providing support for teachers to improve teaching and learning, and providing internship and job opportunities to high school students. BATEC has partnered with the organization, which serves as the center's K-12 educational partner in its effort to "align and articulate advanced IT courses to provide a streamlined IT educational pathway for…students" (Patton, 2006).

The infusion of ATE funding has enabled the organization to hire a full-time college liaison. With his knowledge of the high school context, as well as his affiliation with the organization, the liaison is coordinating activity among high school administration, college IT department chairs, career services, admissions, and financial aid offices. Given this existing infrastructure supporting student advancement, BATEC's synergistic efforts may prove particularly effective.

During our site visit to BATEC, the liaison described a newly implemented strategy for increasing enrollment in the colleges' technology programs as one that tracks high school students through the entire process of recruitment, enrollment, and retention efforts. Therefore, the recruitment plan – to target high school students enrolled in IT-related classes, invite them to half-day mini technology fairs at the college campuses, then follow up with contact from the colleges' admissions and financial aid offices – is one that incorporates evaluation into each step of the plan. This represents a more comprehensive and cohesive strategy for recruiting and, potentially, for retaining students at the two-year colleges.

High school articulation. A number of the centers we studied supported the development of articulation between their partnering community colleges and the feeder high schools. This is a significant component because it reinforces student's perception that college is an option. Despite challenges with community college-high school partnerships, the relationships forged between the community college faculty and high school faculty appear to be resulting in improved alignment of high schools courses with community college courses, thereby enabling a more efficient transition from high school to college. In encouraging these partnerships, the centers are combating the longstanding divide between K-12 and postsecondary educational systems. Although some states have made conscious efforts to better coordinate the two systems,

the heavy focus on No Child Left Behind at the K-12 level has not been integrated with policies at the postsecondary level. In California, for example, K-12 standardized testing requirements do not complement the entry-level placement assessments at the college level (Kirst & Venezia, 2004).

The centers are also supporting the increasingly younger students who do not have prior work experience or a significant maturity level by offering structured internships or programs that focus not just on technical skills but also on social and workplace skills. For programs that have typically drawn older students with years of work experience, increasing the proportion of traditional age students has course-level implications. Faculty across the sample colleges noted that younger students are often less adept at and comfortable with working in teams on project-based assignments. At several different colleges, instructors who had experimented with case-based learning and collaboration in classes dominated by younger students (most frequently in computer programming) spoke of the time needed to socialize these students to this unfamiliar classroom environment. In contrast, according to instructors, students with greater work experience had few problems adapting and working productively. As the number of traditional students increases in the programs the importance of attending to such socialization issues takes on greater urgency. Nonetheless, the centers are generally paying attention to these demographic shifts. This is important because these new students represent a new population of students for the community colleges.

Postsecondary connections. The importance of postsecondary credentials to employment is growing, and the focus on creating visible 2+2+2 paths around two-year technical programs has resulted from the ongoing expansion of higher education and the commonplace belief that skilled work requires more than a high school degree. Research on educational expectations has found that the vast majority of high school students indicate their intent to attend college and to earn a bachelor's degree (Rosenbaum, 2001; Schneider & Stevenson, 1999). At the same time, federal and state policymakers have targeted increased postsecondary access as a necessity for economic development. The ATE centers' work to align 2+2+2 technical educational paths fits fairly neatly into this context. The major problems that they face are related to unresolved issues of articulation between the two- and four-year levels and the perceptions that stakeholders have of community colleges as lower status institutions.

There are examples of state policies which are aimed at improving community college transfer among our study sites. For example, Kentucky enacted the Postsecondary Education Reform Act of 1997 which consolidated the technical/community colleges in the state and thereby disconnecting the colleges from the university system and the technical colleges from the K-12 system. In theory, the resulting community college system is overseen by two chancellors, one academic (a position that is currently unfilled) and one workforce, illustrating its commitment to both educational goals. Presumably, the two-year colleges can develop articulation agreements across its system as one mechanism to increase its college-going rate. At the same time, disconnecting the community colleges from the university system has enabled the community college system to make changes (to courses, programs, etc.) more quickly. The expedited program approval process, according to the chancellor, has been "a tremendous opportunity for

responding to the needs of business and industry, and one which our colleges have made substantial use of" (Bird, 2004).

In response to a legislative mandate in 2001, Tennessee's State Board of Regents designated a core set of general education (GE) courses as transferable (in a block) throughout the system. This action necessitated change at the two-year colleges. The community colleges originated as technical colleges and developed into community colleges (permitting transfer to four-year colleges) at different rates. (One respondent described this evolution as a "natural" development trajectory.) Certain colleges in Tennessee were propelled to hurry that process and thereby facilitate students' transfer to a four-year college, both inside and out of the state. At one college, for instance, the need to comply with the Southern Association of Colleges and Schools (SACS) accreditation rules shaped the college's program and curricular requirements. In addition, some faculty members in IT-related programs have had to earn higher academic credentials to continue teaching.

Legislative efforts have established system-wide articulation/transfer agreements in most of the states we studied, governing the block transfer of general education core curricula to colleges in the state's regional or state college system, and instituting specific policies regulating transfer in specified social science/humanities and math/science majors. Such agreements tend to be focused on general education courses and not technical programs, with few, if any, provisions for accepting technical course credits. California, CREATE's state, provides a case in point. While community college students in the state are guaranteed transfer to the four-year state college system in various "academic" fields, colleges that are trying to create new agreements – in IT programs, for example – are negotiating them on a college-by-college basis. Thus, the work that the CREATE colleges are accomplishing helps other colleges in the sense that it provides a precedent or model for other colleges to point to in their own efforts.

In the end, the potential for two- and four-year college transfer/articulation within ATE programs depends, in large part, on the broader state policy environment, which the center cannot control. Yet, the centers we have studied provide models for working within existing policy environments and thus illustrate how ATE centers can, nonetheless, play a role in developing transfer and articulation options for students in their programs.

Case-by-case negotiations. Consequently, the majority of the articulation efforts connect individual two-year colleges with a willing four-year college in the area. In many cases, four-year colleges have become increasingly willing to create formal links with local two-year colleges in the face of state budget shortfalls, heightened competition for postsecondary students, and, in some cases, declining enrollments. One example is CREATE, which has articulated the community college program with an existing industrial technology program at the state university. The center worked with the state university to coordinate offering courses locally and online so that the course options would be physically accessible for community college students. Furthermore, at CREATE, someone is specifically dedicated to identifying bachelor's degree programs into which the CREATE students can transfer, if they express a desire to continue their education. Other examples of case-by-case negotiations include the programs at MCIT's

Metropolitan Community College which can transfer to both the University of Nebraska and University of Lincoln and Iowa Western.

Four-year articulation. Several centers have successfully eased the community college to four year college transition by developing new four-year programs that lead to a BS degree. CREATE, for instance, has been instrumental in developing a BS in IT at CSU Channel Islands which requires an AS (or its equivalent) in an IT-related field (e.g., networking, computer security, computer system administration). The coursework draws from two areas of study, incorporating math, science, and programming from the computer science department and business/management courses found in the department management information systems. Possible concentrations include: (a) web programming and technology, (b) database theory and design, and (c) data communications and networking. The program's website description locates it between two conventional programs: computer science and business:

> This program does not have the rigor of mathematical analysis, design, or object-oriented programming found in a typical BS in Computer Science, nor does it have the depth of business systems analyses found in a degree in a typical BA in Business.

Rather, the program is meant to satisfy the need that sits between these two extremes, emphasizing the fastest growing segments of both computer science and business: web systems, databases, and networks.

At BATEC, a bachelor's degree in IT is under development at UMass Boston. Initiated by two faculty members in the computer science department, the degree is intended to relieve the high rate of failure in the introductory computer science course. One respondent noted that traditionally 60-70 percent of students fail the course, with many of them transferring from two-year colleges. In his view, the problem is that students are being thrown into the field of computer science too quickly and too deeply; instead, they should be eased into the program. One solution has been to create a two-semester alternative to the introductory course so that students learn the same material at a more manageable pace. Interestingly, this instructor did not attribute students' problems to inadequate mathematical preparation: "It is not only about math but also about programming, in the sense that students are not well prepared to juggle several variables and different objects, and in knowing how to organize a program; it's about a certain composition of skills." As they design the four-year program, they can develop courses for the community colleges and clarify their expectations to the two-year college instructors, in essence saying to them, "if you teach this way, it will be recognized and your students will be ready."

One interesting development in terms of articulation agreements with four-year colleges is the number of regional centers that have encouraged the creation of such agreements with online bachelor's degree programs at area colleges. For example, the KIT colleges have a standard agreement with Murray State University's telecommunication systems management program but they also have an agreement with Western Kentucky University's online IT bachelor's degree. Other examples of regional centers that are working with colleges that have articulated their programs to online bachelor's programs are CREATE and MCIT.

Developing articulation agreements at the state level between the four-year and two-year colleges is difficult. Coursework transferability has been an issue for SCATE's two-year colleges and the crucial obstacle is that the two-year college physics courses are not calculus-based. Florence-Darlington Technical College is in the process of making transfer agreements with the University of South Carolina, as well as North Carolina State, Piedmont Technical College has full articulation from the SCATE engineering technology curriculum to the BS Degree in Engineering Technology at South Carolina State University, and Tri-County Technical College has articulation agreements with certain programs at Clemson University. Calculus-based physics also emerged as an issue at Penn State. Penn State University requires calculus-based physics credits for admittance to its engineering programs. Therefore, completion of the ATE program at the community colleges (which involves "applied" courses and physics without calculus) does not, in itself, enable transfer to Penn State University's engineering or nanotechnology programs. In fact, strictly speaking, the articulation agreements for nanofab have been built on the pre-existing articulation agreements in conventional "transfer" fields, such as physics and chemistry. Students can then transfer into the same department of one of the participating four-year state colleges. Thus, because their baccalaureate degree is in one of the traditional sciences, the new coursework counts as a minor concentration.

Despite the challenges, it is clear that there have been successes in developing options for students to continue their education. Given NSF's charge to increase the quality of STEM workers, pathways for obtaining a four-year degree in a STEM field are important, yet the primary emphasis for the ATE program is on technician education rather than pathways to four-year degrees. Clearly, the community college play a critical role in creating a workforce that is well prepared with certificate and associate degrees, but to improve the overall workforce there also needs to be opportunities for students to pursue advanced degrees in the STEM fields.

Connections to Industry

The role that the ATE regional centers play in building and maintaining strong connections to industry is critical for the regional centers to meet the goal of workforce development. Without these connections, the centers would be unable to meet local industry's needs or to create job opportunities for their students. This section considers the role of industry on the regional center advisory boards and proposes that the centers are acting as *workforce intermediaries*.

Industry participation on the advisory board. One critical component of industry relationships, beyond hiring, is the role that employers play on program advisory boards and the ATE regional center advisory boards. It is common for technology programs, and in some cases required for accreditation purposes, to have an advisory board made up of local business representatives. Sometimes they are simply a pro forma board that is inactive, as one BATEC faculty member indicated of his computer science advisory board. But in other cases they are very active and help to guide the curriculum as a way of making sure that the graduates have the skills needed by the local industries. One MCIT faculty noted that, for her, the participants in the advisory committee are the best source of her information about business and industry. They meet

formally once a semester, but she works with each member at least once per month and they call her to let her know about job openings that might be good for her graduates.

The reasons for industry participation vary significantly. For example in contrast with the example above, one of the CITE faculty noted that when their two lead companies originally began working with the center the reason was that they believed that it was their mission to be involved with the future workforce. Thus they worked with the faculty to develop the original model and continued to be a resource for future faculty. The PI noted, "Faculty were encouraged to talk with people in their community, people who were involved with businesses that required an IT workforce. One faculty was able to use his networking skills in the community to enlist people."

However, in the case of BATEC, industry participation is partially the result of a spirit of community service. One board member for BATEC characterized his involvement with the center as more the result of his own desire to support BATEC, though his role as a BATEC board member is also compatible with the priority his company places on community involvement. He explained that "the fact that I am involved with BATEC is supported by my company's enthusiastic endorsement for me to be involved because it does align with my goals and objectives."

In contrast with the community service ethic, industries in other regions are pursuing partnerships with regional centers for reasons of self interest: they need more skilled workers. One SCATE faculty member noted: "The need for technicians is so much greater than the supply, statewide, region wide, if there were any way we could graduate more technicians they would be snatched up immediately." This sentiment was echoed by a local business partner, who currently has four or five interns through SCATE and eight to 10 SCATE graduates of the program.

ATE regional centers as workforce intermediaries. This report has articulated the ways in which ATE regional centers are unique in their concentration on a particular field, the specification of a logically defined region, and their attention to academic program reform. The ATE regional centers emerged from the specific needs of the ATE program leadership for a new organizational form to undertake the program's mission. Nevertheless, these new organizations resemble both in form and mission what have been recently called workforce intermediaries in community college workforce development circles. This concept was developed in the early 1990s by many workforce development policy experts who saw the need for locally-based organizations to aggregate and articulate the skill demands of groups of companies to training and education providers, such as community colleges. The assumption is that these organizations could specialize in the linkages between both employers and community colleges and become an "honest broker" between these two groups. While the original concept was directed at community-based organizations, such as Project Quest in San Antonio and the Wisconsin Regional Workforce Partnership, by the end of the decade there were attempts to apply the concept of the workforce intermediary directly to the work of community colleges (Giloth, 2003). The Anne E. Casey Foundation funded these workforce intermediaries in five cities in the United States, and the two projects that remained in existence after the original funding cycle

linked their efforts with the local community colleges. This work has shown that through intensive intervention by an alliance of community-based organizations and community colleges, career pathways into technology jobs are possible for many low income residents

Workforce intermediaries are characterized by organizations whose "approach is dual-customer, serving employers and workers as well as job seekers" (Giloth, 2003, p. 217). Intermediaries have two primary functions: (a) an organizing function, in which they bring together labor market stakeholders, often organized by industry or geography, negotiate with employers, reach out to congruent organizations, conduct research and advocate for public policies in an attempt to create programs and pathways in support of workforce development efforts generally directed at low income workers while improving the business productivity; and (b) the provision or brokering of services to job seekers including job matching, training, and post employment support services (Giloth, 2003; Kazis, 1998; 1999; *Workforce Intermediaries*, 2004).

ATE regional centers possess many characteristics of a workforce intermediary. Their organizing function is clear: they bring together multiple community colleges, universities, businesses, and, often, local and state government partners; and they are organized around a core industry and use focus groups with employers to create programs supporting the hiring needs of groups of employers concurrently with the educational needs of local students and employees. As we have noted elsewhere in the report, the research component is somewhat limited and the importance of that function in workforce intermediaries underscores our suggestion that rigorous research on local labor markets and the impact of the center's programs on its students and industry partners is critical. Many of the centers also fulfill the role of brokering services insofar as they provide some job matching services and support community colleges in developing training programs. While they are often located inside the community college structure, they perform a very different function from the traditional academic for-credit programs at the institution. They are aggregating the technology skill needs of a specific sector or industry and presenting them to the community college faculty for a programmatic response. Yet, unlike the traditional customized training units, their goal is not to train the incumbent workforce as much as to seek out new opportunities for the community college students in the college's traditional programs. Because of their ties with the industry, the programs created should produce students with skill sets that are relevant to the industry. Moreover, in their programmatic activities they are balancing the needs of their industry partners with community college capabilities, performing exactly the mission of an intermediary which attempts to bring both institutions together around a common goal – the economic development of particular region or area.

The regional centers differ from the traditional concept of workforce intermediaries in some ways. They do not engage in post-employment support services, providing a follow-up for students who are holding jobs. Indeed, immediate employment may not be the goal of some of the centers as much as preparation for continuing students' education into four-year degree programs. In addition, the centers have not directed their efforts exclusively toward low-income community residents, although their focus on community colleges results in reaching many low-income students. The most important difference is that the regional centers stress a particular substantive area – either a field of study or a specific technology – with the goal of preparing students for jobs in that particular area, typically by helping them earn a degree. The workforce intermediaries are willing to work with the employer needs of any set of firms as long as there

are jobs for their constituents. Nevertheless, the regional centers are focused more on helping students develop a substantive skill set than on serving as an employment agency.

The Evaluation Study indicates that a majority of the ATE projects solicit direct input from their business community for the development of their programs (Evaluation Center, Value Added to Business and Industry, 2006). One of the central functions performed by the projects was to take the state workforce strategy and implement it within the traditional credit parts of the college, serving as another means by which the community colleges developed their programs in close contact with business and industry.

The ATE regional centers in our study are serving as effective intermediaries between their regional community colleges and industry. Given their ability to garner resources unavailable to community colleges, their specialized skills and entrepreneurial nature enable them to create structures that the colleges cannot. In addition, since they are generally small organizations, a characteristic consistent with workforce intermediaries, the centers are able to be a lot more flexible and adaptable. Finally, the PIs at many of the centers display a charisma and political savvy that is critical for the success of a workforce intermediary. They operate within the college but not of the college. While there were many critics of the workforce intermediary concept within the community colleges who argued that it was unnecessary to overlay an additional layer to the relationship between the college and the firms served, the ATE regional centers might present a happy compromise by being part of the institution, yet sufficiently separate and situated to warrant the trust of the private sector they serve. Some of the points made in this section about the most effective intermediaries are also important characteristics to note as we consider issues of sustainability in the next section. As intermediaries, the ATE regional centers may represent a new form of the concept of sustainability.

SUSTAINABILITY AND INSTITUTIONALIZATION

Our research questions concluded by asking how the regional centers conceptualize sustainability and what they are doing to achieve it. This is a key question, particularly for those initiatives that had a positive impact on the region's workforce: how does a good program keep going? Our interviews revealed consistent concern about sustainability and varying degrees of efforts to address it.

As we conceived of sustainability, a center might find other sources of funding in order to continue its work. Alternatively, the program level impacts might become institutionalized within the college or system such that the sustainability of the center itself is no longer a concern. These two approaches will be addressed below, along with a set of four impediments to sustainability.

The easiest way to keep a center running is to find funding sources, whether that means obtaining another NSF grant, as all of the eight centers have already done, or identifying other resources. Those alternative options vary greatly, as demonstrated by our sample of regional centers. For example, KIT has both tied itself into the state's efforts to improve the community college system and found private funding for affiliated projects. Similarly, CREATE now receives support from Cisco for some of its programs. CITE became actively involved in a local initiative to prepare students beginning in the elementary schools and has shared its pedagogical approach with the K-12 system. In another model, SCATE has created a not-for-profit organization designed to carry out successful initiatives that have been seeded with grant money. And the manufacturing program affiliated with CNME is closely tied to the state's workforce development initiatives.

Institutionalization

The regional centers that have found ways to incorporate their curricula into the regular functioning of the colleges are those that have been truly institutionalized. For example, both CNME and CREATE have installed new degree programs at the community colleges which are now a regular part of the course catalog. Conversely, while the activities of SCATE were originally adopted by a large number of college faculty, those numbers are declining as community colleges drop the program. As a corollary, one CITE faculty member noted: "This cannot be done with one faculty member in isolation in the classroom. It really has to have institutional support." Thus, even when a faculty member at a school is passionate about the project, it is unlikely to succeed if there is no institutional support for it.

When the administration seeks to impose a project on the faculty, it is also unlikely to succeed. One interviewee said: "If faculty were encouraged to explore [a possible project] and were given the option to make the choice about whether to do it or not, those that did it under those conditions were very successful. In one case… [everyone was]… expected to take this on. It was not a choice. That is really important, because those faculty who were recruited to do this

without a choice were the ones who had a less than positive experience." This issue, heard at colleges regardless of the center with which they worked, is illustrated by the following comment in which a professor noted that once the center no longer provided the funding and release time to implement the curriculum, and the college failed to step in, there was little incentive to continue using a more challenging and time consuming teaching approach: "He said if he wasn't going to get any release time any more, he wasn't going to do it any more. I kind of feel that way too. We got release time the first couple of times, and now we don't get it any more."

Institutionalization of a program is critical, particularly because of turnover at the colleges. One PI said "… [what] happens all the time, and this probably hurt us as much as anything else, is the administration at the colleges change, and when the administration changes the wind blows a whole other direction. And you've got unusual initiatives at the college that were not initiated by the new administration, they come under intense scrutiny and can easily get derailed if you don't have somebody there who champions it." Clearly, turnover is inevitable and is not something that the regional centers can control, but they can prepare for it by making sure that their projects have multiple champions in every partnering college.

This lack of institutionalization, combined with a change in administration, has effects that can be seen in many of SCATE's early community college partners. When asked about what happened once a new administration was installed and the college stopped using the curriculum, one interviewee affiliated with SCATE replied that the instructors went back to their traditional teaching methods. He did note that a few people who participated in the project "inject" the concepts into what they are teaching, but that turnover, even among the faculty, further hinders continued use of the curriculum.

In contrast, one of the colleges that CREATE has worked with for nine years has been supportive of the project both from a financial and a procedural perspective. One faculty member noted, "The institution has matched anything the grant has done and in most cases gone well beyond it." The administration provided initial funding to create the lab and buy the necessary equipment while the curriculum committee worked with the program director to get them through the approval process with minimal effort.

Factors Influencing Sustainability

After considering the experiences of our eight sample regional centers, we developed a framework of four influences on center sustainability. Specifically, we found the most significant influences to be: (1) the center's focus, (2) the longevity of the organization, (3) the connections with industry, and (4) the connections with other initiatives.

The first component seems fairly straightforward: the centers such as MCIT, ITEC, and KIT that primarily attended to workforce expansion (WE) had to deal with changing technology, the absence of a market for the technology they had chosen, and a question of saturation; that is to say, they did not necessarily know what to do once they had trained all the faculty in a given

area. Centers with a program reform (PR) focus tended to be more adaptive, such that if the technology skills changed or the workforce needs changed, their pedagogical approach was still useful. Further, by focusing on program reform, the changes in the needs of the workforce drove the creation of entirely new programs or adaptations of old one. Fundamentally, the workforce expansion focus tended to be more narrowly conceived than the program reform focus. However, it is important to note that while most centers concentrated on either WE or PR, they usually employed both approaches to some extent.

The second influence is whether the center existed in some form prior to the NSF ATE grant. Simply put, the presence of a longstanding already sustainable program signals the ability to continue to function after the ATE NSF funding disappears. It also means that the individuals involved have experience (and in many cases more than a decade of experience) in ensuring the survival of their efforts. Half of the eight centers – CREATE, BATEC, CITE, and SCATE – existed in some previous form.

Third, industry connections were critical because they are an indicator of the ability to stay current with workforce needs and, thus, respond appropriately. Those centers with substantial industry contacts will continue in large part because they have created the need that business now has for them. We found that CREATE, BATEC, and SCATE had substantial industry contacts with very active advisory boards while also allowing for multiple opportunities for engagement. CITE displayed industry contacts of a different nature, with such contacts supporting professional development opportunities and the creation of model IT academies. CNME, ITEC, KIT, and MCIT and had more moderate industry connections with fewer opportunities for formal engagement of industry in their activities.

Finally, the ability to connect the center to another local or state initiative has implications for the institutionalization of a center's work and, thus, its sustainability. If its goals are congruent, or if the center is the mechanism through which the state pursues workforce development, then it is likely that the organization will continue.

Sustainability is clearly identified as a critical component of the ATE Regional Centers concept in the NSF RFP. However, further consideration of sustainability is warranted. We found that sustainability emerged in two forms: those that continued in the same model as they had while being funded through ATE and those that transformed into something different as they responded to local industry needs. Clearly, in both cases, the center's core is sustained, although the extent to which they are seen as continuing in the same form or even by the same name may differ.

CONCLUSION

This report describes the role of regional centers in the National Science Foundation's Advanced Technical Education program. We began by asking whether the regional center concept was unique and useful. We found that these centers are playing a useful role in addressing needed community college academic reform, are emerging as new and unique forms of workforce intermediaries, and have cultivated critical relationships with other educational sectors.

We are pleased to see that the regional centers have generally prioritized fundamental academic reform in community colleges as we suggested in a previous final report on a study of the National Centers (Bailey, Matsuzuka, Jacobs, Morest, & Hughes, 2003). We saw evidence of this academic reform in the attention paid to creating articulation agreements for students in these programs, the strengthening of the math and science requirements in existing programs, the use of case-based learning, and the integration of STEM topics across the curriculum. Such an attention to the academic core of the programs provides program graduates with greater opportunities after they leave the community college.

The role that the ATE regional centers play in developing industry connections is critical for the regional centers to meet their goal of workforce development. Thus, we highlighted the role that the centers have as workforce intermediaries. We suggested that they are a new form of workforce intermediary because they posses the characteristics of traditional workforce intermediaries but also focus on additional educational opportunities, not just immediate employment. Further, the centers have tended to concentrate on particular fields of studies and reach out beyond the traditional low-income population.

Finally, we saw significant relationships with other educational sectors, such as the K-12 system and the four-year colleges, promoted by the regional centers. Such relationships are critical in supporting a pipeline of well-educated students who are prepared for technical jobs at all levels of the organization.

In conclusion, the ATE program was developed and nurtured by a dedicated group of individuals within NSF. They have used their creative talents to implement some substantial programs – one of which is the regional center model. However, as the community college movement expands and matures, the time has come for the ATE program to align its efforts with the activities of others who are reforming the colleges. When this happened unintentionally the regional centers were stronger and more rooted in their work. Such alignments will prevent the program from being viewed as simply another source of money; rather, the regional center concept will be considered part of a larger effort to bring innovation and change to the most important new institutions of postsecondary education in America.

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