2006-857: CT COLLEGE OF TECHNOLOGY'S NSF ATE REGIONAL CENTER FOR NEXT GENERATION MANUFACTURING

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Karen Wosczyna-Birch has been a champion of engineering and technology education for the past 25 years. She has been the state director of the CT College of technology where through her leadership she has been instrumental in creating a nationally recognized seamless pathway between all 12 two year colleges in CT with six university and college technology and engineering programs. She has received numerous awards and grants and has been recognized for her accomplishments as a professor and for her passion for increasing the diversity of the engineering and technology population. Most recently, she has received a NSF ATE grant to establish a next generation manufacturing center under the umbrella of the College of Technology.

DRAFT

Next Generation Manufacturing in Connecticut's College of Technology

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The northeastern region of the United States, including Connecticut, is at the forefront of the global transformation in manufacturing. Its prominence in the design and manufacture of aerospace systems (United Technologies: Pratt and Whitney, Hamilton Sundstrand, Sikorsky, and Kaman), laser technologies (Trumpf, Coherent Deos); and its pioneering leadership in the hydrogen economy and fuel cells (Proton Energy Systems, Fuel Cells Energy, and UTC Fuel Cells) and medial instrumentation (Becton Dickinson) are critical to the U.S. economy.

To be successful these industries have embraced a global supply chain and a rate of technology change that presents enormous challenges to the regional workforce. Between 1990 and 2000, although aerospace manufacturing employment in Connecticut dropped by 45%, productivity increased and wages for the average aerospace manufacturing worker went up 63% to $68,737. As the manufacturing workforce ages there will be a need to replace these highly skilled & highly paid workers as well as for continuous upgrading in worker capabilities.

The National Association of Manufacturers notes, in their recent report "Keeping America Competitive: How a Talent Shortage Threatens American Manufacturing" that there will be a projected need for 10 million new skilled workers by 2020. They believe that "A long-term manufacturing employment and skill crisis is developing, one with ominous implications for the economy and national security." Given the significant job losses in manufacturing, it is becoming increasingly difficult to attract a new generation of young people into advanced technological education programs, which would prepare them for high skill; high wage jobs (National Association of Manufacturers). Manufacturing is severely challenged by old negative images about the factory floor and an education and training system that does not promote engineering and technology careers. New strategic alliances between education and industry will be required to both market manufacturing careers and prepare youth and adults for the highly skilled team structure in today's manufacturing sites.

Next Generation Manufacturing:

The transformation of global manufacturing was clarified in a 1995 to 1997 study co-sponsored by NSF and other federal agencies. The culminating report "Next Generation Manufacturing" concluded that manufacturing companies must transform themselves into "agile enterprises" that operate by adding value into extended supply

chain networks. This was reinforced by the National Research Council's Board of Manufacturing and Engineering Design's report on "Visionary Manufacturing Challenges for 2020" which emphasized that the future of manufacturing will be characterized by knowledge sharing, innovative technologies and attention to environmental issues.

In response to statewide, regional and national manufacturing crisis, Connecticut's College of Technology, in collaboration with CT Business and Industry Association (CBIA), and local and regional business and industries have initiated several systemic activities to implement and market advanced manufacturing.

The College of Technology (COT) is a seamless pathway program in technology and engineering between all 12 Community Colleges and six four-year institutions. Students can complete either an A.S. degree in Technological Studies or an A.S. in engineering science. The infrastructure of the program allows flexibility of the curriculum such that the programs can respond to industry needs with specific options and implement the new curriculum within 3 months. In addition, there is a statewide COT site coordinators council that includes faculty and administrative representative from all of the institutions of higher education, secondary partners and business and industry liaisons. This COT Council has been instrumental for the systemic integration of the COT at the partner institutions.

CBIA is ……..

Connecticut is long known for manufacturing innovation has an opportunity to build on a number of successful NSF projects and regional and national relationships. The College of Technology has used system investments along with NSF ATE, CCLI, and CSEMS funding to make significant progress towards in engineering and technology disciplines. CBIA has also received four previous NSF grants for private sector partnerships to improve public education. The NGM Initiative is building on these prior investments, thereby, partnering effectively with industry to establish curriculum pathways that prepare workers for 21st Century jobs.

For the COT-RCNGM Initiative and its objectives to be successful, it must attract students to career pathways in manufacturing. The RCNGM and CBIA has been developed a state wide campaign to make manufacturing a preferred career choice of 18-28 year olds by the end of this decade. This multi-faceted campaign will require strong collaboration between the business community and higher education to achieve the goal of attracting new participants into manufacturing and will build on the strong relationship that the COT has with CBIA.

This paper will focus on the marketing campaign initiative in CT and how the characteristics of agility, innovative technology and global metrics (quality and environment) are being incorporated into the educational process and thereby prepare the workforce that must support US industry to remain competitive. In addition, the paper will include strategies that are being used for the successful marketing, recruitment and

retention of students

Curriculum Development

Industry participation in creating and delivering curriculum content is key to success in advanced manufacturing education. Hands on experiences and the use of advanced equipment are typically more effectively provided through industry partnerships rather than in traditional academic classrooms or labs. A number of collaborating organizations, representing a cross section of industries and degrees of maturity. The organizations must represent:

Sustainability via Participation of Established and Emerging Companies: Organizations involved must represent new, growing companies, as well as mature multi-national corporations.

Broadened Impact via Multiple Industrial Sectors: Three key manufacturing sectors were chosen to assure relevance to a range of industry worker and technology requirements;

- Aerospace: Connecticut's world leadership in the mature industries of gas turbine, helicopter and aircraft systems.
- Fuel cell and clean energy industrial sector: Connecticut companies lead in this emerging industry offering careers in manufacturing and system operation.
- Medical devices: This is a growing field due to the rapid expansion of CT's pharmaceutical and bio-tech industries. New drug discoveries are requiring new drug delivery mechanisms and production processes.

Connecticut's Next Generation Manufacturing initiative will spearhead two categories of curriculum reform: (1) Core Curriculum providing a solid foundation for continuing education; (2) Specialized courses that provide skills and knowledge for employment and careers

For each of the curriculum reform efforts, a curriculum advisory team was formed that includes faculty from two and four year College of Technology partner institutions, industry representatives, and a web based curriculum designer. In each case, the curriculum advisory team built on the significant investments made in the past by NSF, industry, the community college system and other ATE organizations. Areas of technology enhancement will be identified, assessed for relevance and incorporated into existing or new courses. This process with faculty externships will provide an ongoing opportunity for the RCNGM faculty to stay current.

NSF's ATE program has already invested in the development and implementation of six online technology courses in photonics and telecommunications (NSF 0101654). The results of these piloted courses have demonstrated the need for a blended delivery of online courses, using on-site laboratories to augment online delivery of thereby. In addition, the following curriculum elements were identified as being critical to the development of a Next Generation Manufacturing focus within the COT: (1) quality control courses; (2) Information Technology; (3) Precision Machining; (4) specific disciplines such as fuel cells, aerospace and nanotechnology and (5) globalization. The following table outlines the curriculum elements and the current status of each:

Table 1.1 Curriculum Elements for the College of Technology

Curriculum Elements	Status and Content
Core Curriculum	
Intro to Next Generation Manufacturing	*New Course: Global manufacturing and product realization, key industry requirements of aero, fuel cell, medical, overview of Next Gen Manufacturing technologies*
Manufacturing Quality and the Environment	*New Course: Green, Lean, Quality, ISO 9000 and 14000, 6-Sigma*
IT for Manufacturing	*New Course: Computers in manufacturing, data management, process and product specifications, process control*
Specialization Courses	
Precision Machining	*Existent Courses: Need to be enhanced for web/blended delivery & expanded application*
Fuel Cell Technology	*New Course: Intro course is available and can be put on web, but additional courses relevant to manufacturing and service require development*
Laser Applications	*New Course: Photonics basic courses and industrial application courses are available as basis for course development*
Technology Enhancements	
Medical Device Manufacture	*Incorporate into Courses: The unique requirements for medical device manufacture will expand range of application for technologies taught in existent courses*
Nanotechnology	*Incorporate into Courses: Nanotechnology and nanomanufacturing technology elements will be integrated into existent or new courses.*

Each of these curriculum elements will be developed in a multi phased process over the three years of this program. The process is intended to provide a structured and sustainable approach to progressive curriculum development that includes defined stages that permit faculty to stay abreast of changes in industry and advances in technology. This structured approach parallels the industry best practice of a "stage gated" approach to technology maturation. The three year program is described in Table 1.2, below.

Table 1.2 Staged Developments and Implementation of Curriculum and Enhancements

Stage of Development	Year 1 Activity	Year 2 Activity	Year 3 Activity
Implement Web/Blended Course Delivery	*Precision Machining* *Intro to Fuel Cells*	*Fuel Cell Tech* *Intro NextGenM*	*Complete FuelCell Curriculum* *Complete NextGenM Core Curriculum* *Laser Applications*
Develop Curriculum Content	*Fuel Cell Tech* *Intro NextGenM*	*Fuel Cell Tech* *NextGenM Core Curriculum* *Laser Applications*	*Add Medical Device &Nanotech Enhancements into Curriculum*
Establish Curriculum Needs	*NextGenM Core Curriculum* *Laser Applications*	*Medical Device enhancement* *Nanotechnology Enhancement*	
Technology&Career Pathways Awareness	*Medical Device Manufacture* *Nanotechnology*	*Nanotechnology*	

A blended/hybrid learning environment has proven to be effective in increasing student satisfaction and learning. The intent of the NGM Center is to utilize the flexibility of a blended/hybrid learning environment to engage students and workers in next generation manufacturing and to support them in an ongoing career path. The College of Technology is itself structured as a virtual college with courses delivered from various community college campuses, and therefore has piloted several online/hybrid and technology/engineering courses.

Career pathways, student retention and continuing education

Manufacturing industries provide specialized training for their workforce specific to their needs; but the delivery of technological knowledge can become more educationally effective. The RCNGM uses industrial designed classes and translates them into modules more suited to a variety of learners and more readily accessible. A blended/hybrid instructional delivery system provides for varied instructional methodologies, adaptable to the learning strengths and talents of students interested in the manufacturing fields. This instructional approach encourages collaboration and support in ways that emulate the workplace; and it allows for industrial apprenticeships and hands-on experience specific to the learner's needs. The implementation of the RCNGM educational program is designed to attract students to the manufacturing field and enhance the careers of technicians presently in the workplace.

Articulation

In 2003, the College of Technology signed a system to system tech prep articulation agreement with the 17 vocational-technical high schools. This novel articulation agreement allows high school students to earn ATE credit at their respective high schools that transfers seamlessly at any of the community colleges and the four year partners. As part of the agreement, new courses in networking, cabling,

telecommunications and corresponding certifications were developed and implemented in the vocational-technical high school curriculum. Professional development and certification opportunities were provided for the high school teachers by the community colleges, strengthening the 2 + 2 pathway and the infrastructure necessary for a successful program.

The RCNGM, in collaboration with the State Department of Education and its State-wide technology consultant has expanded articulation agreements to include magnet high schools that focus on science and technology and comprehensive high schools who have implemented a pre-engineering curriculum. Further expansion of these arguments will be implemented regionally and will formalize existing local partnerships between the community colleges and its feeder high schools. The implementation of web-delivered, hybrid/blended instruction increases the opportunity and incentive for students in these schools to enroll in community college courses.

Marketing Campaign:
TV AD

Radio Announcement

Computer Pop-ups

Web Site

Evaluation Results

The COT and its Next Generation Manufacturing initiative and CBIA have made significant inroads in addressing the crisis in manufacturing, both in the workforce and in education. However, this is only the beginning of a systemic initiative. The COT-RCNGM and CBIA are well on their way to creating models that will make a difference in manufacturing, education thereby addressing local, regional, and national workforce needs.

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Biographical Information

Dr. Karen Wosczyna-Birch is Professor of Applied Science and Technology and the State Wide Director of the CT College of Technology. She has been instrumental in facilitating the implementation of the College of Technology and developing industry based curriculum using local and national skill standards that have responded to industry needs in technology and engineering. She has over 23 years of experience in higher education, focusing on two year technology and engineering technology education.