AC 2011-2791: ROBOKNOWLEDGE: ADAPTABLE, ON-LINE ROBOTICS PRODUCTION TECHNICIAN INSTRUCTIONAL COMPONENTS ADDRESSING MOBILE ROBOTIC DEVICES

William C. Beston, Florence-Darlington Technical College

William C. Beston has been actively teaching Engineering, Mathematics, and Physics for the past 43 years. He is currently teaching Phys102- Explorations in Physics online for Embry-Riddle Aeronautical University and is developing three online Robotics courses for Florence-Darlington Technical College. From January, 2001-August, 2002, he served as Staff Associate for the National Science Foundation (NSF), Division of Undergraduate Education in Arlington, Virginia. He currently works as a consultant for NSF and serves on the National Visitation Committee for the National GeoTech Center housed in Corpus Christi, TX. He is Professor Emeritus in the Engineering Science/Physics/Physical Science Department at Broome Community College in Binghamton, NY, having taught there from August 1968-January, 2001. He was the 1997 recipient of the New York State Chancellor's Award for Excellence in Teaching and the ASEE St. Lawrence Section's Outstanding Teaching Award. He was the faculty advisor of the first nationally recognized community college Student Chapter of ASEE. He currently resides in Binghamton, NY.

Elaine L. Craft, Florence-Darlington Technical College

Elaine L. Craft has served as Director of the National Science Foundation-funded South Carolina Advanced Technological (SC ATE) Center of Excellence since 1994. Currently, she serves as a Co-Principal Investigator for the SC ATE National Resource Center for Expanding Excellence in Technician Education. Craft is also founder and President of SCATE Inc., a 501(c)(3), not-for-profit corporation created in 2005 to promote systemic change in Advanced Technological Education and help sustain the SC ATE Center of Excellence. Her postsecondary education includes a baccalaureate degree in chemical engineering (University of Mississippi), and master's degree in business administration (University of South Carolina).

RoboKnowledge: Adaptable, On-line Robotics Production Technician Instructional Components Addressing Mobile Robotic Devices

Overview

To address the rapidly emerging need for "next generation" robotics-savvy technicians for the manufacture of mobile robotic devices, Florence-Darlington Technical College in South Carolina, in partnership with the National Robotics Training Center (NRTC) located in South Carolina, is completing initial development and dissemination of an on-line sequence of learning modules that provides a new, e-learning, "plug-in" robotics specialty option for associate degree programs in Electro-Mechanical Engineering Technology (EMET) or similar programs. The instructional modules, including an advanced certificate option for incumbent workers, can lead to certification as a Robotics Production Technician (RPT) and be aligned with the Manufacturing Skill Standards Council's (MSSC) "Certified Production Technician" credential, which is recognized by the federal National Skill Standards Board as the "Voluntary Partnership" for manufacturing.

The project team has established the following goals:
1. necessary skills for RPTs will be updated and validated;
2. six instructional modules leading to certification as a RPT will be developed for on-line delivery;
3. completers will demonstrate "readiness" for industry- recognized certification;
4. student success rates will meet or exceed that of face-to-face courses in the discipline;
5. faculty development will result in full adoption of RoboKnowledge on-line modules by pilot sites, and student participation will broaden (become more diverse) where RoboKnowledge is implemented; and
6. rigorous evaluation and dissemination will improve and fully document outcomes as well as help make "next generation" robotics education broadly accessible.

Emerging Need

Bill Gates, leader of the personal computer revolution, predicts that the next hot employment field will be robotics. Mr. Gates is not alone in his prediction.[1] *Scientific American* issued a special report early in 2008 entitled "Your Future with Robots: How Smart Machines will Change Everything."[2] There is increasing evidence that robots will have the same impact on the new economy as the computer had on the information age. The Robotic Industries Association reported in February, 2008 that North American robot orders jumped 24% in 2007.[3] Robotics and robotic systems make up an emerging global industry in excess of $100B dollars in which the United States must be competitive. Currently, however, Japan is the global leader in both the development and use of robotics, with the United States (USA) a distant second. Japan is far outpacing the USA in patents; however, the United States leads in the development of software programs used in robots and robotic systems.[4]

Many other countries are emerging as major competitors as well. The South Korean government has vowed to support and nurture their nation's robotics industry because it has the potential to

grow into a $29.7 billion business by 2013.[5] In December, 2007, it was reported that the South Korean government plans to invest the equivalent of $1.6 billion dollars to build two robot theme parks as part of an effort to boost that country's robotics industry.[6] European Union countries are also strong competitors. In 2005, the BBC News reported that the European Union's 25 member states have a 35% share in the global manufacturing of robots.[7]

Service robots for personal use worldwide are projected to increase by 160% over the next three years. Approximately 12 million service robots, which include professional, domestic, entertainment and leisure types, are forecast to be sold between 2009 and 2012.[8] Currently, mobile platforms optimize industrial production processes, shopping guides help customers to navigate their local do-it-yourself store, and autonomous forklift trucks simplify logistical processes.[9]

Recently, robots were used in the containment of the blown-out oil well in the Gulf of Mexico off the Louisiana coast. Reported at the time:

> They're like Superman, but underwater: able to withstand [2235 psi] of subsea pressure, lift up to a ton, take 3D video images and transfer hydraulic power to other equipment. Submersible robots can do what no person ever could, and they're serving an important role in the fight to stop the oil gushing from the blown-out well in the Gulf of Mexico. A sub-city of underwater robots is busily working 5,000 feet below the surface to help contain the leak that has gushed millions of gallons of oil into the water since the Deepwater Horizon blew up April 20, killing 11 workers. Anyone who has watched online video of the crude spewing from the seafloor has seen their work – the cameras that provide the feeds are attached to the robots as they maneuver around the spill site.[10]

Additionally, vacuum cleaners clean thousands of households, lawn mowers autonomously care for lawns, underground sewers are inspected and relined, and many other industrial and personal services are performed on a daily basis. In 2009, IEEE (the world's largest professional association for the advancement of technology) offered a series of webinars addressing mobile robotic devices.[11] Increased applications of unmanned, mobile, robotic devices in many sectors are creating an urgent need for highly skilled technicians with this expertise.

The U.S. National Intelligence Council's publication *Global Trends 2025: A Transformed World* predicts that service robotics will be a game-changing technology over the next decade for the following reasons: In domestic settings, widespread use of the technology could leverage manpower, disrupt unskilled labor markets and immigration patterns, and change care-giving for a growing elderly population. As early adopters, governments could provide increased security and combat power with reduced levels of manpower and system life-cycle costs.[12]

In addition to the growth in the manufacturing and use of commercial and consumer robotics, the U.S. military has set a goal of having 30 percent of the Army comprised of robotic forces by approximately 2020.[13] Currently, military contractors are leading the demand for robotics production technicians. Robotic devices for U.S. military applications are all manufactured by companies in the U.S. for use on land, in the air, and on the surface and underwater. In 2006, robots in defense, rescue, and security applications accounted for the highest share of the total

number of service robots for professional use; this number is projected to increase by over 75% over the next three years.[14]

The total unmanned ground vehicle's (UGV) market for military, homeland security and first responder applications is forecast to grow worldwide from $807m in 2009 to $7,748m in 2016.[15] The worldwide market, from 2010 to 2019, for unmanned air vehicles (UAV's) is forecast to total 109 billion dollars.[16] Major Kenneth Rose of the US Army's Training and Doctrine Command outlines many advantages in robotic technology in warfare: "Machines don't get tired. They don't close their eyes. They don't hide under trees when it rains and they don't talk to their buddies.... A human's attention to detail on guard duty drops dramatically in the first 30 minutes.... Machines know no fear."[17] In response to national defense implications and the economic impact of robotics as an emerging technology, the Congressional Bi-Partisan Robotics Caucus has been formed to focus on key issues facing the robotics industry.[18] The caucus was formed because robotic embedded systems will play a key role in our national security, both in our economy and our defense.

Over the past year, two surveys have been conducted by the NRTC to define the need for robotics production technicians: a national survey of 76 companies drawn from the membership of the Association of Unmanned Vehicles Systems International (AUVSI), and a local survey of six companies who together employ 716 technicians. These surveys indicate a need for technicians with skills specific to the manufacture, operation, and maintenance of unmanned robotic vehicles and indicate a demand for 733 new technicians over the next three years with an excellent pay scale for these technicians ($25,000-50,000/yr. locally and up to $72,800/yr. nationally).[19] These technicians will be needed in geographically diverse locations across the country. The Association for Unmanned Vehicle Systems International (AUVSI) conducted a research study for the Congressional Unmanned Aerial Vehicle Caucus entitled "Unmanned Aircraft System Integration into the United States National Airspace System: An Assessment of the Impact on Job Creation in the U.S. Aerospace Industry" which forecasts that if the National Airspace System were accessible, 23,000 jobs would be created. These jobs are just the jobs that have to do with the primary unmanned systems marketplace; there is a larger realm of possible jobs that include composites, payloads, and air traffic control.[20]

Educational Response

The decision to develop the RoboKnowledge courses for online delivery responds to the need for cost-effective delivery options for colleges, limited faculty expertise in the geographic areas where industry demand is growing, and growing demand by students and incumbent workers for flexible scheduling options. The shift to on-line learning in higher education continues. Nationwide, 4.6 million students – about one in every four higher education students – enrolled in at least one online course in 2008. In addition, online enrollments across the nation are growing at about 17 percent annually, much faster than the 1.2 percent overall growth of the higher education population.[21]

Robots and robotic systems are ubiquitous; these systems cut across all industry sectors: energy, agriculture, manufacturing, health care, service, construction, education, and defense. Applications run the gamut from milking robots for dairy farmers, to demolition systems for the

construction industry, to robot-assisted surgery.[22] Engineers at the National Aeronautics and Space Administration (NASA) are testing a robot that they hope to shrink to nanobot size, merging nanotechnology, robotics and intelligent systems.[23] The integration of robotic systems in many of the technologies upon which we have come to depend, along with the American economy's need to compete globally with China, India, Russia, and others, requires technical educators to rethink and retool both the training processes used to prepare technicians and the recruitment initiatives to bring a larger number of students to study this transformational technology. DACUM (Develop A CUrriculuM) processes conducted by our team to date have found that, along with the expected technical skill sets found in traditional technical education programs, today's robotics-infused industries are calling for more; they are looking for a multi-skilled technician who is capable of working with robots and robotic systems. Virtually no industry or business sector will be untouched by the transformation to robots and robotic systems. However, very few technician education programs today are prepared to respond to this industry demand, and too few students are choosing programs of study that will prepare them to compete in fields with advanced technical skill sets that include robotics.

There is a clear imperative that educators find cost-effective ways to increase both the quantity and quality of American technicians with a deep understanding of next generation robots and robotic systems. Also, educators need to take advantage of the untapped recruitment potential that robots and robotic systems have for increasing the number of highly qualified technicians in the electronics, computer science, manufacturing, engineering technology, and mechatronics fields – critical areas of need for America to compete globally. Unmanned robotic devices are especially important in manufacturing and other fields such as marine science/technology. RoboKnowledge on-line educational resource development supports the national economic cluster initiative already supported by Federal agencies including the National Science Foundation, Department of Labor, Small Business Administration, and the Department of Defense. One of the five key elements to success of a cluster, as presented by Karen Mills, Administrator, Small Business Administration at the Michigan Cluster Initiative Workshop, is more web-based options: "…we need a trained workforce. As you know, the President was here in Michigan just a few weeks ago to announce major initiatives related to reinvigorating our workforce through our nation's community colleges. He talked about how we need to modernize facilities, to improve online courses…"[24] Additional support of online programs was identified in a recent survey conducted by Louis Frenzel of *Electronic Design Magazine* where 75 percent of the responding colleges and universities were in favor of online or web-based electronic technology education.[25]

Educational Methodology

To help our educational system meet these growing demands, a strong team of engineers with experience in robotic manufacturing and technician education is engaged in developing on-line courses that support student success and prepare program completers for industry-recognized certification. RoboKnowledge represents a strong industry/government/education partnership that will help ensure alignment of content with industry needs and recognized skill standards. High school partnerships are advancing career awareness and building new educational pathways for technician education.

Inquiry-based, integrated, and hands-on learning is being infused into a sequence of on-line instructional modules to broaden access and effectively address diverse learning styles. Four self-directed learning components will be included in Module 1 to ensure students in this program know their preferred learning style and know how to use their preferred style to be a better learner. The topics are included below.

Module 1 – Preferred leaning Style Topics
1   Being a Master Student – How do I learn best?
2   Taking the Preferred Learning Styles test.
3   What are my scores and what do they mean?
4   How to use your scores to improve the way you learn.

Dr. Richard M. Felder is Hoechst Celanese Professor Emeritus of Chemical Engineering at North Carolina State University, Raleigh, North Carolina. He states that:

> There are well-defined instructional techniques that make teaching more effective. These techniques can be introduced slowly and methodically, without compromising coverage of the syllabus. They do not require large expenditures of money, time, and effort. Most importantly, the techniques have been validated by careful, documented, repeatable research. Their effectiveness is not simply a matter of opinion. Visual learners remember best what they see – pictures, diagrams, flow charts, time lines, films, and demonstrations. Verbal learners get more out of words – written and spoken explanations. Everyone learns more when information is presented both visually and verbally. In most traditional college classes, very little visual information is presented: students mainly listen to lectures and read material written on chalkboards and in textbooks and handouts. Unfortunately, most people are visual learners, which mean that most students do not get nearly as much as they would if more visual presentation were used in class.

This research supports using 3-D and other visual learning techniques to enhance student learning. "The most attention getting form of activity is 3D moving imagery," says Dr. Hilliard Jason, a clinical professor with the School of medicine at the University of Colorado-Denver and the former editor of *Education for Health: Change in Learning and Practice*. "A lot of the way our brain is shaped and functions can be understood in terms of the survival aspects of evolution," Dr. Hilliard Jason says. He explains that for our earlier ancestors the 3D moving imagery was vital to life: "when they were out, it made the difference whether they found lunch or became lunch." To enhance visual learning experiences for students on-line, we are tapping the capabilities of an EON Virtual Reality Center at the Southeastern Institute for Manufacturing and Technology (SIMT) located in Florence, South Carolina.

RoboKnowledge uses the VEX Robotics Design System basic lab bundle to provide hands-on learning for each student in any location. The VEX kit provides an affordable platform for teaching science, technology, engineering, and mathematics content. In addition, a
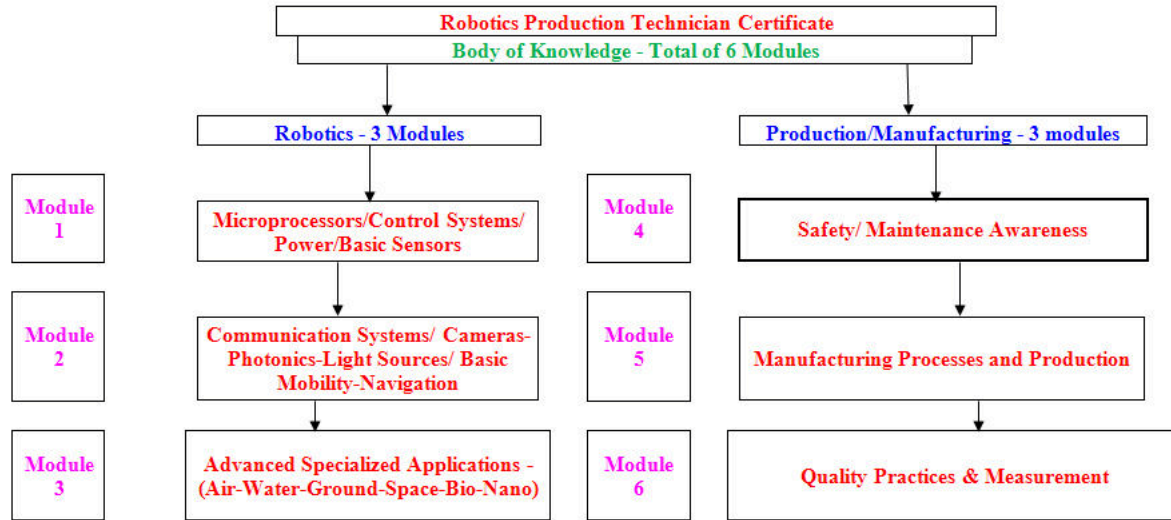
VEX Robotics project encourages teamwork, leadership, and problem-solving. The kit will be used to guide just-in-time instruction as students build, equip, and test the robot throughout the sequence of robotics learning modules. It should be noted that the Vex Robotics project allows students to work with an un-tethered, autonomous robot. Students use a computer to download programs to the robot controller, then un-tether the robot and allow the robot to behave according to the downloaded instructions. Each week as part of the hands-on laboratory experience, students will investigate different components and/or movements associated with an autonomous robotic system. Laboratories for the first two modules have been developed and are listed below. Module 3 will not be developed until Fall 2011.

Module 1 – Lab	Module 2 – Lab
Microprocessors/ Control Systems/ Power/Basic Sensors	Communication Systems/ Cameras-Photonics-Light Sources/ Basic Mobility-Navigation
1 Inventory and Building the Protobot	Adding and Using a Digital Timer
2 Install Robot-C and Running a Program	Adding and Using Digital Displays
3 Making the Robot Turn	Adding and Using a Shaft Encoder
4 Moving Through Maze1	Shaft Encoders II – Precise Movements
5 Moving Forward with a Slow Start/Stop	Shaft Encoders III – Advanced Movements
6 Moving Through Maze2	RF Remote Controls/Joysticks
7 Adding and Using a Front Bumper	Adding and Using a Video Camera
8 Adding and Using a Rear Bumper	Using Video Cameras and Joysticks
9 Adding and Using an Ultrasonic Sensor	Adding and Using Light Sensors
10 Using an Ultrasonic Sensor - Advanced	Using Light Sensors and Light Sources
11 Adding Infrared Sensors & Line Tracking	Adding and Using a GPS Sensor
12 Advanced Line Tracking	GPS Coding
13 Building a Robot Arm	GPS Collecting
14 Using a Robot Arm	GPS Positioning
15 Robot Challenge	Adding and Using an Accelerometer

The sequence of instructional modules is being designed to fit within an existing EMET program and can easily be adapted into a "stand alone" advanced certificate for incumbent workers. Three of the modules will focus on Robotics and three will focus on Production/Manufacturing. Each module will be the equivalent of three college credits producing a total of eighteen credits, which is the usual number of credits associated with an "emphasis." Each module will have three components effectively making each component a one credit equivalent. As a result, institutions may choose to 'plug and play' components to meet specific training needs in a particular area.

The modules will cover the following body of knowledge:

Robotics Production Technician Certificate
Body of Knowledge - Total of 6 Modules

Robotics - 3 Modules

Production/Manufacturing - 3 modules

Module 1 — Microprocessors/Control Systems/ Power/Basic Sensors

Module 2 — Communication Systems/ Cameras- Photonics-Light Sources/ Basic Mobility-Navigation

Module 3 — Advanced Specialized Applications - (Air-Water-Ground-Space-Bio-Nano)

Module 4 — Safety/ Maintenance Awareness

Module 5 — Manufacturing Processes and Production

Module 6 — Quality Practices & Measurement

Each module would be the equivalent of 3 college credits.
Each module will have three components, each being the equivalent of one credit.

Academic topics for Robotic Modules 1 and 2 are shown below. Module 3 will not be developed until Fall 2011.

Module 1 – Academic Topics	Module 2 – Academic Topics
Microprocessors/ Control Systems/ Power/Basic Sensors	Communication Systems/ Cameras-Photonics-Light Sources/ Basic Mobility-Navigation
1 Microprocessors and Numbering Systems I	Communications-Analog/Digital Signals
2 Microprocessors and Logic Gates I	Modems
3 Microprocessors and Executing a Program	Carrier Waves and Modulation
4 Microprocessors and Software Systems	SWR-RFID-Transmission
5 Microprocessors and Decimals/Base 2	Multiplexing-Cabling
6 Introduction to Industrial Control Systems	Photonics in Robotics- CCD/CMOS Devices
7 Closed Loop – Open Loop Systems	Photonics-Digital Cameras/Lasers
8 Summing Op-Amps	Installation of Robotic Photonic Devices
9 Fundamental Battery Structure	Cleaning of Robotic Photonic Devices
10 Battery Connections and Load Testing	Photonics-Safety Issues/Troubleshooting
11 Ultrasonic/Infrared Sensors	GPS-Overview/User Segment
12 Radiation/X-Ray Detection Devices	GPS-Space Segment/Control Segment
13 Multi-Gas/Bio-Chemical Detection Devices	GPS-Positions/Satellite-Receiver Sync
14 Infrared Cameras	GPS-Errors/Biases/Pseudorange Measure
15 Photonic Sensors	GPS-Coordinate/Inertial Systems

Another component of the program comes from the Manufacturing Skill Stands Council (MSSC), a nationwide program designed to enhance the knowledge and core skills of the industrial-based workforce for the 21st century. The MSSC program provides training packages that are organized into four modules: Safety, Quality Practices and Measurement, Manufacturing Processes and Production, and Maintenance Awareness. The topics covered in the modules were identified by a council consisting of several hundred advisors from the manufacturing sector throughout the United States. The objective of the multidisciplinary MSSC training is to boost the worker productivity, innovation, and competitiveness of U.S. manufacturers. Content from four MSSC-developed modules is being converted into three modules, both to align with the RPT (Robotics Production Training) certificate (as shown above) and to recognize the pre-requisite skills/knowledge of manufacturing, engineering, and marine technology students. Each module will incorporate MSSC-ELearning exercises as the laboratory component to the courses.

Certified Robotics Production Technician Program

The NRTC "Certified Robotics Production Technician" (CRPT) credential provides candidates the opportunity to demonstrate they have achieved the skill level needed by today's unmanned and intelligent systems manufacturers. Production technicians in this high tech environment require both production and robotics skill sets to be successful. NRTC has focused on several core competencies in robotics technologies as well as partnering with MSSC who provides credentialing for the production core competencies by offering the "Certified Production Technician" (CPT) credential. The NRTC Certification program offers a new tool to the unmanned and intelligent systems industry to locate technically skilled, flexible, trainable production technicians with a known and verified skill level.

Partnering with The Manufacturing Skill Standards Council

The Manufacturing Skill Standards Council (MSSC) is an industry-led standards-based, training, assessment and certification system focused on the core skills and knowledge needed by the nation's production technicians. The MSSC System awards "Certified Production Technician (CPT)" certificates to individuals who pass any or all of its four Production modules: Safety; Quality Practices & Measurement; Manufacturing Processes & Production; and Maintenance Awareness. The nationwide MSSC System, based upon industry-defined and federally-endorsed national standards, offers both entry-level and incumbent workers the opportunity to demonstrate that they have acquired the skills increasingly needed in the high-growth, technology-intensive jobs of the 21st century.

Certified Robotics Production Technician

Computer Operating Systems
- Knowledge of the functions performed by microprocessors, logic and memory devices and I/O devices
- Understanding of how computer operating systems process data and the functions of the subsystems of a micro processor

Computer Control Systems
- Understanding the operation of robotic controllers
- Knowledge of electronic devices that control robotic arm movement

Power Systems
- Understanding battery technology, load testing and life determination
- AC/DC generation and conversion, variable voltage and phase modulation

Sensors
- Understanding sensor types and functions
- Knowledge of source materials being detected such as radiation and biochemical agents

Communication Systems
- Understanding system components such as source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination
- Converting and understanding digital communications

Cameras, Photonics and Light Sources
- Knowledge of photonic devices used in robotics and digital camera and transmission types
- Knowledge of proper safety and handling of camera sensor and laser devices

Robot Mobility and Navigation
- Knowledge of navigation systems and ranging
- Understanding of the Global Positioning System (GPS) and its major communication protocols

Introduction to Lean Manufacturing
- Knowledge of traditional and lean manufacturing systems
- Knowledge of the different types of waste, different key measures and the lean strategies

Safety
- Perform inspections and emergency drills
- Identify unsafe conditions and take corrective action

Quality Practices and Measurement
- Participate in internal quality audit activities
- Inspect materials, products and processes at all stages of production and communicate quality problems

Manufacturing Processes and Production
- Identify customer needs, determine resource availability, make job assignments
- Coordinate workflow with team members and support groups

Maintenance Awareness
- Perform housekeeping, preventative maintenance and repair
- Recognize potential maintenance issues in production systems; know when to notify maintenance personnel

Five of the modules (1, 2, 4, 5, and 6) will be based upon college coursework that the National Robotics Training Center (NRTC) has recently developed for implementation starting in the spring 2011 term and continuing in summer 2011. This 24 college credit certificate will be realigned to meet the goal of an eighteen college credit "emphasis." Both web-based delivery and hybrid models (partly web-based, partly face-to-face) will be thoroughly tested with academic partners and then be made available nationally to support the development of highly-skilled technicians for the nation's geographically dispersed manufacturers of mobile robotic devices. The breakdown of each module into three components allows Continuing Education Departments the opportunity to "pick and choose" components to match needs for robotics camps for community youth, to provide non-credit workforce development & training opportunities, and to provide community symposiums for employers on the value of Robotics knowledge and skills in the workplace.

Robotics Production Technician Certificate Program

- Training in latest robotics and production technologies
- Prepares student for production technician positions
- All classes are available on-line

Each student that successfully completes the program will:

- Receive an academic certificate from Florence-Darlington Technical College
- Be prepared to take the Manufacturing Skill Standards Council (MSSC) Certified Production Technician (CPT) exams
- Be prepared to take the National Robotics Training Center (NRTC) Certified Robotics Production Technician (CRPT) exams

Visit our web site for more information about the new, challenging field of robotics and intelligent systems technicians at: www.NRTCenter.com

Each class includes:
- Guidance from an on-line instructor
- Text books for all courses
- Lab manual
- Hands-on lab equipment using the VEX educational robotics platform

The VEX Robotics Design System offers students an exciting platform for learning about areas rich with career opportunities spanning science, technology, engineering and math (STEM).

Topics covered in the program:

Computer Systems
Sensors
Communication Systems
Power Systems
Cameras
Photonics
Mobility
Navigation
GPS
Safety
Manufacturing workplace skills
Production processes
Maintenance
Quality and Continuous Improvement

Credit Certificate: Certificate in Applied Science with a major in Robotics Production Technician from Florence-Darlington Technical College, (FDTC) located in Florence, South Carolina.

Florence-Darlington Technical College is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools, located at 1866 Southern Lane, Decatur, GA 30033.

NRTC — National Robotics Training Center

To enroll, please contact the FDTC Admissions Office at (843) 661-8289 or by e-mail at admissions@fdtc.edu

For more information, please contact the NRTC Office at 843-413-2756 or e-mail Dorothy.Czarnocki@nrtcenter.com

www.nrtcenter.com

www.nrtcenter.com

Robotics Production Technician Certificate Program

The Robotics Production Technician Certificate Program will provide instruction in a short-term program for people who want to enter a production position in the robotics manufacturing industry. This certificate will provide students training in the latest technology in the production of robots for the unmanned vehicle systems industry as well as other related robotics manufacturing and maintenance positions.

Prepare yourself for a rewarding technical career in intelligent systems through this program. Let us help you start your future in a rewarding career now.

- 85 percent of all jobs require some college-level training
- Many employers are requiring their employees to be certified
- Prepares the student for certification and employment in the unmanned systems, robotics and intelligent systems industries
- Manufacture and use of robotic systems will increase during the next decade
- Demand for technicians to manufacture and service these complex technical devices is increasing
- High school recent graduates
- Military personnel preparing for a civilian career
- Incumbent workers retraining for a new career

First Term Courses

	Lecture Hours	Lab Hours	Credit Hours
AMT 106, Mfg. Workplace Skills	3	0	3
AMT 161, Computer Systems & Sensors	2	3	3
IET 223, Industrial Safety*	3	0	3
AMT 160, Principles of Qual. & Cont. Improv.*	3	0	3
Totals	11	3	12

Second Term Courses

	Lecture Hours	Lab Hours	Credit Hours
EGR 175, Manufacturing Processes *	2	3	3
AMT 220, Concepts of Lean Manufacturing	3	0	3
AMT 155, Principles of Maintenance*	3	0	3
AMT 164, Communication Systems	1	0	1
AMT 166, Cameras, Photonics, & Light Sources	1	0	1
AMT 167, Robot Mobility & Navigation	1	0	1
Totals	11	3	12

* Required for MSSC Certificate (Mfg. Skills Standards Council)

Prerequisites for entrance:

Test Scores

Mathematics		English/Verbal	
ACT	16	ACT English/Verbal	15
COMPASS Pre-Algebra	60	COMPASS Reading	61
SAT	380	COMPASS Writing	61
		SAT English/Verbal	400

NOTES:
1. Students must have satisfactory ACT, COMPASS, or SAT test scores for entrance into this program.
2. Students who do not meet curriculum entrance requirements may be placed in developmental courses to improve basic skills.
3. Students taking courses online should have regular access to a computer - PC or Mac. These computers should have the minimum specifications of 512 MB ram and 4 GB of free hard drive space after installing all software. Students using older PC's without these specifications could experience some problems with the assignments.

Graduation Requirements
- Complete all required courses specified in the curriculum.
- Any course with the following prefixes requires a grade of "C" or better: AMT, IET, and EGR .
- Fulfill all financial obligations to the College.
- Achieve a Graduation GPA of 2.0 for all courses presented as meeting a program's course requirements.
- Earn at least 25 percent of the total credit hours of his/her curriculum at FDTC.
  Exceptions can be made only by the Vice President for Academic Affairs.

The alignment of the on-line coursework builds upon the work of the NRTC, incorporates MSSC's skills standards, and focuses on the production of unmanned, autonomous, mobile robots. The program also recognizes the need for geographic diversity, as its serves a technical college in South Carolina with a rural service area, Broome Community College (NY, suburban service area), and the regional TIME Center at the Community College of Baltimore County (MD, urban service area). The TIME Center represents 5 community college partners. The project engages a broad spectrum of industry and government employers and leverages the experience and prior work of multiple Advanced Technological Education (ATE) Centers and projects, including two national centers, SCATE and MATE, and the regional FLATE and TIME Centers. RoboKnowledge partners also include the Association for Unmanned Vehicle Systems International, commercial (iRobot) and defense (Raytheon) robotics manufacturers, the Department of Defense, the national Institute for Women in Trades, Technology & Science,

MSSC, the Employ Florida Banner Center for Manufacturing, and Embry-Riddle Aeronautical University (FL).

Future Work

An ongoing and strong industry/government/education partnership will help ensure alignment of content with industry needs and recognized skill standards. High school partnerships will advance career awareness and build new educational pathways for technician education. Rigorous evaluation and dissemination will help ensure maximum impact. A dedicated website, RoboKnowledge.org, will provide easy educator access to this to this educational resource.

RoboKnowledge modules will be tested with students for the first time during the 2011 spring semester; thus this paper represents a "Work in Progress." Results, including the success of student completers on national certification exams and the comparisons of student success rates achieved by on-line delivery versus traditional face-to-face instruction, will be reported as they become available.

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