The Development of a Regional Engineering Center: A Collaboration that Works

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Abstract– The North Carolina Center for Engineering Technologies (NCCET) was created to provide a facility for applied research in engineering related fields in the Unifour region of North Carolina. The center serves as a conduit to baccalaureate engineering education delivered by University of North Carolina system schools, including Appalachian State University, Western Carolina University, East Carolina University, and the University of North Carolina at Charlotte. Instructional delivery is multifaceted and includes face-to-face, online, hybrid, interactive television (ITV), and laboratory instruction via a Virtual Computer Laboratory (VCL).

Conceived as a community supported higher education effort in technical and engineering disciplines, the NCCET was established through a collaboration of business, government and higher education organized as the Future Forward Economic Alliance. This collaboration resulted in a major public-private capital campaign, which raised enough money to purchase and renovate the current building. Once completed, the building was presented to the University of North Carolina system for its intended use. The UNC system assigned Appalachian State University as the center's fiscal agent. The NCCET opened in 2008 with Western Carolina University's Engineering Technology curriculum as the resident degree program. Since that time, the center has served an average of 50 students per semester in engineering related disciplines and currently serves an additional 100 students per semester in other programs.

This paper will discuss the history and development of the center, its current status, and challenges and opportunities involved in cooperating with other universities for a common goal. In addition, educational merit and future plans for utilization of the center will be discussed.

Keywords: Engineering Technology, industry partnerships, educational partnerships

INTRODUCTION AND BACKGROUND

Western North Carolina has been a hotbed of textile and furniture manufacturing for most of the 20th century. Manufacturing employment in several counties reached over 50% of the employment base [1]. The companies were flourishing and were founded on the solid family principle that hard work will produce a good product. In the last part of the Century, however, the climate changed. Global competition reared its ugly head. Labor intensive operations could be much more competitive in countries where a week's wage was equivalent to an hour's wage in the United States. The information age and globalization compounded this issue to the extent that the companies in this region had to consider subcontracting their products off shore. In some cases entire product lines were dropped in favor of foreign produced products.

Layoffs became commonplace and company closings ceased to reach the front page of the paper due to the many companies forced completely out of the market. The employers were resistant to realize that the practices they had built their success upon were no longer valid in this global market. The driving impulse to "buy American" priced

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many product lines completely out of the market. While it was commendable for the company leaders to have the spirit to buy American, the consumers did not share that philosophy. Name brand loyalty fell to cost considerations and the American consumers looked for "bang for the buck" without regard to the source and many times without regard to quality.

The Role of the Future Forward Economic Alliance (FFEA)

The declining economy in Western North Carolina led government officials to develop the Future Forward Economic Alliance in 2002 [2]. The Future Forward Economic Alliance (FFEA) (designated as a 501(c)(3) public charity) is a regional economic development initiative to create a Comprehensive Economic Development Strategy (CEDS) for 12 counties located in the 10th and 11th Congressional Districts in the Western Piedmont and Mountains of North Carolina. The plan initially received funding support from the US Economic Development Administration and the North Carolina Department of Commerce. Former Congressman T. Cass Ballenger appointed a 21-member leadership group to oversee the Future Forward strategy development process, and the Western Piedmont Council of Governments managed federal and state grant funds for the project. Funding has continued with annual financial support from participating counties, cities and, in one instance, a private foundation.

The Future Forward region experienced a substantial growth in population during the 1990s, but much of that growth can be attributed to an increase in the population of Asians and Hispanics. During the 1990s, the region's population of these groups grew fivefold. In several the growth rates for Hispanic populations were 750 percent or more. During the same period, the Asian population quadrupled in the Future Forward region [2].

Per capita income in the region is lower than the state average and fell further behind during the 1990s. At about $24,100, per capita income for the region averaged about 90 percent of the state average and about 81.5 percent of the national average in 2000. This figure was down from 92 percent of the state average in 1990. Per capita income is often closely related to the general education level of the population. While the proportion of adults with a high school degree was higher than the statewide average, the proportion graduating from community college or university was much lower than the state, and that gap widened during the 1990s [2].

The Future Forward Economic Alliance's goal was to renew the region's economy and make the region more competitive in a global marketplace by 1) improving the education and skills of the workforce, 2) encouraging a renewed sense of entrepreneurship and innovation, 3) promoting a more diverse economy, 4) developing and protecting urban and outdoor amenities, and 5) encouraging teamwork among local governments. To accomplish these goals, the Future Forward Economic Alliance focused on the following regional projects [3]:

- Education and Workforce Training
- Collaborative Regional Projects
- Jobs for the New Economy

Key strategies and action items were identified to bring the region together and provide a wish list of key economic development projects for federal, state, local, and private investment. High on the list was a resolution of educational access to citizens of this region. The core area was the largest metropolitan statistical area (MSA) in the state without the presence of a public four-year university. The FFEA sought to address the access to higher issue by raising private funds to purchase a facility that could be used to provide engineering related education to the region.

Future Forward Economic Alliance's signature project became the acquisition and renovation of a former Corning Cable Systems research facility to house the developing engineering center.

The North Carolina Center for Engineering Technologies

Western Carolina University Becomes a Partner

In 2005, Western Carolina University was approached by the FFEA about becoming a partner in developing the new engineering center for the region. Western Carolina has a history of delivering off-site technology education that dates back into the 70's. Western Carolina was currently delivering Engineering Technology classes to the area at Catawba Valley Community College in Hickory, NC and Western Piedmont Community College in Morganton, NC. The distance Engineering Technology curriculum was fairly successful in the area, with an average of 20 students enrolled, but was limited by the lack of laboratory space.

Dr. Duane Dunlap, Department Head for the Department of Engineering and Technology at WCU, and Dr. Bill McDaniel, Dircetor of Distance and Transfer Learning for the department became the point men for WCU's involvement. Immediately, a tour of the former Corning building was arranged and Dr. McDaniel began work with Mr. Ernest Sills, AIA, of CSBA Architects on renovating the structure and making it ready for occupancy in its new role. The 55,200-square-foot building was ideally suited for a wide range of educational and economic development initiatives. Corning agreed to sell the facility to Future Forward at a significantly reduced price in support of the effort to strengthen technical higher education in the region served by Future Forward. A fundraising campaign designed to solicit funds to purchase the building, outfit the facility for educational purposes and acquire initial equipment generated cash and in-kind commitments from local public and private sources totaling more than $1.7 million. Future Forward received additional grants and support from local governments and the regional business community.

As the fundraising was being conducted for the purchase and renovation of the building, Western Carolina was busy developing the educational specifications for classrooms and laboratories. It was determined that several labs would be included in the first phase of development. Those labs were an Engineering Design lab, a Rapid Product Realization lab, a Metrology and Reverse Engineering lab, a Polymers lab, and a Telecommunications lab. These areas would allow WCU to begin delivery of their Engineering Technology curriculum and provide workforce development education for the region. To help equip the labs, Western Carolina submitted a grant proposal to the Golden Leaf Educational Foundation for $2.1 million. As proposed, the center would be completed in three phases. Phase 1 would include the Engineering Design Lab, a classroom capable of delivery of interactive video conferencing from Cullowhee, and all related offices and furniture. The total for Phase 1 was projected to be $770, 000. Phase 2 included equipment and instructional furniture related to the Rapid Product Realization lab and the Rapid Prototyping lab, at a cost of $867,000. In the final phase, the Polymers/Composites laboratory and the Telecommunications laboratory would be completed at a cost of $463,000. The total project cost equaled the Golden Leaf proposal of $2.1 million.

Appalachian State University Becomes a Partner

Future Forward concluded its fundraising campaign in late 2006, raising enough money to pay Corning for the building, and to cover the costs of renovation. During that same time period, a decision was made at the University of North Carolina system office that the center should operate under the fiscal auspices of the closest university,

which happened to be Appalachian State University. Western Carolina University would still provide its Engineering Technology curriculum, as planned. A similar relationship existed with the UNC system created the North Carolina Center for Applied Teaching in Cullowhee. The center was built in Cullowhee in 1985 on land provided by WCU and is still supported by WCU [4]. Another similar statewide project was already in effect in the Microelectronics Center of North Carolina [5]. In 1980, the Microelectronics Center of North Carolina was created to be a catalyst for technology-based economic development throughout the state [5]. In 1985, the MCNC started to connect the university system through a communications network, which became the first broadcast-quality, two-way interactive, multipoint video and audio system in the United States [5]. With these successful collaborations in place, the UNC system followed suit with the NCCET. While the change presented some differences in the original operational plan, it did not change the mission and purpose of the center.

After the completion of enhancements to the facility that made it more suitable as a higher education center, Future Forward transferred ownership of the center to Appalachian State University in December 2007. Western Carolina University began delivery of their Engineering Technology curriculum with 50 students enrolled in January, 2008. Appalachian State University began a BS in Building Sciences in January 2009, with 20 students enrolled. Since that time, Western Carolina and Appalachian have fostered a successful relationship that is a jewel to the region.

CURRENT STATUS OF THE NORTH CAROLINA CENTER FOR ENGINEERING TECHNOLOGY

The center currently provides degree programs in Engineering Technology and Building Sciences, as well as workforce development education and specialized technical training throughout the 12-county Future Forward region. The North Carolina Center for Engineering Technologies, specifically Western Carolina University's Engineering Technology curriculum, is a needed resource in a region that has seen many jobs evaporate and unemployment skyrocket. The Engineering Technology is the right program at the right time due to its options in Engineering and Technical Operations. Engineering Technology is no longer just applicable to manufacturing. As business and industry moves away from traditional smokestack industries, the Engineering Technology curriculum has expanded its focus to rapid product realization, rapid design and prototyping, rapid manufacturing, logistics and supply chain management, safety systems, and telecommunications systems. Specifically, the NCCET partnership will:

- fill an educational void in university-level engineering and technical courses previously unavailable in the Unifour and surrounding region
- assist the region in upgrading the skills of the region's work force
- refocus engineering education from declining technologies to emerging industrial technologies
- foster a spirit of cooperation with the community colleges, private colleges, universities, businesses and industries in the region in order to educate a smarter workforce
- assist in Economic Development activities in the region
- enhance the region's transition toward a more knowledge-based workforce
- promote economic diversity – more entrepreneurial activity and expansion of producer service sector

The BS degrees delivered at the NCCET enable individuals employed in business, industry and government- related occupations to pursue four-year degrees through part-time evening study. The intent of the degree program is to provide an appropriate educational experience to qualify graduates for career advancement. Instructional delivery is a combination of live classes supplemented by an online component. WCU's program is heavily supplemented by hands-on laboratory activities provided in state-of-the-art labs in the NCCET.

NCCET Laboratories

One of the main goals of the Future Forward Economic Alliance was to renew the region's economy and make it more competitive in a global marketplace. The key strategy in doing so was improving the education and skills of the workforce. That goal and the NCCET's emphasis on applied technology necessitated the creation of high-

quality, state-of-the-art laboratories. Western Carolina's original three phased plan of outfitting labs with cutting edge technology served as a blueprint. The NCCET was awarded $600,000 of WCU's original $2.1 million Golden Leaf grant. That sum, and other equipment grants provided an excellent basis for the current laboratories at the NCCET.

Engineering Design Laboratory

The Engineering Design facility allows students to experience the latest technologies available for the design and engineering of new products. Software like ProEngineer Wildfire 4.0, Solidworks, and AutoCAD enables students to virtually design and test new products for many industries in the Hickory area. Equipment includes:

- 25 Dell Optiplex personal computers
- 25 LCD 24" monitors
- HP DesignJet 4500mfp plotter
- HP large format scanner
- 3- Dell laser printers
- Pro/Engineer Wildfire 4.0 parametric modeling software (25 seats)
- SolidWorks 2010 parametric modeling software (25 seats)
- AutoCAD 2011 2D CAD software Suite (25 seats)
- Rapidform XOR, XOS & XOV (25 seats)

Rapid Product Realization Laboratory

The Rapid Product Realization laboratory provides students with real world experience in rapid manufacturing through design and production hardware and software. Students are able to design and produce products on full sized Haas CNC equipment and cutting edge software. Equipment includes:

- Haas VF – 1 Vertical CNC Milling Machine
- Haas SL – 10 CNC Lathe
- Haas TM – 1 CNC Tool Room Milling Machine
- Haas TL – 1 CNC Tool Room Lathe
- Tooling for above
- Grizzly Industrial Drill Press
- Maxus Glass Peening Machine
- Dayton Blade Welder
- Impala 60K Shop Press
- Graymills Parts Washer
- Millermatic 212Autoset MIG welding system
- Kent Surface Grinder
- Tinsmith 4' Sheet Metal Shear and Brake
- Doall Horizontal and Vertical Band Saws
- Small Metrology Equipment
- Surface Plate
- Milwaukee Metal Cut-off Saw
- OneCNC software

Metrology and Rapid Prototyping Laboratory

The Metrology and Rapid prototyping laboratory allows students to have access to the latest measurement and prototyping equipment used in reverse engineering existing products. Rapid product realization is a reality through the Dimension three-dimensional rapid prototyping machine. Equipment includes:

- Mitutoyo PH-A14 Optical Comparator
- Z-Corp 3-D Printer (shared with local community college)
- Dimension 3D Fused Deposition Modeler
- Alaris30 Polyjet 3-d Printer
- Universal Laser Cutter

- Metris 7-axis Laser Scanner
- NEXT Engine Scanner
- Instron Tensile Testing Machine
- Qualtest Heat Deflection Tester
- Rockwell & Brinell Hardness Testers
- A&D Moisture Content Analyzer
- Small metrology equipment and surface tables
- Other associated test equipment

Polymers and Composites Laboratory

The Polymers and Composites area serves as a resource for the many related polymer/fiber industries in the region. There are very few outlets for quality instruction in the areas of polymeric/composite materials and related processing equipment. Students receive instruction in the areas of polymer chemistry, polymer testing, injection molding, thermoforming, extrusion, blow molding, rotational molding, and other processing methods. Equipment will include:

- Battenfeld 750 Injection Molding machine
- MAAC Thermal/Vacuum Forming machine
- Wayne Extrusion Molder
- ROCHELEAU Blow Molding machine
- EMCO Rotational Molding machine
- Branson Ultrasonic Welding machine
- Carver Compression Molding machine
- Tineus & Olson Charpy Impact Tester
- Venz Melt-Flow Indexer
- Gardner Impact Tester

Distance Learning Laboratory

The Distance Learning classroom enables students to interact with colleagues in Cullowhee, Charlotte, Raleigh, Boone, or virtually anywhere in the world. Students will utilize two-way data, video, and voice over internet based systems. The facility will hold 80 students classroom style and high definition video is transmitted and received through a Polycom system. This room has multiple LCD screens and LCD projectors to provide maximum viewing of local and remote sites.

Continuing Engineering Education and Services

The NCCET also provides product development, business process improvement and manufacturing competitiveness assistance; imparts intellectual property transfer know-how; and supports regional economic development activities. Independent to the projects developed by industry employed students, the NCCET has provided engineering related services to over 30 different companies/organizations, primarily in product design and development and rapid prototyping. Many of the companies have worked with NCCET on multiple projects. It has been reported that the efforts have resulted in hundreds of thousands of dollars of increased revenue and many new jobs.

The NCCET hosted a Future Engineers Summer Camp July 12-16, 2010, for rising 3rd to rising 5th graders. The event was designed to further students' interest in math and science, as well as to introduce them to careers specifically in the field of engineering. The NCCET also purchased equipment to support a middle school robotics program. Due to its overwhelming success, the Future Engineers Summer Camp will be continued in summer 2011 with two rising 3rd to rising 5th grader camps and a new Robotics Camp for middle school aged students.

Continued collaboration by the serving Community Colleges and the two primary universities, WCU and ASU, has resulted in top quality instruction resulting in graduating employees that have the necessary skills to make their companies competitive in a global market. These graduates have a propensity to stay in this region for their career.

CHALLENGES AND OPPORTUNITIES

There have been many challenges in the development of the North Carolina Center for Engineering Technologies. Members of the Future Forward Economic Alliance were well aware of the uphill struggle that was ahead of them when they voted to establish an engineering center in the early part of the 21st century. The primary roadblocks identified early on were raising the capital to purchase a suitable facility, and finding the resources to outfit the laboratories in an appropriate manner. One additional concern was the operating budget, once the building and labs were in place. All of these initial concerns were satisfactorily addressed. The building was bought, renovated, equipped, and paid for by the end of 2007. Also, in 2007, the North Carolina General Assembly voted to fund the operation of the center with a recurring budget line of $600,000 per year. In tough budget times, the possibility of cuts is always looming, but the center has been fortunate to stay away from any major budget cutbacks.

Another challenge for the center was to foster the collaboration of two major universities, each with its own priorities, goals, administrations and egos. Western Carolina University is a regional comprehensive university of 9,500 students with over 220 available majors and concentrations [6]. Appalachian State University, almost twice that size at 17,000 students, has 140 majors [7]. While both universities are similar in purpose, they have greatly different priorities. However, both Appalachian State University and Western Carolina University were listed in the top ten universities *U.S. News and World Report's 2011 America's Best Colleges Guide* for the Top Public Universities-Master's south category [8].

Appalachian does not offer any engineering programs, while Western Carolina has several engineering/engineering technology curricula. The two entities work very well together. Appalachian State offers a cohort of Building Sciences: Construction Management at the NCCET campus. Western Carolina is responsible for the delivery of the Engineering Technology curriculum featured at the NCCET. The director and staff of the center work as partners with the director and professors of WCU's Engineering Technology program. The result is a win-win situation for both universities. The real winners are the residents of the Unifour region who have access to the center.

While the current status of the NCCET is very positive for the region, there are still opportunities for growth and improvement. As stated earlier, the center is serving the region through one Engineering Technology curriculum and one Building Sciences curriculum. It was projected that the University of North Carolina-Charlotte (UNCC), East Carolina University (ECU), and North Carolina State University (NCSU) would each add to the opportunities available for students in the Unifour area. That has not yet happened. Currently, Western Carolina and Appalachian State are the only institutions that have shown an interest in offering programs at the center. East Carolina has a variety of successful programs that are totally online. NC State has a complement of programs that are available online also. UNCC offers an engineering technology curriculum that is mostly online, with some required travel to Charlotte. It is hoped that in the near future, these universities will utilize the facility with resident face-to-face offerings or ITV courses.

The NCCET is currently working with Universities and Community Colleges to identify and define paths to engineering education in this region. A renewed articulation agreement for transferring community college students to NC State Engineering programs is nearly finalized. Once this supply chain is clearly established, providing additional baccalaureate engineering degrees to the region will provide a degree path for engineering-ready associate degree graduates who can be successful in a rigorous engineering program.

EDUCATIONAL MERIT AND CONCLUSION

The educational merits of this approach reach well beyond the traditional bounds of the university and have a significant impact in the Unifour region. Students consistently demonstrate that, as a result of the availability of the BS degree programs in Hickory, their potential for career advancement is greatly enhanced. Educational merit is shown by the uniqueness of this approach. The approach implemented at the NCCET provides a logical and systematic method for building on theory and effectively implementing project based learning methods in a quality setting.

The collaboration of Appalachian State University and Western Carolina University in delivering programs in a common facility has been successful in providing appropriate educational experiences for students in a region of North Carolina not otherwise served by a public University. The project has demonstrated there can be successful

partnerships between historically competitive universities when the focus is on the students and the economic development of the region. Both universities have active programs that utilize the resources in the facility. Faculty reported in a recent survey that the equipment and laboratories at the NCCET were equal to or better than that found on their own campuses. The cooperative nature of this venture proves there is a solution to delivering laboratory based programs away from the main campus.

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Dr. Sidney G. Connor

Dr. Sid Connor is currently Professor and Director of the North Carolina Center for Engineering Technologies, a Center of Appalachian State University. Dr. Connor holds both Bachelor and Masters degrees from Wichita State University and a Ph.D, from Kansas State University. Dr. Connor began his educational career at Wichita State University after working in industry and the military for eight years. Connor was named the Dean of the College of Applied Science and Technology at the University of Arkansas at Fort Smith where he also served as Vice President for Curriculum Development and University Center Operations before coming to Appalachian State University. Dr. Connor served as Chair of the Department of Technology at Appalachian State University beginning in 2004and was reassigned to direct the North Carolina Center for Engineering Technologies in 2007. Dr. Connor has extensive professional organization experience and has held over 30 elected or appointed positions with the Society of Manufacturing Engineers including a 2 year stint on the International Board of Directors. He has worked to provide training and consulting to a variety of companies including Boeing, Cessna, Lear Jet, The Coleman Company, Trane and Rheem air conditioning companies, and numerous other industrial organizations.