

Quinsigamond Community College

Internal Program Review

Academic Year 2005-2006

**Manufacturing Technology
Program**

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Table of Contents

	<u>Page</u>
<u>Section I:</u>	
Competitive Analysis and Regional Labor Market Demand	1 - 16
Q1 Market Influence	1
Q2 Programmatic Currency	10
Q3 The Pipeline: QCC Feeders	11
Q4 Role of the Program Advisory Committee	13
Q5 Competition Marketing Strategies, and Enrollment Projections	14
Q6 Opportunities for Program Expansion	16
<u>Section II:</u>	
Curriculum, Instruction, Assessment, and Faculty	17 - 34
Q1 Foundations of the Program	17
Q2 Curriculum	19
Q3 Relevance of Instructional Methodologies, Assessment Strategies and Program Credentials	25
Q4 Program Growth Opportunities	28
Q5 Student and Program Assessment	30
Q6 Faculty	33
<u>Section III:</u>	
Institutional Support and Other Program Resources	35 - 42
Q1 Program Sponsors	35
Q2 Academic Supports	37
Q3 Student Supports	39
Q4 Physical Facilities	40
Q5 Program Financing	42
<u>Section IV:</u>	
Executive Summary of Findings	43 - 49

**SECTION I: Competitive Analysis and Regional Labor
Market Demand**

Section I: Competitive Analysis and Regional Labor Market Demand

1. Market Influences

- A. Provide a broad definition of this employment sector. List specific knowledge and skill requirements for employment in this field.**

The Manufacturing Sector

Manufacturing converts raw materials by technological and hands-on means into goods that are used by a broad spectrum of end users from industry to household consumers. Manufacturing makes all the durable and disposable products that are needed for every phase of our daily lives. And, in today's global economy, manufacturing has expanded its influence from the concerns of local companies to having a heightened visibility in the world picture.

According to NACFAM (National Coalition for Advanced Manufacturing), the desired models for today's manufacturing environment are "advanced high performance firms:

"Advanced high-performance firms are those using computer-based technologies, teamwork, and communications integrated into a system capable of furnishing a mix of products in large or small volumes, with both the efficiency of mass production and the responsiveness of custom manufacturing. Such firms are further characterized as having empowered workers, using TQM and JIT, and continuously improving to be lean and agile."

(National Voluntary Skill Standards for Advanced High Performance Manufacturing, April 1997)

As a result, everyone in manufacturing today must be involved in all phases of the manufacturing world, making raw materials into finished goods; understanding those materials, their processing, necessary tooling; and understanding the requirements of both internal and external service providers as well as all consumers. To various degrees all people in the manufacturing sector must also have some awareness and knowledge of the requirements of the field including engineering, consulting, inventory management, economic concerns, outsourcing, and other disciplines.

Manufacturing has been the backbone of the Massachusetts economy for over a century and will continue to hold that position in the future. However, it is essential that today's manufacturing employees understand more than just the requirements of their specific job in the industry.

The Greater Worcester Area is rich with a diversified manufacturing base of over 400 companies ranging from small local shops to international corporations. Among the companies served in our geographical area are:

- Norton (Saint Gobain)
- David Clark
- Ken's Foods
- Wright Line
- Wyman-Gordon

- EMC²
- Raytheon
- American Semiconductor
- Intel
- BSF
- Gentec
- Hybradon
- Kennedy Die Casting

The following list presents the industry sectors represented by local manufacturers.

- aerospace
- aviation
- biotechnology
- electronics
- computers
- petrochemicals
- food
- steel
- castings
- forgings
- office equipment
- wire manufacturing

The end users for these industries and sectors range from average citizens to major industries and governmental agencies from local to state to the federal level.

All companies require certain basic skills of their entry-level employees which correspond to the basic attributes outlined in the NACFAM Skill Set specifications — ability to communicate, to analyze, and to work not only independently, but also within a group. Central Massachusetts has a wide variety of companies from metal working to medical device manufacturing, from aerospace to pharmaceuticals which brings a unique demand of both old and new form of management. Our research of these local companies indicates that they continue to require higher skill levels of their employees from year to year. Companies need employees who are proficient in more technological skills allowing these firms to be not only competitive, but to excel in their particular arenas. They look for people who have specific knowledge and who understand competitive pressures. They look for new employees who have the background and expertise to perform from the first day on the job without expensive retraining, and they look for their current employees to be willing to expand their current knowledge for the benefit of the company as well as for the employee's own professional growth.

Knowledge and Skills areas

CAD (Computer Aided Design)

CAD has transformed industries from being dependent on hardcopy blueprints to relying on computer-integrated tools for communicating part and product information. QCC provides extensive training in CAD utilizing AutoCAD, an industry standard application, as our software platform. Both manufacturing engineers and technicians require mastery of this technology which provides

computer-generated “wire form” images to provide all views of parts.

Solid Modeling

This discipline is related to CAD and is used to create solid parts design through electronic means. Computers view these parts as reality with mass, material strength, and unique properties. Companies use this technology to model parts, project product life, determine product effectiveness in operational environments, and evaluate parts performance even before they are physically manufactured. Since the parts have electronic shape and mass, they can be directly introduced into Computer Aided Manufacturing (CAM) processes, have research performed, undergo stress analysis, and have assembly drawings built. The use of applications such as SolidWorks is becoming more cost effective for both industries and educational institutions.

Modern Manufacturing System

This knowledge is a main focus of today’s manufacturing environment and includes the areas of MRP (Material Resource Planning), ERP (Economic Resources Planning), JIT (Just-In-Time), and two Japanese systems of material control and continuous improvements (KANBAN and Kaizen). Robotics and factory automation are key systems that fall under this area. These systems drive product flow as material and resource planning systems that allow management to operate facilities efficiently, to plan and justify new equipment and facility changes, and to insure continuous enhancement of their competitive position.

Automated Manufacturing Systems, Cellular Manufacturing, and Robotics

Tasks that can be classified as highly repetitive fall into this area. Companies are looking to reduce lower-skill labor positions and to replace the people with machines. However, the new machines, in turn, require employees with more sophisticated technological skills who are able to do set ups and maintain the necessary operational parameters.

CAM (Computer Aided Manufacturing) and CNC (Computer Numerical Control)

These processes are used to integrate computer systems and manufacturing processes to enhance output and add control throughout the facility. The needs for these skills are growing throughout all types of manufacturing and production. QCC provides knowledge of machining to ensure students are able to fill the standard job requirements in modern manufacturing environments.

Standard Office Applications

All microcomputer application skills are important, but knowledge of Excel and Access are vital to manufacturing. In addition, Word and PowerPoint skills are needed to convey important information throughout organizations and to customers. The ability to gather, organize, store, and manipulate data into meaningful information through these applications is required in many industries. Although most senior engineers perform these tasks, engineering managers prefer to have associate engineers and technicians take over these duties thereby allowing more experienced staff to work on operational and design improvements.

Blueprint Reading and Geometric Tolerancing

These knowledge areas are still important to all companies whether they are CAD or blueprint controlled.

Other Skills

In addition to the technology skills described above, the Employability Standard Skills also include the ability to communicate both verbally and in writing, to analyze, to work in a high paced environment; to produce work in a timely manner, and to work with others.

The following table shows the required skill, the current QCC offering that address that skill, and the course from the proposed new curriculum which will support the skill

Fundamental Skills/ Knowledge/Proficiencies	QCC's Current Program AY 2004	Proposed Programmatic Revisions or New Courses
Computer Aided Design Concepts (CAD)	Mechanical CAD I and II (MNT 101, 102)	
Solid Modeling Capabilities		Recommend development of new course: MNT 103 Solid Modeling (Fall 2005)
Modern Manufacturing Systems, inc. Lean Manufacturing; Automated Manufacturing; Cellular Manufacturing; Robotics	Manufacturing Process II (MNT 216)	Recommend curricular additions to MNT 216: Cellular Manufacturing Robotics Just-In -Time KANBAN KAIZAN (Fall 2004)
Computer Aided Manufacturing	Fundamentals of Computer- Aided Manufacturing (MNT 215)	
Computer Numerical Control	Computer Numerical Control (MNT 210)	
Standard Microsoft Suite Office Applications	Introduction to Microcomputer Applications in Telecommunications (CIS 115)	Recommend change of course to: CIS 111 Introduction to Microcomputer Applications

		(Microsoft Office Suite)
Blueprint Reading and Geometric Tolerancing		Recommend development of new course: MNT 105 Geometric Tolerancing & Blueprint Reading (Spring 2005)
Mathematics	College Mathematics I: Precalculus (MAT 123); Statistics (MAT 122)	Recommend upper level mathematics electives for transfer bound students: Calculus I & II (MAT 233 & 234)
Quality	Statistical Process Control (QLC 221)	
Management/Marketing	Industrial Management (MGT 221)	Program Electives in Management/Marketing
Science of Manufacturing (Physics)	Physics I (PHY 101)	PHY 101 & 102

Note: The proposed new courses need not replace current courses. Instead, they are designed to offer additional avenues of education to allow students to pursue a curriculum geared more towards engineering rather than our current program which is targeted more towards technology.

Careers Choices

QCC offers both a certificate and A.S. degree program in Manufacturing Technology. These choices allow our student to pursue a career in manufacturing. In addition, QCC will continue to develop the curriculum to ease transferring to programs at local four-year institutions. WPI and QCC have begun to study how the two schools can work closely to provide transfer opportunities for QCC students.

B. Using relevant labor statistics, indicates whether employment opportunities in this field are expected to increase or decrease over the next 3-5 years. Please cite the sources that you have used to make these predictions. (Note: It is easier for Admissions and Marketing Departments to refer to these predictions if they can quote the source)

Response: Massachusetts employment data show an overall decrease in the number of manufacturing jobs in the commonwealth. Those jobs being eliminated are in the less-skilled areas. However, the demand for higher-skilled jobs is increasing as proficiency in modern manufacturing techniques is required. QCC's

Manufacturing Technology program is targeted to meet these needs.

A review of current employment statistics via the Massachusetts Division of Career Services the website (See: http://lmi2.detma.org/lmi/lmi_ces_a.asp) indicates that for the most recent thirteen month period available—July 2004 through July 2005—manufacturing employment (i.e., durable goods, non-durable goods, and computer & electronics products) within the Worcester metropolitan region has averaged 29.2%. These statistics “represent monthly estimates of employment, hours and earnings by industry for the Commonwealth and for seven Metropolitan New England City and Town Statistical Areas (NECTA). “

An article published in the May 15, 2005 edition of the Boston Globe indicates that although there has been a general decline in employment within the manufacturing sector across the state, manufacturing continues to represent a significant segment of the economy within some 30 Globe west communities (i.e., 495 beltway and west). In fact, “about 11 percent of the jobs in the 30 communities were in manufacturing.” It is reasonable to assume a multiplier effect with additional employment generated in those industries comprising the supply chain network necessary to providing the raw materials and supplies for manufacturing.

A March 2004 review of the Monster.com Web site of manufacturing-related jobs showed a total of 2,863 openings in Massachusetts. Even when limiting the search to include only “Manufacturing and Production” positions (which removed many manufacturing disciplines), the results still showed 507 statewide employment opportunities with 116 in the Worcester area alone.

It should be noted that as of the writing of this report, DET does not include the manufacturing employment opportunities that are available in the rapidly growing field of biotechnology which is becoming a major factor for Worcester’s economic profile. These emerging positions will add significantly to future employment numbers.

C. Review and analyze the most recent five years of institutional data to determine whether graduates of this program have found employment in their field and/or transferred to a related four-year program in their field within one year of graduation

Response: There is limited follow-up data for our graduates. The following information was supplied by QCC’s Experienced-Based Education Offices.

Note: The majority of our current and past students were employed prior to and during their years of study. Some are in search of promotions while others are getting back to school and looking for a way to get an A.S. or B.S. degree.

Manufacturing Technology Placements

<i>Student</i>	<i>Date of Hire</i>	<i>Company</i>	<i>Title</i>
Student 1	1/2/2004	Wyman-Gordon Co.	Engineering Technician
Student 2	5/20/2003	Intel	Manufacturing Tech
Student 3	5/20/2002	Acambis Inc	Manufacturing Associate
Student 4	4/1/2001	Magnetic Technical	Engineering
Student 5	12/20/2000	LUTCO	Engineering (promotion)

These five (5) students are or were working in full-time positions.

D. Please identify the specific occupations (and job titles, if possible) for which program graduates are prepared. Identify the types of employers that have hired graduates of this program within the last 5 years.

Response: Some of the occupations or job titles associated with those occupations our graduates are prepared for are

- engineers
- supervisors
- production managers
- technicians
- computer-manufacturing specialists
- manufacturing programmers
- continuous improvement technicians
- equipment maintainers
- CNC programmers
- value engineers
- inspectors
- quality engineers
- manufacturing managers

Intel, David Clark Company, and Wyman–Gordon have supported our program in the past and have indicated that they are committed to working with QCC to produce the very best graduates for their needs.

At a breakfast meeting this past March, Matt Deminico, of Wyman-Gordon’s Human Relations department stated, that the company intended to hire QCC graduates annually and to provide Co-Op opportunities. Recently, Wyman-Gordon hired one of our students as an associate engineer rather than an applicant with a four-year degree because the QCC student had the specific skills needed at the moment. Wyman-Gordon’s decision shows great confidence in our program

E. Identify the institutions to which students have transferred in the last three years.

Response: No students have transferred to other institutions over the past three years. However, we are currently working with UMass-Dartmouth and WPI to gain transfer agreements into the programs offered by those institutions in Manufacturing Engineering and Mechanical Engineering programs. These agreements would supplement and augment our current agreement with Fitchburg State College in the manufacturing technology area.

F. Summary and Analysis: Market Influences

Response: According to our latest information, New England manufacturers are focusing on modern manufacturing techniques and require employees to be skilled in these identified areas.

External Forces That Will Guide Program Design And Revision

The program clearly views its curriculum as a dynamic entity that will change and expand as needed to better respond to ongoing industry advancements and workforce needs. Advancements within the automated high performance manufacturing industry will guide program design and revision. Regular cooperation with forward-thinking industry and higher education partners will provide the program with the most meaningful understanding of industry needs. QCC's close relationship with Intel Corporation and with its partner--MATEC, the Maricopa Advanced Technical Education Center, will further enable the program to stay abreast of developing changes in the skills, knowledge, and abilities requirements of the automated manufacturing marketplace. MATEC provides QCC faculty with several opportunities each year to participate in intensive high quality faculty and curriculum development initiatives.

Ever evolving workforce skill demands will serve as a key driver behind future growth and curricular revision. Today's manufacturers are seeking highly skilled employees who possess strong technical skills, knowledge, and abilities, who are able to think critically and to work successfully within their organizations as members of cross-functional teams. These employees provide the employer with expertise in cutting edge manufacturing techniques in engineering, robotics, lean manufacturing, throughput efficiencies, and inventory management. Other employers are searching for well-qualified employees who possess fundamental manufacturing skills such as those identified by the National Coalition for Advanced Manufacturing (NACFAM) in its skill standards document titled **A Blueprint for Workforce Excellence (MSSC Skill Standards)**.

In addition, the manufacturing technology program intends to build closer ties with QCC's Center for Continuing Education. CCE's has a strong track record of training success with local manufacturing companies. CCE's programs may serve as a model pathway to the Manufacturing Technology certificate and/or degree program.

2. Programmatic Currency

A. Describe how the program maintains curricular currency.

Response: The Program Coordinator periodically surveys local manufacturers to identify the skill sets needed in their respective industries. These manufacturers add to our understanding of the economy and the status of each industry. They help to identify new course development opportunities and advise us about graduates whom they employ or those who are interviewed for various positions. We have also worked closely with WPI, UMass-Dartmouth, and Fitchburg State to review their curricula to develop appropriate articulations.

B. Explain the existing mechanisms that allow for regular input from local employers or other relevant sources.

Response: The Program Coordinator currently maintains contact with key area employers and continues to contact additional companies. In addition, we are developing an annual employer survey to summarize the needs of local industries.

C. Describe how this input affects the program. (Note: It is helpful with our accreditation processes if you can include some specific examples of input that have led to recent changes in the program.)

Response: Contact with local employers insures that not only are the general areas of manufacturing knowledge being taught, but that any specific needs of the Worcester area industries are identified to be included in the curriculum. Furthermore, the program has offered training to employees of a specific company to target particular requirements and will continue to offer that service to industries. This provides not only knowledge for the employees, but also allows instructors to gain additional insight into an individual company.

D. Describe ways that the College could support program faculty's incorporating more area industry input.

Response: QCC needs to maintain a constant presence in the local manufacturing sector. Both the faculty and administration must engage area industry in joint ventures so the college can not only provide, but also anticipate the needed skills identified by Worcester area corporations. Our local industries need to be informed and assured that QCC not only provides instruction in essential skills but that it is willing to provide specific educational courses needed for their success. In addition, the QCC faculty should work to develop consulting opportunities with local companies to mutual benefit. Through these means we can expand both our Co-op and CCE programs.

E. Summary and Analysis: Currency

Response: Today, currency is achieved by ongoing meetings between the Program Coordinator and contacts at local industries. Additional vehicles, including the establishment of an Advisory Committee are in the development stage. The program also has to grow through targeted training, and developing consultancy opportunities.

3. The Pipeline: QCC Feeders

- A. Identify all feeders, both actual and potential, (i.e. sources of applicants) to the program. Please include any potential “customized” feeders the College might be able to develop.**

Response: Local high schools, local vocational schools, and local companies which rely on manufacturing in any degree to produce products for end users are feeders. In addition local community agencies who work with the unemployed worker.

QCC must continue to maintain ongoing contact with these sources and to develop these contacts further to assure mutual goals to provide students and the companies' current employees with the opportunity of furthering education and industry goals.

- B. What is the profile of current student demographics? This information may be helpful in determining new feeders into the program.**

Response: The majority of our students come from the Worcester County area and is currently working in manufacturing on either a part-time or full-time basis. These students have seen that continuous education is essential to both maintaining and advancing in their current employment positions. Many view their course at QCC as an initial step and not the final step in their education.

- C. List all articulation agreements currently in place in this program (i.e., agreements with local secondary schools, community-based organizations, proprietary schools, etc.).**

Response: None as yet.

- D. Do program faculty regularly collaborate with their peers in local high schools, four-year colleges and universities, business and industry or community-based organizations on such activities as curriculum development, work-based learning, or professional development? Please cite examples from the most recent three-year period. If there is no active collaboration at this time, please comment on how this type of collaboration might enhance the program. In what ways could the College provide faculty support in this area?**

Response: QCC has just begun to establish these relationships with high schools, four-year schools. Contact with local industries is more developed and continues to grow. It is essential that these relationships grow to foster a pipeline for prospective students. Vocational school students are particularly positioned to benefit by the enhancement of knowledge which QCC provides.

At a recent visit to Worcester Vocational High School, the QCC program coordinator spent time with that school's faculty and several students. A large percentage needs guidance to steer them to our program. The vocational school's faculty was enthusiastic to see QCC on their campus and is interested in working with us to encourage their students to continue their education at QCC. However, we need to maintain and develop our presence at the school to ensure that guidance and information about the College is available.

QCC may want to consider devoting an individual who is both technologically knowledgeable and who has marketing skills to build these relationships with all area high schools. This person might come from our faculty and teach a reduced course load in order to concentrate the marketing development of the Manufacturing Technology program.

E. Explain the mechanisms in place within the program to insure that students who have been granted credit through articulation agreement transition smoothly into the QCC program. In what ways could the College increase its support in these areas?

Response: There are no such mechanisms as of the writing of this review. However, the program coordinator firmly believes that QCC should develop and implement a program which would encourage and allow high school seniors in our geographical area to take Manufacturing Technology courses at QCC for credit towards their high school diploma. The Worcester Vocational school has indicated that they would enthusiastically support this type of an initiative.

Leominster High School has also contacted QCC asking for an articulation agreement. They state that they had had a program with Mount Wachusett Community College in the past until that school dropped their manufacturing technology program. They would like to establish a new alliance for their students wishing to further their education in the manufacturing technology disciplines.

F. Explain the program's involvement with the area Tech Prep consortia or other educational collaboratives, if relevant.

Response: There is no involvement at this time. This is an area that QCC should be involved in to further our goals.

In addition, the program should consider involvement in the K-12 STEM Outreach efforts sponsored by QCC (Women in Technology and Minority Achievers, etc.)

G. Summary and Analysis: The Pipeline: QCC Feeders

Response: Although QCC has current contacts with local schools and industry, the College needs to devote additional time to these institutions and companies to grow its feeder system throughout the area. The potential exists, but time and resources are needed to expand and nurture the inherent opportunities.

The College needs to develop an enrollment management strategy to adequately enroll the program. One focus of that plan should be aimed specifically towards manufacturing with the intent of enrolling students from the Worcester area high schools and vocational schools. We also need to expand alliances with local area manufacturers to ensure the QCC program meets their needs and attracts potential students who are currently employed in the manufacturing sector.

4. Role of the Program Advisory Committee

A. Is there an active (meets at least once a year) advisory committee for this program?

Response: Not as of the writing of this document, but it is the intention of the Program Coordinator to establish an advisory committee within the next academic calendar year.

B. If yes, what is the composition of the advisory committee? How are appointments made to the committee?

Response: Our goal is to have a 15 member advisory committee made up of local industry leaders, students, faculty from local high schools and vocational schools as well as representatives from area colleges and universities.

C. Explain the roles and responsibilities of this committee

Response: The committee will

- establish baseline curriculum standards for the school and local industry needs,
- continue to develop QCC's Manufacturing Technology's program to meet the needs of our local industrial base,
- provide avenues of development for students in area high schools and vocational schools, and
- guarantee articulation opportunities to four-year educational institutions.

D. If possible, cite examples of how committee input has had an impact on the program over the last 3-5 years.

Response: Not applicable at this time.

E. Summary and Analysis: Role of the Program Advisory Committee

Response: An Advisory Committee has not been established. Our goal is to have a committee in place by the end of the 2005–2006 academic year.

5. Competition, Marketing Strategies, and Enrollment Projections

- A. Identify the program’s primary competitors. Describe the process utilized and/or the rationale to determine the list of competitors.**

Response: QCC is the only 2-year school in Worcester County providing Manufacturing Technology education. However, Wentworth Institute (Boston) is a four-year college with a presence for the type of student we are trying to attract.

- B. Identify QCC’s program strengths and market niche with respect to these competitors. In other words, what makes QCC’s program the first choice?**

Response: QCC has only Mount Wachusett Community College in the very northwest corner of Worcester County as a competitor for our general target student base. However, MWCC does not have a Manufacturing Technology program available for its students which positions QCC with the competitive edge.

- C. Explain the specific marketing strategies the College has employed with respect to this program over the last three to five years. Please do NOT list general marketing strategies here. Identify targeted marketing efforts relevant to your program specifically.**

Response: None. This program has not had the dedicated direction, leadership, and resources needed to market this valuable program effectively. There is an immediate need to develop an enrollment management strategy to ensure adequate program enrollment.

- D. Describe how program faculty work with the admissions officers to recruit students into the program. If unknown, outline a recruitment plan with specific activities.**

Response: At the moment, local industry is the major source of new students through our evening continuing education program. However, QCC needs to be visible at all schools where our next generation of potential students will emerge. We also need to explore the possibilities of piggybacking with the program’s certificate offering to gain additional students whose companies will support employees’ educational needs and objectives.

- E. Is the need for this program expected to grow or decline over the next five years? Please base your response on specific data.**

Response: The program is definitely expected to grow over the next five years. Local industry is optimistic about increased employment opportunities for the near future and there is a growing conviction that Massachusetts needs to enhance and expand its industrial base in the areas of advanced, highly productive automation and lean, globally competitive manufacturing technologies.

F. Based on analysis of information presented in this section, prepare enrollment projections for the next five years. Please describe what you believe is the optimum program size.

Response: Beginning in Fall of 2005, we project adding 3 to 5 new students and growing the enrollment number to 20 per year over the next five years. This figure includes students who are currently employed in manufacturing as well as students from local high schools and vocational schools. The Program Coordinator feels that 20 students per year is the optimum student enrollment size based on the current curriculum and the current number of faculty members and their responsibilities. At this time, these projections are dictated by the number of faculty members who teach courses, and the available physical facilities.

As our marketing strategies expand and we grow the program through the establishment of pipelines from area schools and additional companies who wish to educate their employees, these projections will increase and will therefore create a need for more classroom space, additional laboratory/computer equipment, and the recruitment of additional faculty members.

G. Summary and Analysis: Competition, Marketing Strategies, and Enrollment Projections

Response: There is very limited academic competition in the arena of two year colleges. Local industries' reception has indicated that there is a real need for graduates of two-year institutions who are employable as technical help to assist both engineering and manufacturing industry segments. We anticipate that the student enrollment will increase to 20 new students entering the program at the end of our five year-projection plan

6. Opportunities for Program Expansion

A. Are there other directions this program might evolve in order to sustain currency and quality? Consider the following categories, but feel free to include other categories in your responses:

- **New certificate options within the program**
- **New concentrations within the program**
- **Different career ladder options within the program**
- **New associate degree program possibilities**
- **Development of modularized courses**
- **Continuing/professional education in the field (i.e., CEUs, prep for recertification, etc.)**
- **Distance education course development**
- **More proactive job placement/ support post-graduation**
- **Other**

Response: Today QCC offers both a certificate and degree program in manufacturing technology. Although we are producing graduates in both areas with marketable knowledge and skills necessary to today's industries, the College needs to explore and develop additional paths for students to be better prepared for future opportunities.

We should provide a curriculum for students to earn credit for courses taken that can allow them to transfer to a 4-year school for a Bachelor's Degree in Manufacturing Engineering. This type of program could provide an articulation pathway to four-year institutions such as WPI where our students can advance the knowledge gained at QCC for higher level career opportunities. It can show industries that QCC students are trained in academic and industry criteria to be successful in transitioning from a 2-year institution to a full-fledged engineering atmosphere.

In today's highly competitive workplace, employment decision makers in industry look at résumés quickly and cursorily and discard most applications with hardly a glance. Discussions with local industries indicate that the word "engineer" in résumés stands out and commands attention. Those individuals who are able to show this level of accomplishment are most likely to make the first cut leading to face-to-face interviews for available positions.

In the manufacturing world, an engineer stands out as meaning a qualified individual; a problem solver with specific expertise. Most managers in industry are former engineers who now run various manufacturing areas, facilities, plants and plant engineering projects, and serve as sales managers. Others have the entrepreneurial spirit and have started their own businesses utilizing their expertise and provide jobs for others as their business grows. Some of those engineers have an A.S. degree, perform admirably, have been promoted, and even run corporations. When those individuals seek new hires, they often consider their own roots and specifically request an engineer in their as part of the posted job descriptions. QCC can improve our graduates' futures by providing them with the opportunity to gain an engineering degree. An articulation program should be developed to assist students who wish to pursue engineering programs.

The following quotation is taken from the Worcester Polytechnic Institute description of their course offerings for a degree in manufacturing technology which they refer to as an MFE

Manufacturing engineers are employed all over the world for designing and manufacturing every kind of product from biomaterial devices to sporting goods and advanced guidance systems for defense. Manufacturing environments are highly automated, computer-integrated systems of people, machines, computers and software. Many manufacturing environments must be cleaner than hospital's operating rooms, and much larger.

Manufacturing engineers can do everything from trouble shooting a laser cutting process to integrating a global supply chain to produce a product better, faster, cheaper and cleaner. Manufacturing engineers may be employed to improve productivity in hospitals, design better software, coordinate global supply chains, and design products for improved manufacturability in a global economy.

With an MFE degree, graduates enjoy the challenges of transforming resources to meet human needs better, faster, and cheaper, or are part of a design team that assures manufacturability from the beginning of the design cycle. In addition to traditional career paths in established manufacturing areas such as aerospace, automotive and electronics, new paths are emerging in biotechnology and e-commerce.

An MFE degree offers excellent salary opportunities, with average annual compensation are among the highest for all engineers.

— taken from *WPI's Manufacturing Engineering Website*

B. Summary and Analysis: Opportunities for Program Expansion

Response: QCC should explore the feasibility of developing an Associate Degree Program in Manufacturing Engineering and articulation agreements with four year colleges and universities. This development may also enhance an individual student's opportunity for higher levels of employment.

**SECTION II: Curriculum, Instruction,
Assessment, Program Credentials & Faculty**

Section II: Curriculum, Instruction, Assessment, Program Credentials and Faculty

1. Foundations of the Program

A. Describe the rationale for offering this degree with respect to environmental scan information (job outlook) and its unique niche in its particular employment sector.

Response: Today, manufacturing requires more higher-skilled employees than years ago and, in the future employees will be expected to have and maintain even greater skills and knowledge. Manufacturers depend on continuously improved personnel performance and streamlining production techniques to ensure customer satisfaction, to continue to develop new products and technologies, and to maintain a competitive advantage. Today's industries are in the transition from a labor-intensive environment to a highly automated environment. Parts are designed, analyzed for strengths and weaknesses, put into simulated operation, and manufactured through advanced computer technology. Even prototypes of large-scale products — bridges, buildings, ships, and automobiles, aircraft — are all designed, manufactured, assembled, and tested without ever seeing the manufacturing floor. Employees who have advanced skills are essential to the success of manufacturers today and will be even more valuable tomorrow.

The future of low-skilled labor is in trouble as automation, flexible manufacturing, lean manufacturing, and computer technologies define manufacturing processes. Shop floor supervisors need greater technological skills, as do engineers, part designers, and managers. Industry is driven to worker faster, profitably, and with ever higher quality standards to maintain a competitive presence.

B. List degree or certificate objectives in measurable terms. (6-8 overall statements)

Response: The objectives for the students enrolled in the Manufacturing Technology program are:

- To be knowledgeable of manufacturing sciences, engineering, and industry standard technical applications
- To achieve competence in CAD, CAM, and CNC systems with aptitude in solid modeling capabilities
- To know various manufacturing systems that impact today's industries (MRP, ERP, JIT, KANBAN, Kaizen, robotics)
- To solve mathematical problems relating to manufacturing
- To ensure quality is maintained through all phases of the manufacturing process
- To understand business management goals to enhance a company's competitive profile
- To be able to communicate effectively to all levels of a company
- To continue to develop skills as required that support local and nationally-based industries

C. Define expected graduation competencies or student outcomes. Your response should include reference to general education outcomes, employability or “umbrella competencies”, and career-related competencies or technical skills. What will the graduate know and be able to do?

Response: Upon completion of the Manufacturing Technology program, graduates will be current in the technical skills required for today’s manufacturing environment. They will have theoretical, hands-on, and communication skills that will allow them to enter and advance in industries.

The core knowledge provided by QCC will enable graduates to hold the following positions:

- supervisors
- technicians
- programmers
- CNC technicians
- Computer Aided Manufacturing technicians
- sales engineers
- customer support
- problem solvers, purchasing
- technical maintenance

In addition, graduates may also find employment in facility and plant engineering positions working on plant layouts and new equipment installation.

D. Describe how the program supports the College’s mission and purposes

Response: The program supports the College’s mission statement by providing vital knowledge and skills to support each student’s personal goals and development, to continue their education at a four-year institution, to enhance their employability, to advance in manufacturing positions including management, or to create their own business.

E. Prepare a draft program mission statement.

Response: **To be Determined**

F. Summary and Analysis: Foundations of the Program

Response: Manufacturing is a key component of the United States’ economy and society. The QCC Manufacturing Technology program provides needed expertise in the most current manufacturing skills and disciplines enabling students to enhance their employability and to enable local producers to remain viable and enhance their competitive positions. Because of their greater skill levels, our graduates are positioned to meet today’s industry needs.

2. Curriculum

A. Based on the analysis of regional labor market needs, evaluate the current curriculum strengths and identify those areas that you believe require enhancement.

Response: The current curriculum is adequate and addresses the skills required by most modern manufacturing concerns particularly in the areas of training in automation-based industries, lean manufacturing, and increased productivity. The program will continue to evaluate new technologies as they emerge and will incorporate industry best practices into the curriculum as the program grows.

However, beyond the actual class experience, and the actual classes offered, the QCC Manufacturing Technology curriculum is enhanced by the students who are enrolled in the program who bring workplace expertise to the learning experience and who, therefore, help move the courses from a strictly academic pursuit to encompass practical everyday applications.

At present, most of the students in the program are employed in manufacturing and want to better themselves for advancement in their careers. Those students bring shop floor knowledge and awareness to the classroom. As such they strengthen the classroom experience by providing information regarding actual industry information and requirements. They are very motivated to gain additional technical skills but are not in a four-year degree.

As additional marketing vehicles are developed, we expect to draw students from two other areas — vocational schools and comprehensive high schools — both of which have their special strengths.

Vocational school graduates have some hands-on experience and training in certain manufacturing areas such as CAD. In addition to technical courses, those students typically need instruction in basic college-level skills including English, math, and communication. They need to know manufacturing processes, automation, instrumentation, strength of materials, physics, and other scientific and technology courses.

High school graduates may have sufficient verbal and math skills, and have a desire to attend a four-year college to study specific engineering and scientific curriculum after completion of the Manufacturing Technology program.

B. Include the proposed curriculum for each of the current or proposed options in the program.

Response: (See attached)

- **CURRENT**
-
- **MANUFACTURING TECHNOLOGY-Associate in Science**
-

• Course Title	Course #	Offered	Plan to Take	Grade	Credits	• Prerequisites
Cluster A						
Introduction to Computer Applications in Telecommunications	CIS 115	F/S/SU			3	ENG 100 MAT 100 or approp place score
English Composition and Literature I	ENG 101	F/S/SU			3	
College Mathematics I: Precalculus	MAT 123	F/S/SU			3	
Manufacturing Processes I	MNT 110	F			3	
Speech Communication Skills	SPH 101	F/S/SU			3	
Cluster B						
English Composition & Literature II**	ENG 102	F/S/SU			3	ENG 101
Industrial Management	MGT 221	S			3	CIS 115 or Equivalent MNT 110; Coreq-MNT 101
Mechanical CAD I	MNT 101	F/S/SU			4	
Instrumentation in Manufacturing	MNT 115	S			3	
Elective	---				3-4	
Cluster C						
Statistics	MAT 122	F/S/SU			3	MAT 099
Mechanical CAD II	MNT 102	F/S/SU			3	MNT 101
Computer Numerical Control	MNT 210	F			4	MNT 101; Coreq-MNT 102
Physics I	PHY 101	F/S/SU			4	MAT 123
Human Relations in Organizations	PSY 158	F/S			3	ENG 100
Cluster D						
Fundamentals of Computer-Aided Manufacturing	MNT 215	S			4	MNT 102, MNT 210
Manufacturing Processes II	MNT 216	S			4	MNT 102, MNT 210; Coreq-MNT 215, QLC 221
Cooperative Work Experience and Seminar	MNT 299	F/S/SU			3	Approval of Program Coordinator
Statistical Process Control	QLC 221	S			3	MAT 122
Technical Elective***	---				3	
Total credits required					64-65	

- Career Track
- **Transfer Track
- ***Possible Electives-MNT 220 Advanced Topics in AutoCAD, MNT 250 Special Topics in Manufacturing, MGT 225 Quality Engineering Management or a course approved by the Program Coordinator.

- **PROPOSED**
-
- **MANUFACTURING TECHNOLOGY-Associate in Science**
-

• Course Title	Course #	Offered	Plan to Take	Grade	Credits	• Prerequisites
Cluster A						
Introduction to Microcomputer Applications	CIS 111	F/S/SU			3	ENG 100 MAT 100 or approp place score
English Composition and Literature I	ENG 101	F/S/SU			3	
College Mathematics I: Precalculus	MAT 123	F/S/SU			3	
Manufacturing Processes I	MNT 110	F			3	
Liberal Arts Elective	---	F/S/SU			3	
Cluster B						
English Composition & Literature II	ENG 102	F/S/SU			3	ENG 101 MAT 099 or approp place score MAT 123 MNT 110 CIS 111 or CIS 115 or Approval of Program Coordinator
Statistics or	MAT 122	F/S/SU			3	
College Mathematics II: Trigonometry	MAT 124	F/S/SU			3	
Instrumentation in Manufacturing	MNT 115	S			3	
Mechanical CAD I	MNT 101	F/S/SU			3	
Geometric Tolerancing and Blueprint Reading (Spring 2005)	MNT xxx	S			4	
Cluster C						
Mechanical CAD II or	MNT 102	F/S/SU			3	MNT 101
Solid Modeling (Fall 2005)	MNT xxx	F			3	
Program Elective*	---	F/S/SU			3	MNT 101
Computer Numerical Control	MNT 210	F			4	
Program Elective*	---	F/S/SU			3	
Physics I	PHY 101	F			4	MAT 123
Cluster D						
Fundamentals of Computer-Aided Manufacturing	MNT 215	S			4	MNT 102, MNT 210
Manufacturing Processes II	MNT 216	S			4	MNT 102, MNT 210
Cooperative Work Experience and Seminar	MNT 299	F/S/SU			3	Approval of Program Coordinator
Program Elective*	---	S			3	PHY 101
Physics II	PHY 102	S			4	
Total credits required	---				66	

-
- *Suggested Program Electives -- With prefixes BIO, CHM, ERG, MAT, MNT, PHY, PSY, QLC, or SPH; or the following suggested courses: MGT 211, MGT 221, MGT 225, MRK 201, or MRK 221; or a course approved by the Program Coordinator
-

- **CURRENT**
-
- **MANUFACTURING TECHNOLOGY-Certificate**

• Course Title	Course #	Offered	Plan to Take	Grade	Credits	• Prerequisites
English Composition & Literature I	ENG 101	F/S/SU			3	ENG 100
College Mathematics I: Precalculus	MAT 123	F/S/SU			3	MAT 100 or approp place score
Industrial Management	MGT 221	F			3	
Mechanical CAD I	MNT 101	F/S/SU			3	CIS 115 or Equivalent
Mechanical CAD II	MNT 102	S/SU			3	MNT 101
Manufacturing Processes I	MNT 110	F			3	
Technical Elective*	---				3	
Technical Elective*	---				3	
Total credits required					24	

- *Any Manufacturing Elective or a course approved by the Program Coordinator

- **PROPOSED**
-
- **MANUFACTURING TECHNOLOGY-Certificate**
-

• Course Title	Course #	Offered	Plan to Take	Grade	Credits	• Prerequisites
Cluster A						
Introduction to Microcomputer Applications	CIS 111	F/S/SU			3	
English Composition and Literature I	ENG 101	F/S/SU			3	ENG 100
College Mathematics I: Precalculus	MAT 123	F/S/SU			3	MAT 100 or approp place score
Manufacturing Processes I	MNT 110	F			3	
Cluster B						
Statistics or College MathematicsII: Trigonometry	MAT 122	F/S/SU			3	MAT 099 or approp place score
	MAT 124	F/S/SU			3	MAT 099 or approp place score
Instrumentation in Manufacturing	MNT 115	S			3	MNT 110
Mechanical CAD I	MNT 101	F/S/SU			3	CIS 111 or CIS 115 or Approval of Program Coordinator
Geometric Tolerancing and Blueprint Reading (Spring 2005)	MNT ###	S			4	

Total credits required					25	

C. For each course in the revised curriculum, provide a description, statement of goals, major topics covered, primary texts or materials, and instructional technology used. (Please refer to the attached format.)

Response: **Courses under Development**

- **Geometric Tolerancing and Blueprint Reading** helps students learn and apply the language of industrial manufacturing. The blueprint is the universal method of directing the manufacturing of any given component. Parts are defined with many criteria which necessitates the use of industry standard terminology such as runout, parallelism, true center, surface roughness, etc. Manufacturing students need to be conversant in all the terms, to know how to translate them from the blueprint to the actual part, and then to inspect it. Course consists of lecture, practical application of techniques, inspection of various parts, and use of measuring tools.
- **Solid Modeling** involves creating a part in the computer that represents a solid part in the real world with mass, physical characteristics, and chemical variations. Solid Modeling carries CAD to a higher level. Most companies are transitioning to solid versus wire frame drawings produced in CAD.
- **Physics II** enhances students' knowledge of physics for a broader understanding of the science of manufacturing. The addition of an additional semester of physics will help students on the engineering or shop floor and better prepare them for transfer opportunities.

Additional Course Development Opportunities

- **Program Electives** — The current curriculum is restrictive and limits each student's ability to choose courses of greater personal interest and higher level technology. Our new curriculum allows for individual selection with the aid of an advisor to tailor each student's courses to enhance his or her future options.

D. Describe the rationale for the course sequence in the revised program. A rationale of course sequence should be provided for the specific program related courses, the general education courses, electives, etc.

Response: The curriculum was changed to provide a stronger linkage between the certificate program and the degree program. The first two clusters now apply to both programs. Furthermore, the proposed design gives greater flexibility in both liberal arts and technology selections by adding program electives covering a wide variety of disciplines such as management, marketing, psychology, and business.

This modification provides a basis for offering a third pathway leading to a manufacturing technology degree and to bolster the opportunity for articulation to a four-year institution.

E. Explain how the general education components are integrated with the department specific courses.

Response: General education components are interwoven into each course through the variety of instruction and evaluation techniques. Courses contain the basics of all learning: reading comprehension, writing skills, presentations, group investigations, and developing leadership qualities.

F. Does the curriculum incorporate “writing across the curriculum”? Provide an illustration, if applicable.

Response: All courses require writing across the curriculum. Each course requires the student to produce a deliverable in the form of a research paper and/or a manufacturing problem analysis. Oral presentations and other communication requirements make up a significant portion of each course. For example, Manufacturing Process II requires students to develop and present a research paper which analyzes a real time manufacturing problem and presents solutions with a defense of the conclusions.

G. Describe how the program meets the QCC philosophy of “high tech, high touch, high quality.”

Response: High tech: Courses require students to provide technology-based deliverables such as measurements and tolerances, and to create a solid model for several parts which can then be either manufactured or simulated using our state-of-the-art software.

High Touch: Manufacturing is by nature a hands-on endeavor. We use both machining equipment and a factory simulator to provide hands-on educational opportunities.

High Quality: We also analyze local companies to follow their products through the manufacturing process and develop alternative methods of production to ensure currency with industry standards.

H. Does the program structure provide students with at least one elective choice? If no, is it possible to revise the curriculum so that there is at least one elective? Please explain your response.

Response: Yes. The new program allows for three electives: a liberal arts choice and two program choices. These three electives allow students to select courses to suit their personal interests and goals.

I. Summary and Analysis: Description of Curriculum

Response: The new curriculum increases each student’s flexibility in selecting the best pathway for his or her future success. The choices provide for a greater exposure to mathematics, management, marketing, science, and engineering disciplines.

3. Relevance of Instructional Methodologies, Assessment Strategies and Program Credentials

A. Summarize the INSTRUCTIONAL METHODOLOGIES utilized in the program. What are the strengths and challenges of these methodologies?

Response: Instructional methodologies include lectures, demonstrations, discussions, hands-on use of machinery, small group work, and presentations of information from local industries.

B. Provide recommendations for additional methodologies that would enhance students' learning. More specifically, are there additional ways in which instructional technology could enhance students' learning? Options for distance learning? Please explain your answer, and include how the College might support these efforts.

Response: The current curriculum relies on classroom lectures, demonstrations, class participation, and limited hands-on laboratory work. Because of the nature of Manufacturing Technology, these methodologies will continue to be the backbone for instruction. The existing equipment in the laboratory must be brought fully on line and additional equipment purchased in order to provide students with the comprehensive technical skill development and hands on experience they need to be successful in the workplace.

It would be very valuable to have a laboratory assistant who would be available to work directly with students to design and manufacture products in our lab. Laboratory assignments and applications of the lecture theory needs to be more fully incorporated in order to meet the program's full potential and to best prepare our students to go forward with either employment or onto a four-year degree program.

The discipline does not lend itself to distance learning courses. Some computer-based courses might be developed, but the software licenses and costs may cause problems for off site instruction. In addition, many of the courses require hands-on knowledge of the materials in the laboratory.

C. Please provide a detailed ASSESSMENT plan outlining the methodologies used for on-going student assessment and final outcome assessment.

Response: Students are assessed through testing, class participation, application of knowledge-based learning, presentations, research papers, and group learning activities.

D. Describe the strengths and challenges of each of the assessment methodologies listed above.

Response: Because the majority of students are currently employed in the manufacturing sector they are geared to producing results against their companies metrics. The program's strength of its assessment vehicles is that it requires students to think about not only discrete job requirements but of company and industry needs. As such they become more valuable and well-rounded employees.

E. Provide recommendations for additional methodologies to evaluate student achievement. Please consider, but do not feel limited to, the following strategies.

- 1 Student work samples**
- 2 Student portfolios**
- 3 Capstone projects**
- 4 Laboratory activities**
- 5 Presentations**
- 6 Panel discussions**
- 7 Seminars or interdisciplinary projects**
- 8 Juried review of students projects**
- 9 Performance on case study / problem**

Response: The College needs to continue to enlist the aid of local area companies to have students gain valuable experience in a variety of environments and solicit feedback from those companies on those students' performance. Our Co-op helps, but we need to develop alliances with more companies with different products and processes. We may be able set up consulting opportunities for faculty to be directly involved with local companies providing both consulting services and allowing us to utilize students to gather and analyze data working towards manufacturing improvements and efficiency enhancements. This would be a great learning experience and would provide students with an increase in their awareness of their self worth through the success of the practical application of the developed skills.

F. Has this program been evaluated by an EXTERNAL ACCREDITATION organization within the last five years?

Response: No.

G. If yes, please provide name of organization and date of last accreditation review. Did the program meet all of the accreditation requirements? If no, please explain. Attach the summary of the accrediting team's recommendations.

Response: Not applicable

H. If the program has not been evaluated externally, list any appropriate professional accreditation or licensure for this program that the College should pursue. (e.g., industry certifications, professional associations, etc.) Please note that federal and state funding agencies are strongly encouraging program accreditation as a measure of performance accountability.

Response: Obtaining accreditation from the Accreditation Board for Engineering and Technology (ABET) is a future goal, but requires additional curriculum modification and additional laboratory equipment.

I. What changes, if any, might need to be considered to foster enhanced program quality? Consider the following, but you need not limit your response:

- **change in admission requirements**
- **inclusion of an internship or other work-based learning experience**
- **introduction of 1 or 2 electives to allow students to self-select learning opportunities**
- **development of a capstone course to synthesize the learning experience**
- **varied instructional methodologies**
- **enhanced assessment of student competencies**
- **better integration of technology applications**
- **specific instructional aides/software etc.**
- **more coordination of faculty efforts, including the possibility of more full-time faculty**
- **attainment of program accreditation, certification, or licensure**

Response: We need to develop an enrollment management strategy to adequately enroll the program. Our focus of that plan should be aimed specifically towards manufacturing: enrolling students from Worcester area high schools and vocational schools. . Furthermore, we must develop articulation agreements with those schools so that students can gain college credit for specific technological courses they completed in high school.

J. Summary and Analysis: Relevance

Response: The Manufacturing Technology program maintains relevance through its instruction in industry-standard requirements. Having students who are currently employed with manufacturing companies also adds credence to the course offerings since they are able to make contributions to the classroom discussions based on their own real-life experiences.

To continue maintaining its relevance, QCC should prepare an enrollment management strategy that identifies perspective students from the area. High school students, working students, and career changing students need to be targeted and made aware of the benefits that the program can offer as they make their educational decisions.

The college must also expand alliances with local area manufactures to ensure QCC meets their needs and attracts potential students who are currently employed in the manufacturing sector.

4. Program Growth Opportunities

- A. In your opinion, would it be beneficial to develop a common core curriculum among related career programs? (E.g., computer education, business, administrative support, electronics, etc.) Please explain your answer.**

Response: While Manufacturing Technology shares several courses with other programs, it is not currently positioned to share a core curriculum with other science and technology programs.

Nevertheless, we are investigating the question of a core curriculum as we continue to develop and offer new courses and as we plan for the QUEST Center which will provided for interdisciplinary contact.

With our new manufacturing curriculum, each student will have choices to mold their program to fit their needs. In addition, we must continuously partner with local industries to offer the specific skills required to make our graduates the preferred choice in the job market and then work with the faculty members of other disciplines and courses of study at the College to establish a common base of studies that would benefit several areas.

- B. Describe, in detail, all potential areas for program growth. Include, but do not limit your response to the following:**

- **Career Ladder Potential**
- **New Degree or Certificate Options**
- **Professional/Continuing Education Opportunities**
- **Professional Recertification Preparation/Testing**
- **Flexible Delivery Options**
- **Enhanced Instructional Methodologies**
- **Improved Assessment of Student Competencies**
- **Distance Learning Course Development**

Response: As mentioned above, we feel that it is essential to develop articulation agreements for our students to transition to four-year colleges. We need a new track geared to this specific purpose while leaving the established tracks for the program certificate and the A.S. Degree.

- C. Summary and Analysis: Program Growth Opportunities**

Response: Program growth has many avenues to address. We have failed to properly market our program to area high school students. The program should be made more versatile by offering three major tracks: Certificate, A.S. Degree, and B.S. Degree Articulation. Each of these plays major rolls in our success.

1. The program needs to be marketed aggressively throughout central Massachusetts. There are over fifty high schools and vocational schools from which to draw to a freshman class. The connection to these schools can be established or enhanced through articulation agreements for manufacturing and computer courses taken while in high school.

2. Manufacturing Technology has to reach out to local industries to get QCC better known and to help us identify new technologies and provide co-operative learning and college credit. These co-ops are a means to enhance our student's ability to find good employment options while continuing their education.
3. We must formalize articulation agreements with area colleges. We have begun with WPI and UMass-Dartmouth. Additional agreements will be required in the future, but these two place us in good standing.
4. The program must grow through the acquisition and use of additional equipment and laboratory tools for our students. One of the most common complaints from our students is the lack of equipment. We need measuring tools and tables, more machining equipment (including a lathe and a tool sharpener), manual equipment, plastic machinery, and others to enhance to hands-on learning experience. The program should look for various industry partners to help through funding, donating surplus equipment, etc. We also should explore purchasing equipment and tools through auctions thereby saving thousands of dollars in expenses. We do not always need new equipment and tools since industrial tools are designed to work for many years in a manufacturing setting running three shifts and 52 weeks a year for decades. Our usage is quite small and, therefore, a good used machine will last us a lifetime.

5. Student and Program Assessment (Review relevant data over last five year period.)

Student Statistical Data

- A. What have been the incoming students' average scores on QCC placement tests each year for the last five years?**

Response: Not Available

- B. Please identify a key course in the program and analyze student performance over the last 3-5 years. Look at average grade in course and grade distribution, as well as course completion rates.**

Response: Not Available

- C. What are the graduating students' average college GPAs over the last five years? GPAs in major courses? Please describe the additional measures of central tendencies; i.e. median, mode, etc.**

Response: Not Available

- D. If relevant, how have students performed during their field placements or related work-based learning experience?**

Response: Not Available

- E. Indicate the number of students who have transferred to a four-year program, if applicable**

Response: Not Available

- F. Track the average earnings of program graduates each year for the three years immediately following graduation.**

Response: Not Available

Program Statistical Data

- G. Provide a summary of the program's enrollment patterns over the last five years.**

Response: QCC has not systematically collected and analyzed program data.

The program is only five years old and the first years were primarily concerned with introduction of the curriculum to potential students and the typical start up concerns. As a result, little data is available about patterns because there hasn't been a sufficient base to draw conclusions. It would be honest to say that efforts

to encourage enrollment in the past have been sporadic and little marketing effort has been spent to adequately target potential students.

H. Indicate the program retention rate over the same period.

Note: Consider two cohorts: Fall to Spring (same year); Fall to following Fall (one year).

Response: We do not have information on program retention rates as of this report.

I. Determine the average number of semesters it takes for students to complete the program. What methods are used to evaluate the quality of the program?

Response: Unknown

J. Define indicators of program quality. Describe specific strategies used to assess the success of the program in achieving its stated objectives.

Response: The proposed Advisory Committee can evaluate industry needs and assess student's cooperative placements. Today, with the limited enrollment there is no statistical means to assess program quality adequately, but our industry partners can be very valuable in assessing the knowledge base our students have acquired and how well they apply these skills in the workplace.

K. Summary and Analysis: Program Assessment

Response: Since student and program statistical information is not readily available, it is not possible to offer specific data in this section. However, it is clear from even a preliminary examination that the program suffers from several shortcomings which can be readily identified and which must be addressed in the near future.

The first is the lack of a developed and ongoing enrollment management strategy to attract area students. Potential students from high schools and vocational schools need to be made aware that successful completion of the QCC program can help them acquire necessary skills required in the workplace and/or to plan to attend a four-year college after Quinsigamond. However, these potential students are choosing Wentworth over QCC, as mentioned in Section I, mostly because they are not aware of our technological programs.

However, we have a small catch-22 scenario because we are competing for students but lack a full compliment of equipment and facilities that could serve to attract them and we cannot increase the number of pieces of equipment or expand facility without funding from increased enrollment.

We believe that marketing strategies are of primary and vital importance in developing and maintaining the program. The research for this IPR underscores the need to develop stronger bases in industry and in our feeder schools with

vocational schools given first priority and then followed by high schools. We need to offer college credit to be competitive with Wentworth and to develop articulation agreements with area colleges to establish a distinct edge.

The second priority is to enhance our facilities and equipment for hands-on learning. Most vocational schools have similar equipment and tooling. Their students have already used them to manufacture various parts and inspected them to the blueprints specifications they created. Students must be granted college credit for their achievements in high school and not repeat them at Quinsigamond.

6. Faculty

A. Is the current faculty able to adequately address the instructional needs of all courses, both general and specialty, in the program?

Response: No. Today, we struggle to provide qualified instruction with one full-time faculty member and two adjuncts. With the increase in courses offered, we must also address the question of whom we want to teach these courses. Our needs will become greater as our marketing success grows with area high schools and vocational schools. Greater demands will become more apparent.

B. Is institutional support for upgrading faculty credentials required? If yes, please explain the kind of upgrade required and approximate cost associated with the upgrade?

Response: The College should continue to underwrite the opportunities for faculty to be part of professional associations and to attend seminars and professional conferences to further both academic and industry goals.

C. Over the last five years, what has been the ratio between full-time and part-time faculty within this program?

Response: Over the past few years, the ratio has been 1:1. This year it is 1:2. It should be noted that the majority of MNT courses are offered during the evening due to the demographics of the students who are currently interested in the program.

D. Describe how adjunct faculty are integrated into the existing program.

Response: Adjuncts provide an excellent source of instruction utilizing their expertise in industry to engage students not only with the theory, but also with knowledge based on meaningful practical experience in the workplace.

Adjuncts are included in all phases of curriculum development. The program is small enough at present to allow for frequent interaction with the faculty members.

E. Should the College employ additional full- or part-time faculty in this discipline? Provide a detailed rationale.

Response: As enrollment increases, the issue of faculty shortages will become apparent and we must be positioned to act quickly. Students will become disenchanted if they are not able to take full course loads. More adjuncts are required now. The conflict between instructor availability and course offerings stretches our current resources especially for the evening division

F. Describe how all faculty members contribute to curriculum development and overall program cohesiveness. Do ALL faculty members, both full and part-time have an opportunity to contribute to curriculum development?

Response: Yes, both are integral to development of new courses and to evaluate changes in current courses as technology advances.

G. Does the current level of support staff meet the needs of the program faculty? Please explain your answer.

Response: The needs are being met at the present. However, as marketing functions are upgraded to allow QCC to establish a solid presence in the area's high and vocational schools additional support staff may be necessary.

H. Summary and Analysis: Faculty

Response: The current faculty, one full-time professor and two adjuncts, are just adequate under the current enrollment. As student numbers increase, additional instructors will have to be sought in order to provide the best education and service to students.

**SECTION III: Institutional Support and Other Program
Resources**

Section III: Institutional Support and Other Program Resources

1. Program Supports

(Please note: Use this section to reflect upon what institutional supports would be useful and why.)

A. List targeted program marketing and recruitment strategies employed over the last two years? In your opinion, are they appropriate to sustain strong enrollment?

Response: There have been no such strategies. The Manufacturing Technology Program must establish a presence at vocational schools and high schools to have students and their school counselors know us and develop a relationship with the College. Some students want to attend a four-year college and we must have articulation agreements in place so they understand that they do not need to spend a full four years of higher tuition at an institution such as WPI. They must be made aware that they can obtain the necessary technological skills in the Manufacturing Technology program at QCC at a fraction of the tuition cost and then transfer to a four-year institution.

B. Provide recommendations for new or additional marketing or recruitment strategies.

Response: The program must maintain an active and aggressive presence at area schools through visits by our faculty and enlist high school faculty and counselors to discuss opportunities and identify prospective students whom we can attract to our program.

C. Does the program have sufficient linkages with business, community-based organizations, other colleges and universities, or K-12 public schools? Please explain and cite specific examples. Present in chart form as explained in the guidelines for C & D, opposite page.

Response: No. However, linkages are being developed today as a secondary duty by the Program Coordinator.

D. Provide suggestions for improved program linkages. What, if any, assistance do the program faculty need in order to facilitate these linkages effectively?

Response: We need to develop articulation agreements with vocational schools and high schools so students can be made aware of the career paths open to them through the Manufacturing Technology program at QCC.

The Program Coordinator may need additional release time in order to pursue these linkage opportunities. If this is possible, additional staffing may have to be put in place temporarily to ensure there is no disruption of academic quality.

E. Does the program have appropriate equipment to meet the instructional demands of the program? (e.g., medical equipment, laboratory supplies, computer hardware and/or peripherals)

Response: QCC is in the process of upgrading its equipment as shown by our HAS Mini Mill and the HAS 200 (Factory Simulator). Both are good examples of recent purchases. More pieces of equipment are required to complete the laboratory needed to address the variety of processes which manufacturing uses.

F. If no, provide a list of required equipment purchases or upgrades. Please present this list in prioritized fashion and identify immediacy of the priority.

Response:

- a CNC simulator for Fall of 2004 and is the top priority
- hand measuring tools and inspection tables — verniers, micrometers, intramicrometers, plug gauges, thread gauges, height gauges (for the new Geometric Tolerancing and Blueprint Reading course)
- parts to inspect (to be purchased or made in house)
- a small heat treating furnace
- plastic manufacturing equipment
- additional machining, CNC, and manual equipment

A long-term proposal grant is underway which will convert the area formerly used by the College library into a cross-disciplinary technology and science laboratory, the QUEST Center (Quinsigamond Engineering, Science, and Technology). The proposed lab would bring together compatible programs which can share resources in a common location. Physics, Electromechanical, Electronics, Basic Engineering, and Manufacturing programs would reside in this location along with faculty offices and would optimize the use of the now vacated space and circumvent the need for the additional expense of constructing a new building.

The QUEST Center will be a cross-disciplinary area and additional material needs will come from the other departments who will use it. Resources can be identified as collective, cross-disciplinary needs and not just relegated to discrete, individual disciplines as they are today. The laboratory will become a business, information, and problem solving area where students, faculty, and industry leaders can develop relationships and work to develop specific manufacturing efficiencies.

G. Summary and Analysis: Program Supports

Response: The program needs a focused and aggressive marketing program to local schools and the fostering of linkages with local industries. Current equipment is adequate for current classes, but additional material is required to support enrollment and to present a state-of-the-art educational experience.

2. Academic Supports

A. Are there sufficient instructional/research resources to support student learning in this program?

Response: Not as of the writing of this report. The library needs to have its catalogue of manufacturing-related materials upgraded in the upcoming years with magazines, periodicals, and research books which support the manufacturing disciplines. We also intend to purchase various video presentations to provide a visual complement to classroom instruction.

B. Assess the overall currency of the current collection of books, periodicals, and audiovisual materials in the library. Recommend new acquisitions and/or periodical subscriptions. In addition, please work with the library staff to weed outdated materials from the library's current holdings.

Response: We have only just begun to identify our needs, but our initial review shows we are lacking in manufacturing and various engineering resources. The library has relatively few holding of material for manufacturing and those are generally old and outdated. In the interim, students must use WPI's library as a resource as we build our capabilities.

C. Are there sufficient technology resources, specifically software and hardware resources? Are these resources available and accessible to students? to faculty?

Response: No. We are involved in an ongoing assessment of both application and computer requirements for both students and faculty needs.

Although the equipment acquisitions we have proposed will last for many years, the fast paced evolution of the manufacturing sector makes both software and computer bases which run those machines subject to obsolescence far more quickly than had been the case in the past. In other words, the durable machines will last, but the computer intelligence which drives those machines will have to be upgraded to meet industry requirements.

D. Provide a list of recommended technology acquisitions (i.e., software, hardware, PC projection units, etc.) Please prioritize this list and identify the immediacy of the priority.

Response: The acquisition and upgrading of computer hardware and industry-specific applications is an ongoing endeavor and challenge. As new technologies evolve, the program will have to acquire and upgrade computer-based hardware and software.

In addition, the program will need funds to purchase various technical research books published by organizations and associations such as ASM (American Society of Metallurgy), ASME (American Society of Manufacturing Engineering), ASNT (American Society of Non-Destructive Testing), and ASTM (American Society of Technology and Metrology).

E. Does the Individualized Learning Center provide ample academic support services for students in the program?

Response: Yes. Their expertise involves mathematics and language arts services along with other pertinent study skills which have proven valuable to the students in the program.

F. Provide recommendations for improved academic support services.

Response: The system is currently adequate with the two most important areas are covered in depth. Manufacturing is a mathematics-based technology but draws on a variety of additional studies including metal working, electronics, physics, and bioengineering. These additional disciplines are ones, which are not likely to have academic support services supplied by the college especially for the currently small number of students enrolled in the program.

G. Summary and Analysis: Academic Supports

Response: The current level of academic support is adequate for students enrolled in the program. The library is in need of expanding the available material to support research for the program. An initial review showed little material with much of the holdings old and outdated. The program's faculty members are developing a list of recommendations.

3. Student Supports

A. How do your students explore career opportunities and prepare to access them?

Response: The Placement Center works on all aspects of the job search process from résumé writing, interviewing skills, research, and job placement services.

The program should also expand in the areas of field trips (both outgoing and incoming) and participation in technology career fairs.

B. Provide recommendations for enhancing students' career exploration and planning.

Response: The program needs to develop closer alliances with area business to allow students greater exposure to real time, hands-on experience.

C. Are current student support services adequate to support the teaching and learning process? Describe specific activities in which you may have been engaged relative to student support services.

Consider:

- **Counseling Services**
- **Disability Services**
- **Health/Wellness Center**
- **Transfer Information**
- **Other Services (as listed in QCC catalog)**

Response: Yes

D. Provide recommendations for additional services that would be beneficial to your students.

Response: None

E. Summary and Analysis: Student Supports

Response: The supports in place are adequate for the needs of students who are currently enrolled

4. Physical Facilities

A. Are the current physical facilities sufficient from an instructional perspective? If no, explain and provide recommendations.

Response: The current physical facilities are barely adequate. It is for this reason that we are pursuing funding for the establishment of a new laboratory facility. In addition, the actual materials and tools available to the manufacturing students for use in the classroom are not where they need to be, but they are getting better. We need additional machine tools including

- manual and CNC tools
- verniers and other hand tools
- micrometers
- gauge blocks
- granite inspection tables
- height gauges
- surface measurement equipment
- non-destructive testing equipment
- a small heat treating furnace
- metallographic microscopes

B. Are the current physical facilities sufficient from a competitive perspective? If no, explain and provide recommendations.

Response: No. Most area high schools and all vocational high schools have better facilities than we do. Our advantage is our level of instruction and the diversity of expertise which enable QCC to offer the next levels of skill development. Manufacturing is a hands-on occupation and we should be able to offer more laboratory-based courses. Enhanced facilities would also benefit our Continuing Education Division. Many of our students are taking evening courses and working part time.

C. Given enrollment projections, will additional classrooms or laboratories be required? If yes, please specify the requirements and identify immediacy of the need.

Response: The current classrooms are sufficient for the current enrollment. As more effective marketing practices are established, additional space may be required.

As mentioned elsewhere in this report, the establishment of a state-of-the-art manufacturing and technology laboratory is essential to the success of the program. We need the College's continued backing in providing space for the laboratory and assisting in the search for the needed funding for purchase of additional equipment.

D. Summary and Analysis: Physical Facilities

Response: The availability of adequate physical facilities (plant and equipment) is the second most important item facing our future. Currently, academic needs are being met. However, it is imperative that we grow our facility as we grow our enrollment. The argument of whether to expand the current facilities in an effort to attract more students or to attract more students whose tuition will help underwrite facility expansion is an open-ended one.

5. Program Financing

- A. Has the program's funding been sufficient over the last five years? Please explain your response.**

Response: As the program has been in a start up mode for the past five years, the funding has been merely adequate. As the program grows, it will be incumbent on the department and the College to provide additional funding for new faculty members, facility expansion, and acquisition of equipment, tools, additional computers, and application software.

- B. Provide an analysis of the cost of this program. Be sure to include ALL costs. (For example, costs associated with instructional salaries, space, lost opportunity costs, equipment rentals and/or maintenance, etc.**

Response: Not available

- C. Based on your enrollment projections, are there projected increases or decreases in the budgetary requirements of this program over the next five years?**

Response: We have projected increased budgetary requirements to match our enrollment projections each year for five years. They include equipment, faculty, and support staffing as our new location warrants.

- D. Summary and Analysis: Program Financing**

Response: The funding for the program today is adequate, but provides merely for maintenance of current needs. Additional funding will be necessary over the next several years for faculty, facilities, and equipment as the enrollment increases.

SECTION IV: Executive Summary of Findings
Rev. August 20, 2005

Section IV: Executive Summary of Findings

- **Based on this review, briefly highlight the significant external forces that will guide program design and revision in the next three to five years.**

Understanding the Importance of Manufacturing to the Economy: The Data

Research conducted for this IPR shows that manufacturing continues to represent one of the most significant employment sectors of the national, state, and regional economies in spite of the recent recession and subsequent downsizing so well publicized by the media. According to the US Bureau of Economic Analysis (BEA), “in 2004, strong U.S. real economic growth was widespread; real GSP (gross state product) grew in all 50 states and the District of Columbia, ... GSP is the most comprehensive measure of economic activity in each state.”...Further, according to the BEA, “growth in real US GSP accelerated from 2.8 percent to 4.2 percent in 2004; ...durable goods manufacturing was the largest contributor to growth in 12 states.”

A review of BEA data relative to Massachusetts drawn from 2002-2003, describing various industries’ and their individual contribution by per cent change to the real gross state product shows that durable goods manufacturing in Massachusetts was the single largest contributor to the state’s real GSP change with a 0.66 percent contribution. If coupled with non-durable goods manufacturing that number rises to 0.84 percent.

(Data drawn from the following: http://www.bea.gov/bea/newsrelarchive/2005/gsp0605_fax.pdf)

The Associated Industries of Massachusetts (AIM) asserts that:

- One in 10 Massachusetts workers draws a paycheck from manufacturing;
- Manufacturing wages average 25 percent higher than those in the overall economy;
- Manufacturing brings new the wealth into Massachusetts, instead of recycling the wealth that is already here

A review of current employment statistics via the Massachusetts Division of Career Services the website (See: http://lmi2.detma.org/lmi/lmi_ces_a.asp) indicates that for the most recent thirteen month period available—July 2004 through July 2005—manufacturing employment (i.e., durable goods, non-durable goods, and computer & electronics products) within the Worcester metropolitan region has averaged 29.2%. These statistics “represent monthly estimates of employment, hours and earnings by industry for the Commonwealth and for seven Metropolitan New England City and Town Statistical Areas (NECTA). “

An article published in the May 15, 2005 edition of the Boston Globe indicates that although there has been a general decline in employment within the manufacturing sector across the state, manufacturing continues to represent a significant segment of the economy within some 30 Globe west communities (i.e., 495 beltway and west). In fact, “about 11 percent of the jobs in the 30 communities were in manufacturing.” It is reasonable to assume a multiplier effect with additional employment generated in those industries comprising the supply chain network necessary to providing the raw materials and supplies for manufacturing.

- Understanding the Importance of Manufacturing to the Economy: Actions Taken

The greater Worcester area is rich with a diversified manufacturing base of over 400 companies ranging from small local shops to international corporations. Among the larger companies housed in our geographical area are: St. Gobain Abrasives (Norton Co.); David Clark; Ken’s Foods; Wright Line; Wyman-Gordon; EMC²; Raytheon; American Semiconductor; Intel; BSF; GENTEC; and Morgan Construction.

In its 2004 Annual Report, the Greater Worcester Area Comprehensive Economic Development Strategy Committee indicated, “more than 100 companies and entrepreneurs have contacted that Worcester Regional Chamber of Commerce alone to relocate, expand, or establish a new operation.... The greatest demand in the Worcester region has been for manufacturing and distribution space.” In a later section, the committee asserts that “there were 7 new or expanded manufacturing facilities in the region during the past year, 140 small businesses established or expanded and 17 industrial parks are in the planning stages.”

This past April, Intel Corporation announced that it would create 160 new manufacturing jobs at its site in Hudson, with a concomitant \$17 million dollar infusion to support this expansion. In the same month, April 2005, Tom Jenkins, manufacturing director for superabrasive wheels at St. Gobain Abrasives, Inc. (formerly Norton Co.) implored the MA House of Representatives to “work with vocational schools, community colleges, and others toward developing a skilled blue collar workforce” in order to ease the difficulty in finding qualified candidates to meet regional workforce needs in the manufacturing labor force.

External Forces That Will Guide Program Design And Revision

The program clearly views its curriculum as a dynamic entity that will change and expand as needed to better respond to ongoing industry advancements and workforce needs. Advancements within the automated high performance manufacturing industry will guide program design and revision. Regular cooperation with forward-thinking industry and higher education partners will provide the program with the most meaningful understanding of industry needs. QCC’s close relationship with Intel Corporation and with its partner--MATEC, the Maricopa Advanced Technical Education Center, will further enable the program to stay abreast of developing changes in the skills, knowledge, and abilities requirements of the automated manufacturing marketplace. MATEC provides QCC faculty with several opportunities each year to participate in intensive high quality faculty and curriculum development initiatives.

Ever evolving workforce skill demands will serve as a key driver behind future growth and curricular revision. Today’s manufacturers are seeking highly skilled employees who possess strong technical skills, knowledge, and abilities, who are able to think critically and to work successfully within their organizations as members of cross-functional teams. These employees provide the employer with expertise in cutting edge manufacturing techniques in engineering, robotics, lean manufacturing, throughput efficiencies, and inventory management. Other employers are searching for well-qualified employees who possess fundamental manufacturing skills such as those identified by the National Coalition for Advanced Manufacturing (NACFAM)

in its skill standards document titled **A Blueprint for Workforce Excellence (MSSC Skill Standards)**.

In addition, the manufacturing technology program intends to build closer ties with QCC’s Center for Continuing Education. CCE’s has a strong track record of training success with local manufacturing companies. CCE’s programs may serve as a model pathway to the Manufacturing Technology certificate and/or degree program.

- **Strengths or unique features of proposed curriculum. Briefly describe the program’s instructional approaches.**

A. Strengths

1. The program’s curricular objectives are developed with input from local manufacturing employers. This is evident in the proposed inclusion of blueprint reading and geometric tolerancing as well as solid modeling using Solid Works.
2. Many of our students are full-time manufacturing employees. The program faculty maintains a strong partnership with their employers as it continues to reach out to develop further alliances with local industries.
3. QCC understands local industry needs and the faculty has demonstrated its willingness and its ability to customize the curriculum material to satisfy the needs of our local area manufacturers.
4. The program coordinator has over 25 years of hands-on and managerial experience within a wide variety of manufacturing firms in the region.
5. Adjunct faculty members are drawn from local industry and bring real-life and current experience to the classroom each day.
6. A significant curricular change was realized in moving from a highly prescribed program to one that allows for three programmatic electives thereby allowing students to individually tailor their course of study by selecting from a variety of courses in manufacturing, marketing, management, science, engineering, or mathematics.
7. In addition, the program’s science requirements were enhanced to include a requirement of two semesters of Physics.
8. The curriculum addresses the fundamentals. As referenced earlier, the National Association for Advanced Manufacturing has defined basic manufacturing skill standards. The curriculum addresses these content areas as illustrated below.

Fundamental Skills/ Knowledge/Proficiencies	QCC’s Current Program AY 2004	Proposed Programmatic Revisions or New Courses
Computer Aided Design Concepts (CAD)	Mechanical CAD I and II (MNT 101, 102)	
Solid Modeling Capabilities		Recommend development of new course: MNT 103 Solid Modeling (Fall 2005)

Modern Manufacturing Systems, inc. Lean Manufacturing; Automated Manufacturing; Cellular Manufacturing; Robotics	Manufacturing Process II (MNT 216)	Recommend curricular additions to MNT 216: Cellular Manufacturing Robotics Just-In -Time KANBAN KAIZAN (Fall 2004)
Computer Aided Manufacturing	Fundamentals of Computer- Aided Manufacturing (MNT 215)	
Computer Numerical Control	Computer Numerical Control (MNT 210)	
Standard Microsoft Suite Office Applications	Introduction to Microcomputer Applications in Telecommunications (CIS 115)	Recommend change of course to: CIS 111 Introduction to Microcomputer Applications (Microsoft Office Suite)
Blueprint Reading and Geometric Tolerancing		Recommend development of new course: MNT 105 Geometric Tolerancing & Blueprint Reading (Spring 2005)
Mathematics	College Mathematics I: Precalculus (MAT 123); Statistics (MAT 122)	Recommend upper level mathematics electives for transfer bound students: Calculus I & II (MAT 233 & 234)
Quality	Statistical Process Control (QLC 221)	
Management/Marketing	Industrial Management (MGT 221)	Program Electives in Management/Marketing
Science of Manufacturing (Physics)	Physics I (PHY 101)	PHY 101 & 102

B. Instructional Methodologies and Assessments

At present, the faculty utilizes a combination of lectures, project-based learning, research papers and some limited hands-on laboratory work to accomplish instructional objectives. The faculty does an excellent job at conveying the manufacturing theory and knowledge. However, the existing equipment in the laboratory must be brought fully on-line and additional equipment purchased in order to provide students with the comprehensive technical skill development and hands-on experience they need to be successful in the workplace.

Students are regularly assessed through testing, class participation, application of learning in demonstrations and laboratory work, presentations, research papers, and group learning activities. Laboratory assignments and application of the lecture theory needs to be more fully incorporated in order to meet the program's full potential and to best prepare our students to go forward with either employment or to a four-year degree program

- **Emphasize the specific areas targeted for improvement and discuss the anticipated changes recommended to address the concerns.**
 1. QUEST Center: Prospective students are looking for the WOW! factor in making their college decision. The quality and comprehensiveness of the laboratory environment is the WOW! Factor for a Manufacturing Technology program. Not only does the program need additional equipment to maintain currency with industry needs and standards, it needs a sophisticated laboratory environment in which to work.
 2. Enrollment management: While the program has achieved positive results in attracting students currently employed in manufacturing, there is an additional opportunity to contribute to the program's growth by focusing more intensive recruitment efforts on area vocational and comprehensive high schools. Hopefully QCC's present initiative in enrollment management will specifically address program needs to engage prospective students early on in their high school or vocational school career.
 3. Better pool of qualified adjuncts to teach MNT electives such as computer numerical control and computer-aided manufacturing; The College must address the actuality that some of the most skilled CNC operators--those who would make excellent instructors--may not possess the requisite academic credentials. A more comprehensive instructor recruitment effort should be launched immediately.
 4. Additional Staff and faculty; As enrollment increases, the College must be prepared to recruit a laboratory assistant as well as additional full-time and adjunct faculty to ensure that QCC provides the best quality instruction while maintaining a healthy student-to-faculty ratio.

- **Identify the supports and resources that are needed and are critical to supporting the program's goals.**
 1. The program coordinator is reaching out to local high schools, vocational schools, and local industries to attract additional students, but the program needs the active support and commitment of the College's enrollment management team to ensure success. Enrollment is the key to sustaining and growing the program.
 2. To support enrollment growth, the program must have laboratory space that is equipped to handle the specific needs of computer integration in all aspects of the manufacturing setting. In addition, the program needs to acquire additional equipment, tools, machines, recording instruments, and testing equipment. These can be purchased new or slightly

used through auctions or donations, but programmatic resources have not been ample enough to address the needs to date.

- a. The CNC and CAM courses have yet to be able to provide meaningful laboratory experiences in which demonstrations and hands-on learning takes place regularly.
- b. The program offers a course in instrumentation in which students work in groups to acquire various skills. However, there is only one laboratory station for each discipline of study, so students share equipment, wasting valuable instructional time waiting their turn.
- c. Without these vital instructional resources, the chance of full enrollment appears slim. Students want to see and touch things, especially within the science, engineering, and technology disciplines.

- 3. Along with the equipment, QCC needs to have an experienced laboratory technician who is highly skilled in machining technologies to provide guidance and laboratory expertise so the student gains an in-depth knowledge through both the lecture and laboratory experience.

- 5. Additional Staff and faculty; as enrollment increases, the College must be prepared to recruit additional adjunct and perhaps, full-time to ensure that QCC provides the best quality instruction while maintaining a healthy student-to-faculty ratio.

- **Provide constructive feedback regarding the internal program review. Offer suggestions for improving the process, the guidebook, or related support systems.**

The Internal Review Program requirements as laid out in the current questionnaire and guidelines are structured to elicit responses that are important for both today's needs and tomorrow's vision.

- **In chart form, provide a summary of action steps, prioritizing what needs to be done with an estimated timeline for completion. Use the following codes to indicate priority status for each item:**

- IP Immediate Priority (needs immediate attention)**
- HP High Priority (needs attention as soon as possible)**
- EP Essential Priority (needs to happen for program to be successful)**

Immediate Priority	<ul style="list-style-type: none"> • Make the QCC Manufacturing Technology Program the program of choice for students in the Greater Worcester Area • Develop an enrollment management strategy to adequately enroll the program. One focus of that plan should be aimed specifically towards manufacturing and engineering to increase the enrollment of students from Worcester area high schools and vocational schools. Another major emphasis of the plan should address the development and implementation of a proactive strategy to recruit and retain unemployed (or under-employed) workers accessing education benefits through the Workforce Investment Act, Section 30, and other related worker re-training programs.
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	<ul style="list-style-type: none"> • Establish an Advisory Committee for the program. • Aggressively pursue the development of the QUEST Center. • Investigate alternative avenues of funding and/or grants for equipment acquisition. • Determine a more flexible purchase strategy that would allow the College to purchase high-end equipment via auction in order to maximize cost efficiencies in equipping the laboratory environment.
High Priority	<ul style="list-style-type: none"> • Expand alliances with local area manufacturers to ensure the QCC program meets their needs and attract potential students who are currently employed in the manufacturing sector. • Develop curriculum to allow students to transfer to a four-year institution to complete a bachelor's degree in Manufacturing Engineering. • Develop cross-curriculum opportunities with associated courses in science, technology, and business areas.
Essential Priority	<ul style="list-style-type: none"> • Explore feasibility of developing an Associates Degree Program in Manufacturing Engineering. • Hire a laboratory assistant for the Manufacturing Technology lab. • Recruit additional manufacturing faculty members-both adjunct and full-time as program grows.

Attach required documents as noted in guidelines.