AC 2000-407: Manufacturing Technology Curriculum for the Twenty-first Century

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Manufacturing Technology Curriculum for the Twenty-first Century

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Abstract

Like all engineering and technology educational fields, the manufacturing technology curriculum must change significantly to reflect the profusion of technical advances in the last two decades of the twentieth century. Pertinent manufacturing technology changes include implementation of new and more diverse materials, improved and more varied and more precise processing, automation and controls, and computer aided manufacturing (CAM). This progress requires changes in training materials and program curriculum to reset and then renew the basic technical skills required of manufacturing technologists and technicians. In addition, more radical changes are being implemented in many industries that have little to do with technical skills required for plant operations. Quality management has been introduced into many facilities worldwide either under the guise of TQM (Total Quality Management), a company based quality plan, or even the International Standards Organization standards set forth as ISO 9000 and 14000. Regardless of the name that frames the plan, the implementation of a quality management plan transforms the work environment in any organization or facility significantly.

These new expectations put additional requirements on manufacturing technicians and technologists working in a plant. Not only are technical skills required, but skills that reflect plant worker responsibility for the smooth operation of a manufacturing process as well as the quality of the product and process. Under quality manufacturing plans, plant workers are required to keep and report their own quality control data, operation parameters, work with others to improve processes, efficiency and product quality, as well as proactively engage in troubleshooting activities.

With this new working paradigm and the new technical skills required a new 2- year technical program be being developed at Hillsborough Community College (HCC) in Tampa, Florida. The curriculum for this Associate of Science Degree in Manufacturing Technology is based on the input from the Florida High Tech Corridor Council, a consortium of high technology industries and academic institutions residing along Interstate 4 through central Florida. The curriculum has 4 major components that include; 1, general education requirements; 2, scientific and mathematical background requirements; 3, technical skills requirements; and 4, interpersonal and quality management skills. Although the courses will be separate, the concepts from the four different areas will be integrated in all classes where suitable. Lifelong learning will also be stressed. Graduates from the program will earn an Associate of Science in Manufacturing Technology, and become valuable employees at a variety of high technology industrial manufacturing facilities well into the 21st century.

Background

In 1997, a subset of the Florida I-4 High Technology Corridor Council formed a working group, the Tech-4 High Technology Industrial Educational Consortium. The partners of this consortium are representatives of the high tech industries, community colleges and universities in central Florida roughly along the interstate 4, which runs east to west from Daytona Beach through Orlando to Tampa. The Tech 4 Education consortium was founded to ensure a highly skilled workforce for business in central Florida. Tech 4 promotes training for high school students, community college students, university students, as well as individuals seeking a career change. Beyond education offerings the Tech 4 Education Consortium provides awareness programs that seek to increase the general public's knowledge concerning high tech careers. Additional industry partners are being encouraged, as are new school partners to be involved.

In evaluating the status of the potential workforce in Florida the consortium realized that a bigger and more consistent effort was needed in this area. The consortium undertook the task of evaluating a variety of training programs and 2-year programs in community colleges around the nation. With support from Cirent Semiconductors, a group made site visits to the Maricopa Community College System in and around Phoenix Arizona and Austin Community College, Austin, Texas to evaluate similar training and educational programs that have recently been initiated to support the high tech and semiconductor industries.

Several of the community colleges, the University of South Florida and the University of Central Florida with cash matching from Cirent Semiconductors, Inc., were recently awarded, a 3-year grant from the National Science Foundation. The $1.1 million grant came through the Advance Technology Education, ATE, segment of NSF primarily to establish two-year programs for Manufacturing Technology for semiconductor and other high technology industries in Florida. A second and equally important aspect of this grant is to secure a solid pipeline from middle schools through high schools to community colleges and universities in the area of advanced technologies. Due to the local differences and needs, each of the grantee community colleges will have a slightly different focuses for the new programs. However, specific curriculum modules to support all of these high technology-based programs were assigned to each of the partner community colleges and universities. These modules will be incorporated into each of the individual institution programs as well as be made available to the other partners via distance learning.

Hillsborough Community College

The new Manufacturing Technology Program will reside on the Brandon Campus.
The Brandon campus of Hillsborough Community College in Tampa is the second largest and newest of 5 campuses in the HCC system. The primary focus of this campus since its opening in has been in the area of Associate in Arts Degrees for transfer to four-year institutions. However, it has recently begun a significant move toward the development of its own Associates in Science Programs to serve the needs of the growing service and technical industries in the area.

The Manufacturing Technology program is but one of these efforts to develop workforce-training curricula in Brandon. A full time faculty position was created and space for the

laboratories has been allocated for the program. Additionally, HCC applied for, and was awarded, a grant of $200,000 from the Florida State Workforce Capitalization Incentive Program to purchase equipment for a vacuum technology training laboratory and curriculum materials for the hazardous materials course. Vacuum technology and hazardous materials are two of the modules that HCC is responsible for developing under the NSF grant. A second grant has been submitted for similar funds to support the fluids and pneumatics laboratory modules of the curriculum. The curriculum has been submitted to the College for approval and will officially begin in Fall Semester 2000.

Manufacturing Technology at HCC

The new curriculum is outlined in Appendix A, which gives the suggested semester sequence for students. However the entire curriculum was developed based on the technician needs of many high technology manufacturing industries in the area. The objective of the program is produce graduates who have a solid foundation in four areas of their curriculum. First, all AS degrees must have a minimum of 18 semester hours in general education requirements, which includes English, mathematics, communications, social sciences and the humanities. In this segment, the students take the required Freshmen English, and college courses in the social studies, communication and the humanities.

The second component will be the foundation in math and science to support and enhance their technical training. This component includes College Algebra and Trigonometry, College Chemistry I and Laboratory and General Physics and Physics Lab. Having a background in basic science and mathematics allows the student not only to learn the material in the technical training courses but also understand how and why “things” work the way they do. It also allows the student to develop a more comprehensive image of equipment and/or instrumentation that he/she operates as well as the process or processes that are occurring. Additionally, the student will be more amenable to applying his knowledge to new processes, new equipment, troubleshooting, improvements in the workplace, and continuing his/her own education as desired or required.

The last two components of the Manufacturing Technology curriculum are specific to the workplace. These are the technical training and the quality/interpersonal skills training. Little needs to be said about the importance of the technical training. However, under the paradigm expressed above, in which an individual’s “workplace” changes regularly, a technician must be amenable to, and, even challenged by, a change. These changes may be a new or altered process; for a given product; a change in product that implies a different processing; a change in instrumentation or equipment; a change in location or employer; or, any combination of the above. To produce a worker that fits this definition, the education and training must have both breadth and depth. For breadth and depth, the student must become proficient in some areas and knowledgeable in others that may or may not be related. This requires a strong foundation in the underlying principals and concepts of the discipline under study. In this curriculum, this means that students will become proficient in the basics of vacuum science and technology, fluids and pneumatic systems, and process control systems. The student will also be knowledge about a variety of advanced manufacturing processes that are used in a wide range of industries. In other words, the student will have a working set of “working skills” that can be put together in a

variety of ways or orders. This allows for him/her to adapt to required or requested change in his/her work environment.

The quality and interpersonal skills that are part of the workplace training components is relatively new in the manufacturing environment. Historically, manufacturing has gone through several step-function changes in its own operational paradigm. The most recent one, in which quality became a controlling parameter, had its beginnings early in the twentieth century. However, like many significant changes, it had a slow, spiraling evolution. The second half of this century saw its own spiraling growth in production and trade. These unstoppable trends in the global economy merged with the quality concepts that had been incubating in philosophical and theoretical circles for some time. The result was a working definition of quality. Its manifestation can be seen in TQM (Total Quality Management) and ISO 9000 and ISO 14000 (International Standards Organization) certifications, which are both common language in the present industrial and commercial worlds.

There are several underlying premises of these working definitions of quality. Quality suggests that everyone at every level in an organization is responsible for the betterment of both the workplace and the products or services. Quality implies that technicians can team with with their supervisors and administrators as well as with each other and to tackle a problem or improve a system. Quality means that all employees realize the importance and actively participate in troubleshooting. Quality documentation is often lengthy and comprehensive, describing how and by whom operations are monitored and changed in a facility. Quality is a new operations work place paradigm. To ensure that quality reigns in a facility, training is required. Basic teamwork and other interpersonal skills can be learned in a classroom environment. The manipulations and interpretations of statistical quality control and its resulting data, the gauge of quality can be learned and applied by everyone in a facility. Ethics can be nurtured in a classroom environment. Safety, environmental health, and industrial ecology can also be learned. Three courses in the curriculum will address these issues. They include Statistical Quality Control, Process Safety and HAZMAT, Quality Concepts and Team Building Skills. Additionally, quality issues will permeate all the technical training courses so that students not only have focused classroom learning of the philosophy and concepts, but also a working knowledge of quality as well.

Conclusion

The curriculum has evolved over a year's time. Significant input form local industry, other similar programs throughout the country, and university engineering faculty was blended together under the constraints of a two-year, 64 semester hour Associate in Science Degree program with its own requirements. The program will enroll its first students in Fall Semester of the year 2000. We anticipate success.

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ANDREW HOFF has worked in microelectronics manufacturing for the past twenty years. He received the Ph.D. in Electrical Engineering from The Pennsylvania State University in 1988. Since 1988 he has worked at USF in Tampa, Florida in the Center for Microelectronics Research and is presently an Associate Professor of EE and Director of the College Metrology Laboratory. His research interests include the characterization and control of process related defects and contamination, plasma processing of materials, and process induced charging and associated damage in IC manufacturing.

Appendix A

Hillsborough Community College
A.S. in Manufacturing Technology (focused on High Technology Industries)

Recommended Sequence of Courses (64 credit hours)

YEAR 1

Fall Semester

Freshman English I	3 cr.
College Algebra	3 cr.
Introduction to Advanced Manufacturing	1 cr.
College Chemistry	3 cr.
College Chemistry Laboratory	1 cr.
Introduction to Drawing and Drafting.	3 cr.
Total	14 cr.

Spring Semester

Trigonometry	3 cr.
Intro to Electronics for Advanced Manufacturing	3 cr.
Process Safety and Hazardous Materials	2 cr.
Fundamentals of l Physics	3 cr.
Fundamental of Physics Laboratory	1 cr.
Quality Systems and Workplace Dynamics for AM	2 cr.
Total	14 cr.

Summer Semester

General Education - Humanities	3 cr.
Introduction to Computers and Technology	3 cr.
Total	6 cr.

YEAR 2

Fall Semester

Introduction to Speech	3 cr.
General Education – Social Science	3 cr.
Vacuum Science	3 cr.
Vacuum Laboratory	1 cr.
Industrial Controls I	3 cr.
Statistical Quality Control	3 cr.
Total	16 cr.

Spring Semester

Advanced Manufacturing Processes and Controls	3 cr.
Industrial Controls II	3 cr.
Vacuum Technology and Systems	3 cr.
Vacuum Technology Laboratory	1 cr.
Hydraulic and Pneumatic Systems	3 cr.
Hydraulics and Pneumatics Laboratory	1 cr.
Total	14 cr.