University and Community College Collaboration in North Carolina

George Ford[1], William McDaniel[2] and Aaron Ball[3]

Abstract – The North Carolina Community College System (NCCCS) operates 58 colleges which serve over 850,000 students. According to the System website, one in eight of the state's residents enrolled in one or more of their programs last year. Western Carolina University (WCU) is a regional, comprehensive university and is located in Cullowhee, North Carolina, approximately 45 miles west of Asheville. There are approximately 9400 fulltime, undergraduate students attending the University. Western Carolina University is a member of the University of North Carolina system.

The Kimmel School of Construction Management and Technology at Western Carolina University offers programs in engineering technology, electrical engineering and construction management. According to their mission statement Western Carolina University creates engaged learning opportunities that incorporate teaching, research and service through distance education. In addition to supporting the mission of the University, the faculty in the Kimmel School recognize the value of distance education and collaboration in the creation of student contact hours to support on-campus programs.

The Kimmel School works in cooperation with regional community colleges in the state by providing an engineering technology program specifically tailored for working professionals who complete two-year technology programs at the community college and by maintaining relationships with community college faculty through research collaboration and recruiting and student advising activities. This paper provides details on the activities performed by Kimmel School faculty in concert with community college faculty to provide opportunities for students to continue their education after completing their two-year degree.

Keywords: community college university collaboration, articulation agreements, advising, recruiting

INTRODUCTION

Western Carolina University is a regional, comprehensive university and is located in Cullowhee, North Carolina, about 45 miles west of Asheville. There are about 9400 fulltime, undergraduate students attending the University. "Western Carolina University creates engaged learning opportunities that incorporate teaching, research and service through residential, distance education and international experiences. The university focuses its academic programs, educational outreach, research and creative activities, and cultural activities to improve individual lives and enhance economic and community development in the region, state and nation" [6]. The University offers about 120 programs including construction management and engineering technology.

The mission of the 58 community colleges in the North Carolina Community College System is to open the door to high-quality, accessible educational opportunities that minimize barriers to post-secondary education, maximize student success, develop a globally and multi-culturally competent workforce, and improve the lives and well-being of individuals by providing [4]:

- Education, training and retraining for the workforce including basic skills and literacy education, occupational and pre-baccalaureate programs.

[1] Western Carolina University, Belk 211, Cullowhee, NC 28723, gford@wcu.edu

[2] Western Carolina University, Belk 161, Cullowhee, NC 28723, mcdaniel @wcu.edu

[3] Western Carolina University, Belk 161, Cullowhee, NC 28723, ballaaron @wcu.edu

- Support for economic development through services to and in partnership with business and industry and in collaboration with the University of North Carolina system and private colleges and universities.

- Services to communities and individuals which improve the quality of life.

Whenever possible, to support the Western Carolina University's mission, professors in the Kimmel School of Construction Management and Technology work with community colleges in the state to beneficially enhance educational programs at the University as well as at the community colleges. The Kimmel School provides bachelor degree programs in engineering technology, electrical and computer engineering technology, electrical engineering and construction management. In this article, three Kimmel School faculty members share their community college collaboration experiences to provide examples for other universities and community colleges to consider to provide more educational value for their students.

COOPERATION IN HICKORY AND SPINDALE

The role of the local community college is critical to the success of the off campus Engineering Technology curriculum at Western Carolina University. Applicants to the off-site Engineering Technology program must have an Associate of Arts or Associate of Science degree in Pre-Engineering or an Associate of Applied Science in an Engineering Technology. Additionally, the student will be given credit for 18 hours of lower level (100-level) engineering technology courses and 12 hours of upper level (200-level) engineering technology courses that were taken as a component of their 2-year engineering technology degree. All of the Liberal Studies requirements (with the exception of the upper-level requirement) may be taken through the community college system. In addition, all of the Program Requirements can be taken at the community college as well. The option to take courses locally provides a "win-win" opportunity for both students and the local community college. Students benefit by remaining employed and taking courses at times that best fit their schedules. The community colleges benefit from increased enrollment, which in turn, results in increased funding from the state.

Hickory

Western Carolina University has enjoyed an excellent partnership with its community college counterparts in the Hickory area. Catawba Valley, Caldwell, Mitchell, and Western Piedmont Community Colleges are all strong partners in providing lower-level engineering technology classes, and liberal studies classes for students enrolled in the ET program.

Western Carolina has had a presence in the Hickory area dating back into the early eighties. The Manufacturing Engineering Technology (the forerunner of Engineering Technology) curriculum was delivered face-to-face at classrooms at Western Piedmont and Catawba Valley Community Colleges, and taught by WCU professors. Students could take their Associate in Arts or Associate in Applied Science degrees and articulate them into the Bachelor of Science MET program. That partnership has continued through the present. One major problem was the lack of suitable laboratory space.

In 2005, Western Carolina University was approached by the Future Forward Economic Alliance, an economic development committee, about becoming a partner in developing the new engineering center for the region. Western Carolina's history of delivering off-site technology education was a major factor in the FFEA's plans to develop a regional engineering education center. Soon, a 55,200-square-foot building was found and purchased for the purpose of training engineering professionals in the Hickory area.

The new facility would house badly needed laboratory space for the delivery of the Engineering Technology curriculum. 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. The original three phased plan of outfitting labs with cutting edge technology served as a blueprint. The North Carolina Center for Engineering Technologies (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.

The current status of cooperation in Hickory is very healthy. The presence of the NCCET is an excellent resource for local community colleges. The greatest advantage is the location of a BS degree in Engineering Technology in the Hickory region. Almost as important, is the location of state-of-the-art laboratories and test equipment that these community colleges can utilize. The NCCET employs a full-time Engineering Technologist who is available to assist community colleges with advanced technical problems, field trips, and lab sessions. The equipment is also available to community college instructors who want to upgrade their skills in high-tech areas. The high degree of cooperation between community college and WCU engineering technology faculty can be looked upon as a model for curriculum managers to follow.

Spindale

Western North Carolina has been particularly hard-hit by layoffs due to the increased globalization of furniture, textiles, heavy metals and other traditional manufacturing. Industry in western North Carolina has had to undergo significant changes due to those global economic factors and the subsequent loss of thousands of manufacturing jobs between the years of 1999 and today [3]. No county in western North Carolina has been hit much harder than Rutherford County. Currently, the unemployment rate in Rutherford County is around 15%, second highest in the state [2]. Since the closing of several large textile mills in 1999, Rutherford County has been mired in unemployment. With that as a major driving force, in early 2000, Western Carolina was contacted about the possibility of establishing a distance site for Engineering Technology at the Spindale campus. After many negotiations, in early 2001, WCU offered its first class at the Spindale site. A regional coordinator was hired to recruit and advise students, and the program began to thrive.

The cooperation in Spindale was unique in that several WCU graduates had leadership positions in the engineering technology department at Isothermal Community College. The desperate need to retrain unemployed employees from the textile mills served as impetus to build a strong and lasting partnership. The Spindale group grew to be the strongest of the three sites due to their local leadership. Currently, there are approximately 35 students based in the Spindale area.

COOPERATION AT ASHEVILLE

The Engineering and Technology Department at Western Carolina University has a long standing relationship with Asheville Buncombe Technical Community College, through transfer articulation, program offerings, and applied research. WCU has maintained an office and laboratory to support a four-year off-site program on the campus of AB-Tech since 1992. This presence has provided opportunities for faculty of both institutions to develop a strong working relationship and articulation of Engineering Technology programs between institutions. The agreement between WCU and AB-Tech goes well beyond the typical articulation agreement. Both institutions benefit from the partnership such that students can complete a two-year program from AB-Tech, and their four-year degree from WCU without leaving the AB-Tech campus. Further, graduate level courses have also historically been offered by WCU leading to a M.S. Technology degree, and several of the AB-Tech engineering technology faculty have completed the M.S. program. Therefore, it is possible to complete an A.A.S. all the way through a M.S. degree at one metropolitan location.

Applied Research

WCU and AB-Tech have also worked closely on sponsored and applied research projects for several years. These projects have included the development of a new energy efficiency dehumidifying and water heating appliance funded through a contract by the Department of Energy (DoE) and Oak Ridge National Laboratory, the development of an environmental test chamber funded by the same organizations, and the

development of a Computer Numerical Control (CNC) plasma cutting machine. Highlights of these projects are provided in the following section.

Western Carolina University, Asheville-Buncombe Technical Community College (ABTCC), and Sci-Cool, Incorporated contributed resources and support for the design, fabrication, and testing of a new Water Heating and Dehumidifying (WHD) appliance. The project goal of developing a viable energy saving product was reached, by carrying out a collaborative technology transfer initiative through coordinated efforts by Oak Ridge National Laboratory (ORNL). This creative and applied engineering project provided each institution with the opportunity to integrate applications of theoretical concepts into course and laboratory exercises and direct engineering applications. Additionally, the purchase of new equipment, tooling, and software allowed for the enhancement of engineering technology laboratories at each educational institution. Faculty and graduate students have gained and strengthened technical knowledge of current products and processes in subjects that may have otherwise remained uncultivated. In turn, this newly gained knowledge and experience will prove to be valuable in the development of engineering technology curriculum and in future engagement projects.

The project has helped to build stronger ties with industry, better community relations, and stronger relationships with government agencies. Both educational institutions look forward to future engagement projects so that they may continue to serve the local community, students, and industry. Partnerships among government agencies (ORNL), regional industry, and regional educational institutions offer an excellent opportunity for advancing professional development, enhancing student learning, and promoting economic development. The foundation for economic development in western North Carolina has been demonstrated through collaboration with Sci-Cool, Incorporated and coordinated by ORNL.

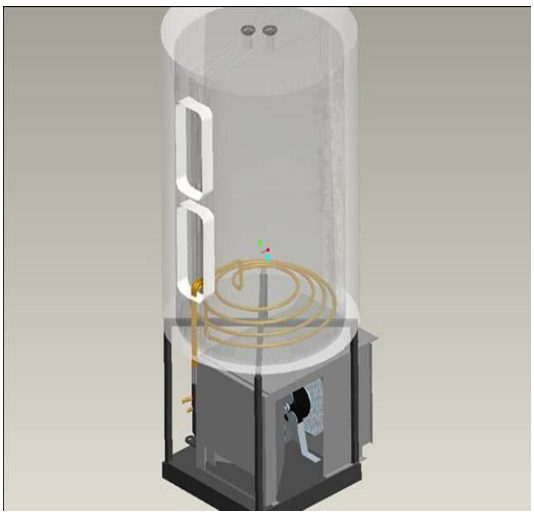

Figure 1: Engineering Model

Figure 2: Field Test Unit: Dehumidifying Water Heater

The benefits gained have been broad in scope and contributory to the overall goal of the WHD project. A win-win situation has been developed and fostered through the non-competitive and collaborative efforts of each contributing team member. It is widely recognized that technology transfer has the potential to enhance the competitiveness of small businesses, which in turn spurs regional economic development and job growth. Small companies such as Sci-Cool, Inc. typically struggle with allocating resources for the development of new products and processes. Additionally, the lack of time, experience, and high-tech equipment necessary for the comprehensive creation of viable prototypes and the risks incurred by refocusing resources are usually not worth the gamble when time spent on improving existing products or processes can immediately affect critical revenues. The authors believe Sci-Cool, Inc. will benefit from the relatively low cost product development through technology transfer. The central missions of Western Carolina University and Asheville-Buncombe Technical Community College have been complimented through efforts in providing new technology and modern engineering support. Oak Ridge National Laboratory gained the potential to expand the body of knowledge and demonstrate concepts of viable alternative energy products.

WCU and ABTCC worked collaboratively in the development of an environmental test chamber at the AB Tech WHD laboratory test site. After receiving quotes for test chambers of adequate capacity and size for testing WHD units, the decision to purchase a chamber was abandoned due to costs. A more workable option was identified by relocating and refurbishing a unit previously used by BASF Manufacturing. Ownership of the BASF facility had recently been transferred to AB-Tech and was located near the ABTCC-Enka campus. This unit consisted of foam filled panels assembled to form a 14' x 8' x 8' structure. Temperature and humidity had been provided by steam piped into the structure from the physical plant; however no corresponding utilities were available at the AB-Tech WHD laboratory test site.

The foam panels were easily disassembled and reconfigured due to the cam locking mechanism integrated into each unit. It should be noted that these panels are readily available from companies such as CrownTonka and a quick internet search revealed numerous 8' X 8' walk-in coolers in the $4,000 through $7,000 price range. Using the panels, the test chamber was reconfigured into an 8 x 8 x 8 unit in the Mechanical Engineering Technology Laboratory on AB-Techs campus by faculty and students. Photographs showing the chamber structure at the AB-Tech laboratory are shown in Figure 3.

Figure 3: Test Chamber at new WHD Test location

A redesign of both the physical size of the chamber and utilities was required since no steam was available at the new site. Additionally, it was desired to create a system with local control and readily compatible with existing plumbing and electrical utilities. A conceptual model was initially developed (shown in Figure 4), and required systems were identified to meet the testing requirements for WHD prototypes. Load calculations were completed based on the specifications required by the federal test for water heating and dehumidification devices along with the added heat load of the units under test.

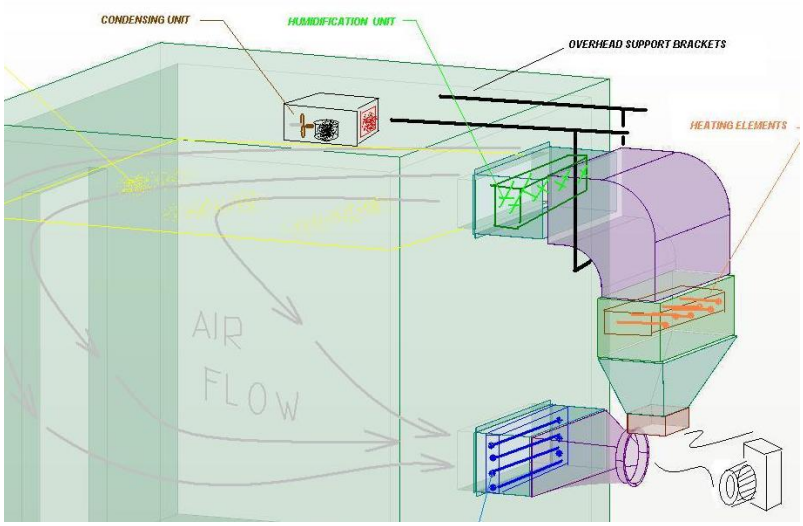

Figure 4: Test Chamber at new WHD Test location

A collaborative effort to develop a new CNC plasma system was initiated in the summer of 2010 and continued through the spring semester of 2011. The integration of PBL as described in this paper focuses on the integration of mechanical and electrical engineering applications through a joint partnership between the university and a regional community college. Elements of entrepreneurship are included such that design and fabrication are developed for a Do-it-Yourself-Kit (DYK) with customer input playing a vital role in the development of the CNC system. The entrepreneurship approach consists of enabling a small business to sell units in a Ready to Assembly (RTA) package. The focus; however, is more on learning engineering principles through direct project development employing PBL as the primary instructional method.

The CNC plasma system developed was done so with several factors in mind. Alternative options providing simple operation and control, relatively low cost and high quality were set forth as desirable design characteristics. Further the system was presented to the student teams for developing a Do-it-Yourself-Assembly (DYA) approach. The focus was not on new component design, but rather implementing off-the-shelf, readily available components that could lead to the development of a Ready-To-Assembly (RTA) kit with options based on the needs of the consumer.

The CNC plasma project presented a challenging opportunity for integrating the development and project based learning (PBL) application into engineering and technology courses. Specifically, the educational goals of the project were the professional and technical skill development of faculty and students, engineering project work for students, and developing laboratory equipment to support research and courses in control systems, instrumentation, and CNC. Community college students participated in structural system fabrication and testing, electrical controls, and assembly. Students at the university were responsible for 3D modeling, custom machining, and drive train verification. Solid models were imported into OneCNC CAM package for producing required CNC programs which in turn were developed for a HAAS V3 machining center. Custom components of the plasma system were fabricated and assembled on the WCU campus then delivered to the AB- Tech test facility for installation.

Faculty members from both the university and community college were involved in numerous activities throughout the project. This close partnership was strengthened through total team participation between the two institutions. Although the lead faculty members served as project coordinators, and community college faculty were initially charged with the responsibility for control development and testing, all faculty were committed to making the project a success. Both institutions freely exchanged support in the form of test site development, instrumentation and control, and testing. As a result of this cooperative team effort, a Plasma CNC system was developed to support both product development and PBL for both two-year and four-year institutions.

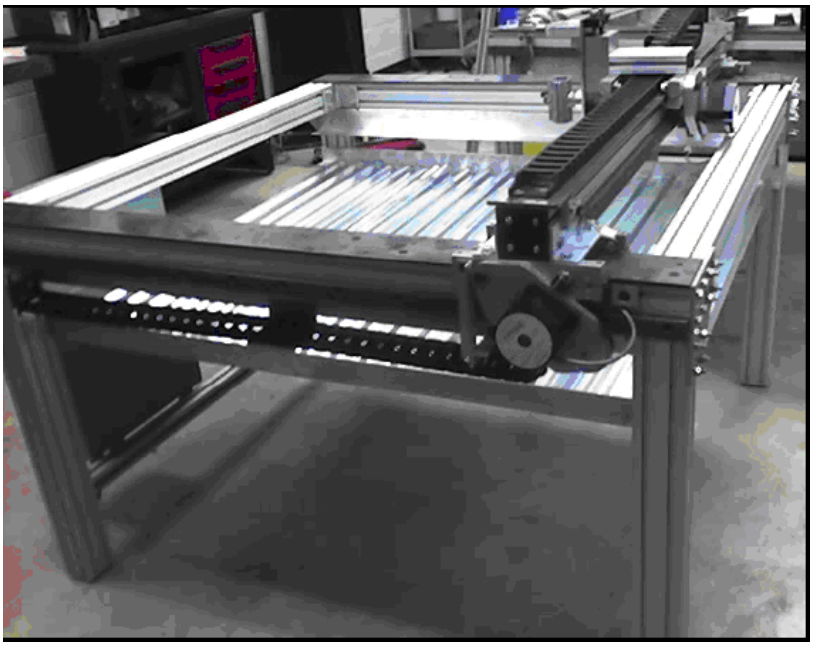

Figure 5: Completed CNC Plasma Machine

Snellenberger [1] and his colleagues emphasized the need for students to attain higher technical skills and practical engineering experience to reinforce a stronger U.S. engineering workforce4. Aside from technical skills, practical engineering experience, and progressive professional skills from industry, advisors often urge that graduates must be made aware of skills such as planning, communications, and safety. The comments from industrial advisory board members have had a major influence on the engineering and technology programs. Under their guidance, the curricula for each of the engineering and technology programs were designed to provide flexibility and accommodate two general categories of students. For

community college students seeking to transfer to a bachelor's degree program, electives in math and science are made available. However, for those students seeking immediate employment with an associate's degree, project classes are recommended to provide workplace experience. Project classes are the vehicles for allowing the student to integrate the technical and non-technical skills in a formal approached called PBL. The Plasma CNC project, with challenges in many disciplines, was well suited for this very type of student experience. This project was in essence the experience that ABET [2] supports and industrial advisory board members desire.

Students from both institutions made important contributions and support to the project. Western Carolina University students were primarily involved with engineering documentation and modeling, rapid prototyping, and component machining. Graduate students also modeled drive trains, verified calculations and configurations for software. Two-year college student involvement included site development work, structural assembly, instrumentation, controls, and testing.

Western Carolina University and Asheville-Buncombe Technical Community College contributed resources and support for the design, fabrication, and testing of the CNC Plasma System. This creative and applied engineering project provided each institution with the opportunity to integrate applications of theoretical concepts into course and laboratory exercises as well as supporting research. The CNC project provides multiple learning and research opportunities for community college students, university undergraduate and graduate students, and faculty from both institutions. Faculty have gained and strengthened their technical knowledge of subjects that may have otherwise remained uncultivated. Further, students were provided opportunities to solve real design problems and gain experience in fabrication, system control, and testing. The knowledge and experience gained will prove to be valuable in the enhancement of engineering technology curricula and support of future engagement projects.

COOPERATION IN SYLVA

Southwestern Community College (SCC) is located in Sylva, North Carolina within a few miles of Western Carolina University (WCU). SCC provides educational programs in civil engineering technology, surveying technology, sustainability technologies, computer engineering technology and electronics engineering technology. The technology programs at SCC were identified as high quality academic programs by the faculty in the Kimmel School of Construction Management and Technology at Western Carolina University. In North Carolina, there is a statewide articulation agreement between the sixteen UNC campuses and the North Carolina Community College System for general studies courses. High quality programs, established articulation and local proximity to WCU make SCC a natural recruiting destination for the faculty in the Kimmel School. The primary aspect of any long-term, strategic recruiting effort is to establish personal relationships. The faculty at WCU worked with the faculty at SCC to establish rapport through various activities. An articulation agreement was established between the Construction Management program at WCU with the Civil Engineering Technology program at SCC. Faculty at WCU serve on the advisory Committees at SCC to maintain up to date knowledge of program changes and to advise students who are candidates for transfer from SCC to WCU. The faculty at both institutions collaborated to produce an articulation agreement which would provide an outlet for higher academic achievement for SCC graduates and also to provide additional students for the construction management degree at WCU.

This two year program allows the community college student to attend SCC, obtain her two year associate of applied science (AAS) degree, and transfer to WCU into Construction Management. The AAS degree allows a student who may not be ready for the university to be better academically prepared, improving their potential for successful program completion. The AAS also prepares students for immediate entry into the workforce if necessary. Many students must work a job while attending college due to their personal economic situation. In addition, the statewide general studies articulation agreement allows students to complete additional courses towards their four year degree at SCC at a reduced rate of tuition compared to university tuition rates. Several transfer students at WCU have taken advantage of the lower cost tuition rates at the community colleges while studying for their four-year degree at WCU. These students are often dual-enrolled. Dual enrollment also allows dual student advising by faculty at both WCU and SCC. Transfer students following the articulation agreement may complete their four year degree in Construction Management with as little as three semesters of fulltime study on-campus at WCU. The articulation agreement can be extended to the other 58 community colleges in North Carolina which offer a civil engineering technology program since there is a common state course catalog for the community college system.

Participation in advisory committee activities at SCC by WCU faculty allows an open line of communication. The Construction Management (CM), Civil Engineering Technology (CET) articulation extends into the advisory committee. Updates may be made in the articulation as needed through committee activities. The efforts needed to maintain this agreement, which extends to the entire community college system, are minimized. Student advising issues may be discussed within the committee. Current issues at both institutions may be discussed and compared. For instance, at the latest meeting in November of 2011, local employment trends were discussed. Potential course modifications based upon these trends were considered primarily for the SCC CET program, but also for the CM program at WCU. The North Carolina Community College System's (NCCCS) new green curriculum was also discussed. According to the NCCCS website, the curriculum description is [4]:

> "The Sustainability Technologies curriculum is designed to prepare individuals for employment in environmental, construction, alternative energy, manufacturing, or related industries, where key emphasis is placed on energy production and waste reduction along with sustainable technologies. Course work may include alternative energy, environmental engineering technology, sustainable manufacturing, and green building technology. Additional topics may include sustainability, energy management, waste reduction, renewable energy, site assessment, and environmental responsibility. Graduates should qualify for positions within the alternative energy, construction, environmental, and/or manufacturing industries. Employment opportunities exist in both the government and private industry sectors where graduates may function as manufacturing technicians, sustainability consultants, environmental technicians, or green building supervisors."

The green curriculum provides for AAS degrees, one year diplomas or one semester certificates. The green curriculum is meant to address five different sectors: energy, transportation, engineering technology, environment and building. The improvements will be used at North Carolina's 58 community colleges with the goal of providing outstanding education for workers for the growing green economy [4]. The CM faculty at WCU are considering green or sustainability content for their program which may build upon the NCCCS program.

CONCLUSION

In North Carolina there are 58 community colleges and 16 four year public university. The per student costs of operating the 16 universities are much greater than those in the community colleges. One can only surmise for the 16 University of North Carolina System (UNCS) campuses that cutbacks are inevitable. For the last three years, state budgets have been so dismal that the faculty at the UNC campuses have not received salary increases while the costs of medical insurance benefits have increased. The community college system will become more and more important to students in a cash strapped state who are financially challenged. According to their respective websites, tuition and fees at WCU are nearly $100 more expensive per credit hour than at SCC. University programs with poor enrollment will most certainly be excluded in future North Carolina state budget discussions. It is incumbent upon UNCS faculty to utilize valuable allies at the local community college to maintain program enrollment and to better serve their local community. The faculty of the engineering and technology academic departments at WCU recognize the need for collaboration with community colleges within the state. This paper discussed a few of the collaborative activities previously undertaken and will hopefully serve as examples for other universities to work as partners with the local community colleges in their service areas.

REFERENCES

[1] ABET Board of Directors, "Criteria For Accrediting Engineering Technology Programs". ABET, Inc., 2003. Retrieved on November 20, 2011 from www.abet.org

[2] Economy Watch, (2011). North Carolina Unemployment rates, county by county. Retrieved on November 20, 2011 from http://www.wral.com/news/state/page/4879060/

[3] Klein, Jean C., Chris Beachum and Catherine Moga, Manufacturing Layoffs: Hard Times for Rural Factories, Workers and Communities, The Rural Center, Number 11, April 2002, Retrieved November 21, 2007, from http://www.ncruralcenter.org/pubs/mfglayoffs.pdf.

[4] NCCCS Website, (2011). Curriculum Standard. Retrieved on November 20, 2011 from https://nccommunitycolleges.edu/state_board/SBCC%20Agendas%20&%20Attachments/2009/SEP%2009/PROG%206B1.pdf

[5] Snellenberger, J. M., D. H. Quick, I. T. Davis, J. P. Tidwell, J. O'Brien, R. M. Haynes, et al. (2004) . Enabling the U.S. Engineering Workforce to Perform: Recognizing the Importance of Industrial Engagement In Professional Graduate Engineering Education, American Society for Engineering Education Annual Conference & Exposition, 2004.

[6] Western Carolina University Website (2011). About WCU. Retrieved on November 20, 2011 from http://wcu.edu/10.asp .

George Ford, P.E. EdD

Dr. Ford is an assistant professor in the Department of Construction Management at Western Carolina University. Dr. Ford worked for over fifteen years in the corporate world in plant engineering and environmental engineering positions and managed numerous construction projects as a plant engineer in the paper, plastics and rubber industries including warehouses, manufacturing buildings and utilities infrastructures.

William McDaniel, EdD

Dr. McDaniel is an Associate Professor and Coordinator of the Distance Learning Program in the Department of Engineering & Technology at Western Carolina University. His professional interests

include Engineering Graphics & 3D Modeling & Animation, Engineering Materials, Polymer Science, and Distance Learning.

Aaron Ball, EdD

Dr. Ball is a full professor in the Engineering & Technology Department at Western Carolina University. Dr. Ball's professional interests include CAM and advanced machining, 3D modeling and high speed machining, Fluid Power, and advanced automation and manufacturing processes.