MIDDLESEX COMMUNITY COLLEGE

ACADEMIC PROGRAM REVIEW

OF THE

CAD TECHNOLOGY

ASSOCIATES DEGREE AND CERTIFICATE PROGRAMS

2007

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Section I: Data (see Appendix D for all data relating to Section I)

The Institutional Research Office will provide a significant portion of the data. Your department is encouraged to request additional relevant information from Institutional Research and to develop and conduct alternative assessments as well. Some examples of assessments that the department may choose to implement are student focus groups and/or student surveys. Input from relevant internal groups such as Advising, Admissions, and/or connected departments will also be necessary. Please include a copy of the data from Institutional Research and all departmentally-developed surveys or focus questions in the Appendix of the review.

1. Please note important trends, patterns and issues that emerge through the enrollment, academic progress and retention data. (Data from Institutional Research Office)

The primary mission of the CAD Technology program at Middlesex Community College is the development of technically skilled academically enriched workers for the high technology industries in our communities. The economic climate for these companies has the singular greatest impact on the enrollment figures for the program. During periods of full employment such as 1998-2002, companies tended to hire anyone with even minimal CAD skills and resorted to on-the-job training to fully utilize these workers. A.S. Graduates of the CAD Technology program during that same period had an abundance of employment opportunities with some graduates receiving multiple offers. The CAD program experienced a slight enrollment decline as a result of the exploding job market. Conversely, in the years preceding the boom, when the economy was sluggish, the program witnessed an increase in numbers of enrollees. Furthermore, the CAD evening classes continued to have strong enrollments because of our menu of CAD software tools. Enrollments for 2002-2005 have shown a decline for both the day and evening programs. This has been attributed to the economic climate of the technologies and more of the traditional manual drafters have now had CAD training.

In 2003, intensive recruitment efforts to attract new students were launched but yielded very modest gains considering the time and effort expended. The demographic statistics of students in the CAD program at Middlesex Community College continues to show a stable predominantly white, male population, aged eighteen to twenty nine. However, the past three years has shown a significant increase of Hispanics. Asians and other multiethnic students. Women represent a small percentage of our enrollments during the day but are somewhat stronger in the evening program. The program wishes to encourage a continued diverse population by possibly recommending offering an introductory CAD courses on the Lowell campus to attract the Asian, minority, and female populations.

The data for retention rates for enrolled students in the program is somewhat misleading. Because of the constricted window of opportunity for adding or dropping a class, normally the first week of classes, teachers of incoming freshmen carry students on their rolls who are virtually "no-shows " - those who attend just beyond the first week but do not formally drop the class. Beyond these students, most students who register for the second semester will complete the program. For students who are willing and able to complete the associate degree, who decide not to continue onto four year degree program, the job placement rate is nearly 100%.

Recent retention issues have been mostly attributed to the financial condition of the student or the student's family's ability to provide financial support. Historically, retention of students in the program was complicated by aggressive recruiting tactics from consulting firms

for students in their second year of the program. However, the program instructors are convincing students of the advantages for completing the program - that each segment expands the designer's repertoire as well as increasing his potential worth to the employer. Another factor that affects the retention statistics, albeit to a lesser degree, is the desire for students to transfer to four year institutions. The Engineering Transfer program at Middlesex is an avenue that the instructors encourage the students to pursue. However, our more academically skilled students that complete he CAD Technology A.S. degree do transfer to four year institutions. On average about two-four students per year pursue this avenue. Even in these instances, the department faculty members take satisfaction that the program provided an opportunity for the students to mature and focus beyond their matriculation period.

The effect of advisement on retention data is more difficult to measure and appears not to be an issue. However, because of the reduction in full time CAD faculty, the number of advisees exceeds the recommended maximum. Having students advised by faculty not part of our program is not in our or the students best interest. Usually if a student has been advised by a member of the CAD faculty, continuation in our program is likely. During the summer of 2005 most of our new students were misadvised by the college enrollment center and a scramble was made just in time to correct this. Each new student's registration needed to be reviewed by the CAD faculty to make corrections. Recent corrections have been made to prevent this from reoccurring

CAD enrollment in the evening has declined to the point that the College has had to cancel all evening CAD courses. This is likely due to the fact that no drafting is done anymore on boards and the operators working in industry already have CAD skills.

2. Please comment on significant information that emerges from the Student Transfer and Employment Follow-up data. (Data from Institutional Research Office and Department Records)

No follow-up data was provided on the issues of transfer or employment follow-up. The CAD department records indicate that most graduates found employment in the industry and most are still employed or have continued to a four year institution.

3. Please summarize findings from student surveys and/or student focus groups. (Data from surveys and/or questions developed by the Department.)

Section II: Mission, Goals, and Target Population

Program faculty, staff and, where appropriate, students provide information for this section.

1. Does the program have a **stated mission?** If so, please state it.

The CAD Technology Program is designed to provide students with a broad general education combined with a comprehensive set of state-of-the-art CAD skills necessary to prepare them far success in selected CAD design and CAD drafting occupations. In addition to offering both certificates of proficiency and associates degrees, the CAD Technology program, through its partnerships with industry, sponsors on-campus and on-site company training/retraining courses. The CAD department works closely with our Business and Industry division to fill the needs of our community.

2. What is the **relationship of the program's mission to the overall mission** of the College as adopted by the Trustees and approved by the BHE?

One of the missions of MCC is to provide career oriented students with a background in general education, combined with the necessary technical skills needed to pursue a career in a specialized field. The CAD Technology Program has as its primary objective the task of preparing students for positions as CAD drafters in Mechanical CAD, Electronic CAD and some Architectural CAD. Guided by the mission described by the Higher Education Coordinating Council in 1992, the CAD Technology program is committed to opening "pathways for individuals to enter careers " and responding to a changing economy by offering training in state-of-the-art skill courses.

3. Does the program satisfy a **unique institutional goal**? If so, please explain.

The program satisfies several unique institutional goals:

- *it provides response to a specific expressed industry need*
- *it provides rapid training in a field in which there is a strong need for skilled workers*
- *it propels the college into the forefront of education in advanced technology-career*
- *it generates partnership between the college and industry, high school, and four year schools that lead to further collaborations,*

4. Based on a review of other college catalogs, list the **colleges in our general area that have similar programs** and **comment on significant differences** from the program we currently offer.

On line catalogs from each of the commonwealth's community colleges were reviewed to determine availability of program offerings in CAD related areas; whether the programs granted certificates of proficiency and/or associated degrees; the particular discipline emphasis and how CAD was used to reinforce the application; and, finally, the number of courses in each catalog that utilized CAD software packages. Of the thirteen community colleges in the system, four offered associate program in CAD and **only** five offered the certificate program in some version of Computer Aided Drafting and Design; out of these five certificate programs only four are active. Bunker Hill and Mount Wachusett do not offer any courses in CAD. Cape Cod, Holyoke and Roxbury have some kind of CAD courses as part of their engineering transfer and/or other programs. The significant differences between the programs are: a) MCC offers mechanical drafting, PCB and E/M layout; b) MCC is using a variety of software packages and offers a GD&T course; c) the other similar programs from other community college have a more extensive engineering or architectural program associated with their CAD course offerings.

Bristol Community College

Program:	Computer Aided Drafting
Associates:	None
Certificate:	Yes
CAD Courses:	Computer Aided Drafting, Computer Aided Design Architectural, Construction Drawing, Computer Aided Design Civil, Civil Drafting and Design, Advanced Computer Aided Design Mechanical, Advanced Computer Aided Design II Mechanical
CAD Credits:	12

Bunker Hill Community College

Program:	None
Associates:	None
Certificate:	None
CAD Courses:	None
CAD Credits:	None

Cape Cod Community College

Program:	None
Associates:	None
Certificate:	None
CAD Courses:	Computer Aided Drafting I, Computer Aided Drafting II (Part of Construction Technology Certificate)
CAD Credits:	6

Greenfield Community College

Program:	Computer Aided Drafting
Associates:	None
Certificate:	Yes
CAD Courses:	Engineering Graphics I, Engineering Graphics II, Engineering Graphics Project
CAD Credits:	6 or 9

Holyoke Community College

Program:	None
Associates:	None
Certificate:	None
CAD Courses:	Engineering Drawing and CAD
CAD Credits:	3

Massachusetts Bay Community College

Program:	Engineering Design
Associates:	Yes
Program:	Computer Aided Drafting
Certificate:	Yes
	CAD Courses: Intro to CADD, Engineering Design w/ CAD I, Engineering Design w/ CAD II, Architecture & Civil CAD Applications, Mechanical Detailing, Program Elective, Animation, Materials & 3D Modeling, Program Elective. Program Elective: Architecture Design, Electro/Mechanical Design, Project Design, Designing Plastic Parts, Arch Drawing & Interior Design 3
CAD Credits:	32 or 31 (A.S. Program)
CAD Credits:	20 (Certificate Program)

Mount Wachusett Community College

Program:	None
Associates:	None
Certificate:	None
CAD Courses:	None
CAD Credits:	None

North Shore Community College

Program:	Computer Aided Drafting
Associates:	None
Certificate:	Yes
CAD Courses:	Principles of Computer Aided Design I, Principles of Computer Aided Design II
CAD Credits:	8

Northern Essex Community College

Program:	Computer Aided Drafting
Associates:	None
Certificate:	Yes
CAD Courses:	Engineering Design Graphics, Computer Aided Drafting I, Computer Aided Drafting II
CAD Credits:	9

Quinsigamond Community College

Program:	Manufacturing Technology
Associates:	Manufacturing Technology
Certificate:	Manufacturing Technology

CAD Courses:	Mechanical CAD I, Mechanical CAD II, Solid Modeling, Geometric Tolerancing and Blueprint Reading, Advanced Topics in AutoCAD, various manufacturing courses
CAD Credits:	16

Roxbury Community College

Program:	CAD Mechanical Drafting
Associates:	None
Certificate:	Yes (program requirements and complete courses unavailable)
CAD Courses:	Intro to Engineering Design with CAD I, Intro to Engineering Design with CAD II, Machine Drafting with CAD
CAD Credits:	11

Springfield Technical College

Program:	Architectural CAD Technology, Mechanical Engineering Technology, Computer Aided Manufacturing, Computer Aided Drafting
Associates:	Yes
Certificate:	Yes
CAD Courses:	Architectural CAD I, Architectural CAD II, Mechanical CAD II: 2D Fundamentals, CAD II: 3D Fundamentals, CAD 3: 3D Design, Introduction to Pro/Engineer, Computer Aided Manufacturing I
CAD Credits:	6, 12, 15

5. Is MCC's program intended to serve a **special population** or clientele? Please explain.

The CAD Technology program is designed to attract a diverse population of students which includes: high school graduates in search of a first career, adults in transition seeking retraining, and others who are exploring CAD for personal enrichment. On occasion, students who are potential transfer candidates enroll in selected courses designed to broaden their technology background.. The CAD Technology program actively recruits graduates of the state's technical vocational high schools by offering articulation credits for CAD courses taken at the high school level. We currently have 17 articulation agreements with area Vocational High Schools and Comprehensive High Schools. Students meeting the criteria of our articulation agreement will typically be granted credit for some of our introductory courses. Approximately 20% of our incoming freshman are articulation students. Articulation students have a better retention rate, are better prepared for our subject and seem to do well in college although we have no data to support this. The program produces highly skilled graduates with broad based computer skills acquired through the use of various software packages: The strength of the CAD program lies in the flexibility and adaptability of its graduates to work across the spectrum of design fields.

The Middlesex CAD Technology program, in conjunction with the college's Business and Industry division, serves the demands of the high tech industry by providing employee training both at Middlesex and on-site

6. Are there plans to target this program to any **new or different groups**? Please explain.

As part of our recruitment efforts we plan to target state regions where CAD programs are not available at the community college level. As an example, Graduates of High Schools in the metropolitan region of Boston have limited technology programs available at the state college or community college. Middlesex is part of an NSF grant called BATEC (Boston Area Advanced Technology Education Connections) that is reaching out to many communities with the intent to develop better Information Technologies. We have used BATEC to reach out to these additional schools by visits to the schools and hosting visits by students. While our current focus is granting advanced placement credits primarily to graduates of the vocational technical high schools, the faculty is being aggressive in the recruitment of more graduates of strong CAD/Drafting programs in the comprehensive high schools. Within Middlesex Community College, the CAD Technology Program is pursuing methods to develop a higher profile among students who have not committed to a major. One group is the undeclared student and the Liberal Studies major. In 2003 the CET provides students with and idea of the technology programs and opportunities at the College. The department would like to increase visibility for the program by conducting mini-seminars in-house, and showcasing student projects and job opportunities in higher traffic areas on both campus. The CAD Technology program plans to promote CAD retraining options both on and off-site through our Business and Industry division.

To help with our recruitment effort beyond our usual base, the CAD program has been selected by AutoCAD, AutoDESK Inc. via Torcomp Inc. as a training site for teacher development. Several of these sessions were conducted in 2005 on our Bedford Campus. We hope to continue to work with AutoDESK and Torcomp.

7A. **CAREER PROGRAMS** - Please describe mechanisms or procedures currently in place to **monitor changes in the job market** and **review the program's currency and "fit"** with the educational interests and needs in our region by:

a) Relevant **external** parties, such as advisory groups or speakers, corporations/agencies. (If there is an advisory committee in place, please attach names of members and indicate frequency of meetings);

Our advisory board consists of a diverse membership, who collectively have accrued approximately 130 years of related experience in the engineering, CAD and drafting technology fields. Most members have become leaders in their respected CAD disciplines after progressing along career paths that serve as models for our current student population. The

board has several graduates of our CAD program. The board consists of Mechanical, Electrical, Architectural engineers and designers as well as a technical recruiter. The board meets at least once per academic year during the spring semester, ***(See attached Advisory Board Member List Appendix A and meeting minutes Appendix B.)*** *The advisory board is an invaluable resource for supplying industry projections and expectations of our program's graduates.*

Technical recruiters, corporate Human Resource personnel and program alumni maintain active contact with program faculty and are principal sources for assuring informed currency of the CAD program, A 1998 graduate survey was taken to determine starting and projected salaries as well as current industrial hardware and software preferences. However, the data yielded was inconclusive. The faculty members attend various CAD seminars, educational workshops and technical vendor demonstrations such as Design for Manufacturing, CAM, CAD Vendor software demos and trade shows.

b) Relevant **internal** groups or individuals;

We currently rely on the work experience of our full-time faculty and adjuncts to communicate industry trends and practices. When needed, our advisory board members are always willing to share ideas and guidance. Although we have no established college committee to monitor changes in our program, the program's full time day faculty and adjunct faculty have extensive ties to the CAD industry.

Middlesex Community College's Business and Industry Program coordinates or sponsors courses and seminars that are taught on-site or at our facilities. The CAD Technology program has developed course offerings and short term seminars relevant to the needs of the region s technology companies. Feedback from the Business and Industry division, the corporate sponsors, and from course participants provides another means for evaluating program quality. Most recently the department provided B&I instruction for the Army Corp of Engineers and in basic AutoCAD and Geometric Dimensioning and Tolerancing for an Aerospace manufacturer.

c) **Other populations** (i.e., students, alumni, community members).

Student and alumni feedback has proven to be an excellent indicator of the program's effectiveness. On an informal basis, alumni often return to visit and describe their employment activities. Many have advanced in their respective companies and return to the program to seek new personnel for their departments. Several of our second year day students are serving part-time paid internships in companies with program alumni; others are in full-time positions in related career programs.

Most graduates are working in the engineering fields and are familiar with the industries' technical requirements; they, therefore, serve as barometers to monitor the currency and effectiveness of our program

8. Are there plans to change or add to strategies currently in place to **assess the program's fit** with student interest and market demand?

The CAD Technology program is continuously evolving to both assure student interest and to meet the needs of industry. Our most notable change is our recent addition of an

Architectural CAD course. Several students have shown interest in this course. These changes are noted by our advisory committee as well as our instructors, some of whom are active as consultants. The curriculum is constantly being re-evaluated and upgraded to reflect industry's needs. For example: Last fall the program reduced the PCB courses and added Architectural CAD with support from the Advisory Bard. Up to the present, the CAD Technology program has maintained a position in the forefront or leading edge for educating or upgrading the skills of CAD drafters. We have been able to provide the software tools that are most widely used in the industry because of the support we receive from our division and the college. Both realize the importance of having up to date hardware and software. The college has a four year max life for our CAD workstations and has provided high quality equipment.

9. Are program faculty currently working with the Admission Department to **recruit students** into the program? What role(s) do they play?

- *The CAD technology faculty, working with the Admissions department, did the following:*
  - *Participated in Technology Day events*
  - *Developed a department Web site with program information and sample projects*
  - *Created CAD brochures for mailings and information displays.*
  - *Participated in the College Open Houses*
  - *Hosted field trips by several area high school and vocational-tech schools seeking to explore our CAD program.*
  - *Provided in-house demos for the college student body both in Bedford and Lowell.*
  - *Participated in the early awareness program, Project Leap, at the City Campus.*
  - *Traveled to area vocational technical schools to promote the CAD program,*
  - *Participated in a Career Day for area middle school students.*
  - *Provides hands on in-house seminars for the Admissions and Advising departments to enlighten them on the technology- of CAD*

10. Are there **additional recruitment efforts** in which program faculty would like to be involved? Please be as specific as possible.

CAD Faculty would like to use MiddleNet to advertise our program and to present information to visitors of the Web page about information sessions. Faculty would like to visit area high schools with the admissions department, host more visiting comprehensive and vocational-technical high schools and become active in a College Day on campus. Faculty would encourage the implementation of a Technology Day on campus. A Technology Day was held in the spring of 2004 and was well attended. Another consideration might be conducting micro workshops (show and tell sessions) for students and interested faculty. The CAD department does offer a CAD Seminar through our Business and Industry division. The cost of attending is $ 139 for six sessions. We should explore offering shorter sessions free of charge for recruitment purposes.

A major untapped target audience is the population of Middlesex Community: College's Lowell campus. While the CAD program could enhance its visibility by using the techniques suggested above, there may be reason to explore the feasibility of offering an introductory CAD

course on the Lowell campus. Specific courses that fit this category include CD1115, Introduction to CAD.

Section III: Curriculum

1. Please indicate below the **major educational outcomes** for students enrolled in this program, **how each outcome is attained** (i.e., through a specific named course, activity, or project) and **how the attainment of each outcome is assessed**. Five to ten major programmatic outcomes should be listed. If there is nothing currently in place that is intended to provide for the attainment of a particular outcome or to assess the extent to which the outcome has been realized, please leave the appropriate space blank. The "blanks" will help to identify areas that need further development.

Graduates of the CAD Technology program will be able to exercise the following cognitive and productivity skills:

1. *Demonstrate proficiency in advanced CAD skills by creating complex drawings using wireframe and solid modeling techniques, manipulating analytic and non-analytic surfaces: analyzing drawing data: and developing customizing techniques.*
2. *Demonstrate proficiency in applying selected software packages used in the electronics related industries for drawing schematics and designing multilayered printed circuit boards.*
3. *Apply related academic skills (from Mathematics, e.g.) to resolve drafting and design problems.*
4. *Extrapolate information, data and specifications from technical resources and standards for application on drawings, projects and reports.*
5. *Collaborate and cooperate in a team setting to enhance cognitive and social learning by sharing in a CAD engineering environment.*
6. *Demonstrate an ability to apply knowledge of CAD Technology and Engineering Design.*

Program Outcome No.1

Graduates of the CAD Technology program should demonstrate proficiency in advanced CAD skills by creating complex drawings using wireframe and solid modeling techniques, manipulating analytic and non-analytic surfaces: analyzing drawing data: and developing customizing techniques

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CAD Course	*Strategies For Attainment of the Learning Outcome*	*Assessment Criteria and Methods*
CD1125 *Mechanical Drawing III/CAD*	*Generate solid models using feature based parametric tools*	*Analysis of process and product used on assignments*
CD1227 *Advanced CAD Applications*	*Create 3D wireframe model from a 2D mechanical drawing* *Develop macros that streamline and enhance the drawing speed of repetitive routines* *Create simple basic 3D models using basic primitives.* *Apply presentations using render and shading tools* *Customize startup drawing templates and profiles*	*Caster Wheel consists of all 3D parts, including hardware and external referenced solid models.* *Use Caster for presentation.* *Use PBL module to create customization.* *Use PBL module for data extraction.*

Program Outcome No. 2

Graduates of the CAD Technology program should demonstrate proficiency in applying selected software packages used in the electronics related industries for drawing schematics and designing multilayered printed circuit boards.

CAD Course	*Strategies For Attainment of the Learning Outcome*	*Assessment Criteria and Methods*
CD1129 *Printed Circuit Board*	*Self paced tutorial to teach basic features of PADS LOGIC schematic capture program from vendor's online tutorial* *Develop basic 2 sided and multilayer skills using PADS-PCB* *Familiarize and knowledgeable in PCB fabrication.* *Apply the rules and principals for designing multilayered PCBs*	*Successfully and accurately complete a simple digital and analog schematic.* *Extract and import a netlist into a PCB design.* *Compare the differences between the interactive and autorouter modes of the software.* *Design project incorporating all CAD drawings required for fabrication and assembly.*
CD1207 *E/M Layout*	*Develop knowledge in sheet metal folding and fabrication.* *Create cable diagrams to be used in instrument packaging*	*Design and layout an Electro/Mechanical chassis sing common electronic components.*

Program Outcome No. 3

Apply related academic skills (from Mathematics, e.g.) to resolve drafting and design problems.

CAD Course	*Strategies For Attainment of the Learning Outcome*	*Assessment Criteria and Methods*
CD1102 *Mechanical Drawing II*	*Calculate dimensions and tolerances for fit and function*	*Draw mechanical details to various scales.* *Mate details to verify calculated dimensions using assembly details*
CD1207 *E/M Layout*	*Calculate bend allowances for sheet metal parts. Design flat panels for mounting electronic hardware.* *Determine proper hardware size and hole locations.*	*Use manufacturers data sheets and web site information to select components.*
CD1230 *Architectural CAD*	*Use design tools to determine building footage, elevation heights, space allowances.*	*Design a residential and commercial building using computed data and customer requirements. Research door and widow manufacturers web sites and download detail drawings*
CD1227 *Advanced CAD Applications*	*Extract attribute data.*	*Sort and modify data using Microsoft Excel.*
CD1228 *CAD Practicum*	*Keep journal of design considerations and changes*	*Write a paper on design considerations and present the results orally with a powerpoint presentations*

Program Outcome No. 4

Graduates of the CAD Technology program should extrapolate information, data and specifications from technical resources and standards for application on drawings, projects and reports.

CAD Course	*Strategies For Attainment of the Learning Outcome*	*Assessment Criteria and Methods*
CD1102 *Mechanical Drawing II*	*Project containing parts properly dimensioned to lock or freely move together.*	*Extrapolate and convert fits from accepted industry standards.*
CD1207 *E/M Layout*	*Determine specifications and dimensions of selected electronic components.*	*Use manufacturers data sheets and web site information to select components.*
CD1230 *Architectural CAD*	*Select appropriate doors and windows for a given house design.*	*Research door and widow manufacturers web sites and download detail drawings*
CD1227 *Advanced CAD Applications*	*Select appropriate hardware for assembly.*	*Select accurate hardware from Machinist Handbook and online information specifications.*

Program Outcome No. 5

Collaborate and cooperate in a team setting to enhance cognitive and social learning by sharing in a CAD engineering environment

CAD Course	*Strategies For Attainment of the Learning Outcome*	*Assessment Criteria and Methods*
CD1228 CAD Practicum	*In conjunction with tean analyze an assigned mechanical design layout and determine how it functions*	*Develop a Power Point presentation for the completed project and include drawings and other data as deemed applicable. Be prepared to answer questions posed by the design review team-your CAD instructors-in critiquing your project.*
CD1227 Advanced CAD Applications	*In a cooperative effort with team members, create attribute information and apply to drawing block, create Excel worksheets that can back annotate to the CAD Drawing and supply document end-user instructions for installation and use*	*Accuracy of extracted data. Evaluation of end-user documentation/instructions and oral demonstration of usability of the data.*
CD1230 Architectural CAD	*Assign team members to various design elements of a typical residential design such as space planning, electrical, plumbing and landscape.*	*Assess accuracy of each team members CAD relationship to each others component for finalization of residential project.*

Program Outcome No. 6

Demonstrate an ability to apply knowledge of CAD Technology and Engineering Design.

Show that they can employ general CAD practices using commercial and ANSI standards and principles, in the solution of particular engineering problems. For a particular problem, graduates should demonstrate that they can:

(1) Define and describe the pertinent principles and appropriate assumptions, theories, concepts, and/or formulas;
(2) Select the appropriate CAD Design Tool to the engineering problem.
(3) Explain how they are appropriate to the problem; and demonstrate how they have been applied in the solution of the problem.

2. Respond positively, after they have been employed, to the instruction and guidance they received in applying knowledge of Mechanical and Electronic CAD.

3. Achieve a positive rating from their employers regarding their ability to apply general principles of CAD Technology to particular engineering situations.

CAD Course	*Strategies For Attainment of the Learning Outcome*	Evidence of Assessment Criteria and Methods
CD1228 *CAD Practicum*	*Define and describe the pertinent principles and appropriate assumptions, theories, concepts, and/or formulas;* *Select the appropriate CAD Design Tool to the engineering problem.* *Explain how they are appropriate to the problem; and demonstrate how they have been applied in the solution of the problem*	*1. Portfolios: Samples of CAD Drawings and Projects from selected courses and the CAD Practicum..* *2. Results of Fundamentals of CAD Technology: Percentage of students and graduates who take selected course and percentage of those who pass it.* *3. Survey of graduates: My education at Middlesex has given me the ability and the confidence to apply general principles of mathematics, science, and engineering to the engineering problems I encounter at work.* *4. Survey of employers: The Middlesex graduate is entirely satisfactory in his or her ability to apply general principles of CAD Technology and*

		engineering to engineering problems
CD1227 *Advanced CAD Applications*	*Create 3D wireframe model from a 2D mechanical drawing* *Develop macros that streamline and enhance the drawing speed of repetitive routines* *Create simple basic 3D models using basic primitives.* *Apply presentations using render and shading tools* *Customize startup drawing templates and profiles*	*Caster Wheel consists of all 3D parts, including hardware and external referenced solid models.* *Use Caster for presentation.* *Use PBL module to create customization.* *Use PBL module for data extraction.*

Individual CAD Course Skills / Outcomes

CD1101 Mechanical Drawing I

- *Identify line types*
- *Identify and use basic drafting instruments and reproduction equipment*
- *Sketch geometric features*
- *Identify principle planes, views and surfaces*
- *Sketch multi-views using orthographic projection method*
- *Identify and sketch missing views and sketch isometric view*
- *Using template to draw multi-view drawing*
- *Using template to draw auxiliary and section views*
- *Fundamental of dimensioning drawing*
- *Sketch and draw part and assembly drawing*
- *Apply recommended drafting practices established by the American National Standards Institute (ANSI)*
- *Select and use resources - standards, texts/references, catalogs, and tables - to apply design features*
- *Apply geometric constructions and functional spatial relationship concepts to resolve graphical problems*
- *Fundamentals of scaling drawings*
- *Learn how to work in a team environment*

CD 1115 Introduction to CAD

- *Learn AutoCAD basic commands*
- *Create geometric features using AutoCAD*
- *Edit and modify these features*
- *Use AutoCAD to create multi-view drawing*
- *Use AutoCAD to create section views*
- *Use AutoCAD to create auxiliary views*
- *Use AutoCAD to create assembly drawings*
- *Apply ASME Y14.5M-1994 drafting standards to prepare drawings*
- *Manage files using both CAD utilities and Windows*
- *Select and use resources - standards, texts/references, catalogs, and tables - to apply design features*
- *Apply geometric constructions and functional spatial relationship concepts to resolve graphical problems*
- *Identify and use the components of a microcomputer CAD system to include the computer and its peripherals for inputting, processing, and plotting drawings*
- *Apply fundamentals of dimensioning to drawings using paper space/model space method*
- *Fundamentals of scaling drawings*
- *Learn how to work in a team environment*
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CD1129 Printed Circuit Board Design

- *Interpret Electronic Schematic diagrams and Electronic Symbols*
- *Manually redraw a sketched schematic using correct symbols and practices.*
- *Create a finished CAD Schematic from an engineering sketch to ANSI standards and practices.*
- *Manually, using freehand techniques, connect and place components from sketched PCB assignments.*
- *Manually, using freehand techniques, layout single and double sided PCBs.*
- *Using Schematic Capture techniques from Power Logic, extract a netlist.*
- *Interpret and modify a netlist.*
- *Import netlist data into Power PCB.*
- *Using Power PCB, place and interactively route electronic components using commercially accepted PCB practices and techniques.*
- *Understand and interpret IPC (International Printed Circuit organization) standards that will be used as a guide for layout rules and manufacturing processes.*
- *Edit and Modify PCB Designs using Back Annotation tools.*
- *Produce a finished PCB Drawing package including…. Schematic, PCB, Assembly using plots and data files.*
- *Have some basic knowledge in the fabrication of Printed Circuit Boards.*

CD1102 Mechanical Drawing II/CAD

- *Learn advanced AutoCAD commands*

- *Create complex multi-view drawings using AutoCAD*
- *Create complex section view drawings using AutoCAD*
- *Create complex auxiliary view drawings using AutoCAD*
- *Create complex assembly drawings using AutoCAD*
- *Apply ASME Y14.5M-1994 drafting standards to prepare drawings*
- *Manage files using both CAD utilities and Windows*
- *Select and use resources - standards, texts/references, catalogs, and tables - to apply design features*
- *Apply geometric constructions and functional spatial relationship concepts to resolve graphical problems*
- *Apply fundamentals and advanced dimensioning techniques including GD&T to drawings using paper space/model space method*
- *Scaling drawings*
- *Create weldment drawings employing ANSI/AWS A2.4 symbols*
- *Locate and extract technical data from standard references and manufacturers' catalogs*
- *Learn the fundamentals of Mechanical Components*
- *Learn the fundamentals of manufacturing processes*
- *Material selection fundamentals*
- *Engineering documentations fundamentals*
- *Learn the key elements of the design process*
- *Learn how to work in a team environment*

CD 1169 3D CAD

- *Generate solid model parts, assemblies, and detail drawings using feature-based parametric design CAD programs, such as SolidWorks and Inventor.*
- *Create assemblies with the solid model parts.*
- *Produce production drawings from the solid model parts.*
- *Incorporate design changes utilizing the appropriate editing features.*

CD1227 Advanced CAD Applications

- *Customize AutoCAD commands, menus and Toolbars.*
- *Configure AutoCAD for personal settings using a profile, startup drawing and startup templates.*
- *Create 3D Solid Models using standard AutoCAD features.*
- *Create Wireframe and Surface Models*
- *Edit all AutoCAD 3D CAD files.*
- *Master the use of Xrefs and Attributes for individual designs and Team Projects.*
- *Participate in a simulated Team Project.*
- *Create a 3D walkthrough video*
- *Create a CAD Project Presentation*
- *Be knowledgeable in the use of network file sharing to administer a typical CAD project*

CD1225 Mechanical Drawing III/CAD

- *Use advanced commands on a CAD system to create solid models, product detail and assembly drawing*
- *Generate solid models, assemblies, and detail drawings using feature-based parametric design CAD programs, such as SolidWorks and Autodesk's Inventor.*
- *Create families of parts and assemblies building multiple configurations utilizing embedded Excel worksheets.*
- *Model sheet metal parts, creating flat patterns and using the forming tools provided.*

CD 1230 Architectural CAD

- *Create and edit architectural working drawings that include walls, doors, windows, stairs, and roofs of residential and commercial buildings.*
- *Create wall, door, window, and stair styles.*
- *Edit the display representation of the components of objects per layout tab.*
- *Create and edit wall modifier styles, endcaps to create wall design.*
- *Import and export wall, door, and window, stairs and schedule tables.*
- *Determine multiple roof intersections and create roofs for dormers.*
- *Create and apply AEC Profiles to mass elements.*

CD 1207 Electro/Mechanical Layout/CAD

- *Interpret various types of electronic diagrams and schematics*
- *Electronically redraw a sketched diagram using correct symbols and practices*
- *Create a finished CAD Schematic from an engineering sketch to ANSI standards and practices*
- *Be familiar with Autodesk Inventor or SolidWorks in building sheet metal parts*
- *Edit and modify E/M Designs*
- *Produce a finished set of E/M Drawings including schematic, sheet metal, assembly using plots and data files*
- *Have some basic knowledge in the fabrication of sheet metal layout and design*
- *Understand common fasteners related to E/M Design and packaging*
- *Virtually assemble the personal computing devices by knowing how to fasten/join the PCB to rack, panel, or case, and how to wire between electrical units and PCB (Motherboard).*

CD 1205 Geometric Dimensioning and Tolerancing

- *Engineering drawings and tolerancing*
- *Fits fundamentals*
- *Introduction to Geometric symbols and terms*
- *Rules and Concepts of GD&T*
- *Form Controls*
- *Datums (Planar)*
- *Datums (Axis and Center plane)*
- *Orientation Controls*
- *Tolerance of Position*

- *Concentricity and Symmetry Controls*
- *Runout Controls*
- *Profiles Controls*

CD 1228 CAD Practicum

- *Design a set of 3D solid / surface models of an E / M design, mechanical design or architectural design.*
- *Use the finished design to create 3D presentations using slides, scripts, animation and / or rendered outputs.*
- *Develop 2D detail drawings from the solid models;*
- *Apply geometric and dimensioning requirements to the detail drawings using a CAD software package;*
- *Incorporate engineering changes to the solid models and revise and record the changes on the detail drawings;*
- *Provide plots of drawings utilizing the paper space mode of CAD for plotting.*
- *Collaborate and cooperate in a group setting to enhance cognitive and social learning.*
- *Construct potential solutions to design problems through lecture and reading activities.*
- *Communicate to others the deeper processing of content and the critical development of literacy skills and strategies.*
- *Analyze the process for manufacturing in order to reduce product cost.*
- *Employ explanatory writing techniques to transmit existing information or ideas acquired through reading, note-taking, and listening.*
- *Create unified and coherent short papers that include writing for analysis, description, explanation and evaluation of specified workplace issues / situations.*
- *Use the journal entry format of informal process or response to compile a database of personal information.*
- *Prepare resumes and cover letters that reflect individual strengths.*
- *Develop an essay that describes the class project in the context of an industrial project and include suggestions for design and design process improvements and implementation.*

6. Is there a desire to introduce any new or revised student outcomes for this program? Please specify the proposed or revised student outcome, the proposed or revised strategies for attainment of the learning outcome, and the proposed assessment criteria and methods.

   We are currently considering incorporating part of our CAD Practicum and possibly our new Architectural CAD course to include a service learning component. Another consideration for our CAD Practicum is to have students work on a design project with other college programs. The S2006 project required our students to design a hospital bed using solid modeling tools and presentations. Hopefully we can expand this process by including students from other programs to help with design considerations for a common project.

Proposed New or Revised Student Outcome	**Proposed Strategies For Attainment of the Learning Outcome**	**Assessment Criteria and Methods**
Employability Skills	*College Project and*	*Team Project with students*
Workplace Behavior	*Service Learning*	*from different programs*

13A. Using the chart below, please indicate the courses in your program that satisfy a core intensive. List strategies for attaining each intensive (i.e. through specific activities or projects) and describe how the learning of each will be assessed.

Intensive Value	**Program Course**	**Strategies for Attainment of Learning Outcomes**	**Assessment Criteria and Methods**
1. Multicultural Perspective	*General Ed Electives*		
2. Global Understanding	*General Ed Electives*		
3. Written Communication	*CD 1228 CAD Practicum*	*Create unified and coherent short papers that include writing for analysis, description and evaluation of specified workplace issues / situations* *Develop an essay that describes the class project in the context of an industrial project and include suggestions for design and design process improvements and implementation.*	*1. Written materials must include the design intent and clearly define the project.* *2. Papers must be written in clear, logical prose, and exhibit the ability to analyze, synthesize, and evaluate information.*
4. Computer Literacy	*CA 1101*		
5. Values, Ethics, or Social Policy	*General Ed Electives*		
6. Impact of Technology, Environmental Issues, of Health	*CA 1101*		

13B. Please describe any new efforts to incorporate intensive values into program requirements, or to ensure appropriate advising of elective courses.

A Written Communication intensive value has been added to the CAD Practicum. All other core curriculum intensive values can be met in General Education requirements.

14. Please describe any **interdisciplinary courses** which are provided as an integral part of this program.

N/A

15. Please comment on **work-based learning** opportunities with the program (i.e., coop, internships, service learning). What percent of program students participate in each of these activities? Indicate any problem being faced in incorporating work-based learning.

During the period of 1999-2003 well over fifty percent of our second year students were employed part time as CAD drafters in some technical discipline. Because of the decline in technology the years 2004-2006 the part-time employment opportunities have declined significantly to less than twenty five percent. The availability of CAD jobs is dependent upon the job market and, therefore, economy driven: currently the demand for part-time CAD student/workers and graduates of the program do not exceed the supply the program can process. This is improving with the recent improvement in our economy. Other students are employed in related technical areas such as engineering support services, inventory control, and manufacturing activities. The two greatest long term problems of work based learning are the inability to connect with companies willing to support internships or a coop program and maintaining currency of CAD software to keep our students attractive to an ever changing industry. Our software is current with those used in other programs and in most cases more current than many companies. The coordination needed to aggressively pursue coop, internship and service learning alternatives is limited with only two full time faculty members.

16. Please comment on the **scope and sequence** of courses now in place. Is the flow and relationship of courses to one another satisfactory? Are there changes indicated, based upon program objectives and/or new needs identified through the assessment process?

At its inception in 1982 as a full fledged Associate in Science degree granting Electro/Mechanical Drafting Technology program, all skills were board based and manually executed. By 1985, the program had received its first ten microcomputers and several courses were literally transcribed using CAD software. By the beginning of the 1990s, virtually all drafting was performed on computers. In 1994, the decision was made to change the program name from Electro/Mechanical Drafting Technology to

CAD (Computer Aided Drafting and Design) Technology. The past decade has brought significant design tools that allow for three dimensional (3D) mechanical solid modeling. Changes have been made to introduce basic 3D instruction after students have completed traditional introductory two dimensional CAD and manual drawing courses. Several course objectives and content have been modified to reflect these improvements in CAD design tools.

The following scope and sequence of courses reflect input at that time from the Advisory Board, faculty review, and students and alumni:

1st Semester
Mechanical Drawing I
Introduction to CAD
Printed Circuit Board Design

2nd Semester
Mechanical Drawing II/CAD
3D CAD
Advanced CAD Applications

3rd Semester
Mechanical Drawing III/CAD
Architectural CAD
Electro/Mechanical Layout/CAD

4th Semester
Geometric Dimensioning and Tolerancing
CAD Practicum

The CAD Technology program, by necessity, maintains a fluid, dynamic evaluation process. The program must maintain currency with the high technology industries with state-of-the-art software and hardware so as to produce graduates with incomparably broadly ranged marketable skills. Based upon the industries ' expectations from our graduates, the changing scope of CAD software, and spurred by the self evaluation process, the faculty frequently meets on numerous occasions to formulate and implement a proposal for revamping both the course structures and adding new or revised courses. We also review any input from our Advisory Board for suggest changes and trends. Among these changes are:

- *The need for a "bridge " or transition course after the introductory CAD course that would emphasize fundamental three dimensional drawing concepts. 3D CAD was introduced to accomplish this requirement.*
- *The need for a "practicum " or "capstone " course that would enable exiting students to work in a cooperative atmosphere on multivariate projects with multiple teacher/mentors that will emulate the workplace, build team skills, written communication and workplace behavior. Our CAD Practicum course was introduced a few years ago to realize this.*

- *The need to expand into Architectural CAD to expand he employment opportunities as recommended by our advisory board. A revised Architectural CAD course was conducted in the Fall 2006 semester..*
- *The need to update our one-semester Printed Circuit Board course to include materials that were previously contained in two courses. The software advances in* PCB software tools and the need to add Architectural CAD made this change necessary.

17. Please comment on the role of **developmental courses** in your program? Which ones are relied upon by significant numbers of students in the program, what conclusions are you able to draw about the impact of these courses on students' preparation levels?

Development students can enroll in our CAD courses as they take developmental courses.

18. Describe any plans to introduce **new methodologies** into required or elective courses.

The CET division has been very aggressive with having the CAD faculty redesign the course syllabi and content to include course outcomes, skills assessment employability skills, and project based learning. This ongoing effort has allowed the faculty to reflect on past learning objectives and student assessment. Although our intent is to revise all course materials, our CAD Practicum has provided us an opportunity to use these new methodologies. Our students have gained immediate contact with team-taught teacher/mentors as well as student colleagues of varying abilities and strengths. The content enables the students to extrapolate materials learned in previous courses, develop higher level CAD skills in several fields, and synthesize all the learning with new presentation techniques. The interactions between colleagues has simulated those that occur in the workplace. An outcome of this course has been the opportunity for the students to make presentations of themselves and their projects to varying groups such as corporate recruiters, incoming freshmen, invited employers of our graduates, the Advisory Board, etc.

Another opportunity that presents itself for inclusion in the CAD Practicum" course is for exiting students to career shadow their industrial counterparts. The CAD Technology program has a twenty year backlog of graduates working in various design fields. There could very well be opportunities to create linkages between current and former students. The feedback would be twofold: exiting students get a glimpse of the "real world": alumni have the chance for program input.

Any new revision to our syllabi will include workplace skills. These will include employability skills recommended by NWCET.

19. Describe any new **student assessment methods** that have been implemented in any of the core program courses or in a general programmatic way. If you are able to assess the effectiveness of such methods, please do so.

Newly revised course materials now include better defined course outcomes and skills with assessment criteria. During the past several years the college has provided seminars and training sessions to help the faculty revise course materials to include assessment materials. By nature of the size of our program, each instructor has virtually daily contact with his students and is able to informally monitor their progress. The department's physical facility encourages supportive non-competitive interactions among the students: students are encouraged to work together with civility and form strong bonds. After all, one's colleague may one day become one' s fellow team member. Therefore, the trend in several courses has been toward the presentation of a portfolio and project based learning modules instead of formal exams or quizzes. Another assessment method has been the evaluation of a team effort using self and group evaluation techniques.

Based on the above observations, several years ago a "CAD Practicum " or "capstone" course was implemented to include workplace behavior and employability skills. This course has enhanced the attributes that are inherent strengths of the CAD Technology program as described above,

Section IV: Instructional Support

20. Please discuss the adequacy of the **staffing level to teach and advise** for students enrolled in the program.

The department currently has two full-time and two adjunct faculties. The present staffing level is adequate for the current number of students enrolling in the program in the most recent years. However, this staffing will be inadequate if the numbers of student enrollee return to the 1980's and 90's level. Because the number of workstations per labs determines the course enrollment, class sizes are limited to fifteen students. CAD courses, which do not require workstations, have a greater number of enrollees. Students have ready access to their advisors who are full-time faculties. However; the ratio of advisor to advisee is inadequate because the advisors have more advisees than the amount required by their CBA. Department faculty have been generous in comment on advising center and incoming students – accepting additional advisees

1. What specific **support services and activities** (i.e., tutoring, media, library, disabled student support, computer labs, service learning coordinator) does this program require? Please comment on the availability and adequacy of these services (be specific about any current deficiencies or projected needs).

The program employs one second year student as a part time CAD lab assistant who maintains open lab hours four evenings per week. It is the lab assistant's responsibility to ensure that the facility is secured at the end of the evening classes, that computers and peripherals are shut down, and the labs tidied for the morning classes. It is NOT his responsibility to troubleshoot the computers beyond the very basics. For more complex tasks we have relied on the services of a faculty member, Patrick Boyle. The need for an expert in CAD Software and configuration is needed and will be required in the future because the college

does not maintain the resources to support the technology at this level. Recently, the college I.T. and Academic Support department have taken ownership of the physical hardware. The CAD server is now located on the Lowell campus and is maintained by computer services. This allows for better security and regular backups according to college policy. All software upgrades and configurations relating to the CAD software are performed by the CAD faculty. This function is usually performed over the summer months and requires 40-80 hours to create images of the 8 CAD packages.

22. How adequate and appropriate are **program facilities and equipment**? Please be specific about current deficiencies or projected needs.

The CAD Technology program is fortunate to be housed as an intact facility in the South Academic Building on the Bedford campus, which is centrally located amongst towns that support high technology industries. The college has been supportive in updating hardware and software requirements and students have been holding their own in reflecting currency of skills. The program has been able to keep pace with the latest software versions because of a superb relationship between the department and the software companies. This crucial relationship is the result of the department chair, Patrick Boyle, leadership. The software is upgraded as new versions are being introduce to the market. Our costs are insignificant compare to their market value and some companies donate their software to our program. The department recently acquires a new plotter capable of plotting all drawing sizes. However, the CAD department in order to maintain its leading-edge position must invest in new technologies such as 3D printer.

23. Are there unmet **professional development needs** of program faculty or staff? If so, please describe.

The college and the division has been very supportive and shown generous financial support for professional development. We regularly attend seminars, trade shows and conferences. Training for software updates has lagged somewhat because most training is based on the industry calendar and these tend to take place during the teaching semesters.

24. Describe the **program budget** if a specific one exists. How is it currently allocated among program expenditures?

Currently, there is no specific budget for the CAD program. Hardware and some software upgrades are in general included in the general operating budget of the college. CAD software upgrades, plotter supplies and other minimal expenses are included in the Computer and Engineering Technology Division budget.

25. Are there specific fiscal needs that have not been previously identified? If so, please specify them.

The Dean of the Computer and Engineering Technology Division, Barry Werner, has been very successful at moving the CAD department from its earlier following-edge position in CAD technologies to its current leading-edge position. However, maintaining this position will require the department to adopt new technologies and the faculty to be trained regularly. At least two of our high school partners have made significant investment in 3D printers and rapid prototyping equipments. The department will need to act quickly in order to regain the technological advantage it used to have over its high school partners. This advantage would play a significant role in recruitment and retention. We need some sort of fiscal mechanism that will enable the department to implement new CAD technologies as early as possible. A typical 3D printer cost $35,000 and requires significant funds for maintenance.

Section V: Additional Questions and Program Evaluation Summary

Program Evaluation Summary

This section should be completed based upon review and consideration of both the data supplied in **Section I** and the questions posed in **Sections II, III, and IV.**

A. Major Program Strengths

Using the support of the CET division and the financial support of the College the CAD Technology has been able to maintain current technology materials. Our CAD labs are equipped with equipment and software that is comparable to industry.
All of the CAD Technology facilities are located in the South Academic Building. There are two CAD laboratories on one floor and, a classroom that has desks that can be used for manual drafting and an adjacent classroom on the first floor complete the facility. All CAD labs and lecture rooms have projection systems linked to our network. Faculty offices are located near to the CAD classrooms. The configuration of physical facilities greatly enhances opportunities for student to instructor interactions and promotes collegial interchanges among students. Each student has access to his instructors, each instructor knows all of the students, and the atmosphere of the department is one of inclusion and cooperation. All CAD majors are assigned advisors within the department.

A major strength of the CAD Technology program lies in the diversity of its two full time and adjunct faculty members, each committed to fostering growth in his niche of the program. Each member contributes a body of expertise which synergistically makes the program greater than a sum of its parts. Each faculty member works at self improvement by maintaining contacts with industrial associates and/or educators, acting as consultants in technological areas, attending conferences and/or in service with other areas of the college. The faculty is a relatively autonomous, loosely woven network which has strengthened through time with a coordinator, rather than a director, at the helm.

Another major strength of our program is the CAD Practicum. This capstone class provides students with an example practical exposure to application of industry standards, team work, problem solving, critical thinking and design process methodology. This class also provides students with a platform to apply their writing and presentation skills leaned in other academic courses. The CAD practicum provides students a major exposure to the industry needs by requiring them to write a resume and cover letter and to look for job openings. Finally, this practicum was moved to another level with the introduction of interdisciplinary collaboration with other MCC programs by choosing design projects where our students need to get information from these different programs.

The Advisory Board meets annually. The board membership includes former students who can contribute industry needs from the perspective of having been through the program. There is good attendance and spirited discussions that have informed curriculum.

B. Program Weaknesses or Needs for Improvement

A weakness of the program is the current staffing level. The program currently has two full-time and one adjunct faculty. Efforts to recruit more adjunct faculty members for the day division have been difficult because the recent upturn in technology employment. The current staffing level is only sufficient to maintain the current status quo but, is not sufficient to move the CAD program to meet any new challenges and opportunities within this industry. Furthermore, the small size of the department faculty make it difficult for the department to participate in the college activities such initiatives upon departments such as ISLO, Skills Assessment, Employability Skills, Workplace Behavior or take advantage of some of the professional development opportunities.

The low enrollment in evening courses resulted in cancellations of all or nearly all offerings in a given semester. As a result a decision has been made to discontinue the CAD evening program. This has a serious effect on our connection to the industry. The evening certificate was widely known, respected and advertised by the participants. It was also a feeder to our day program where companies were given their employees the opportunity to take day classes to complete their associate degree.

The college supports faculty professional development; however, a new strategy and additional resources should be looked at in order to improve the CAD faculty skills to search out and utilize opportunities during the summer. Many industrial training seminars and trade shows are held during the academic year and are very expensive or take too much time away from class. It may be more helpful to schedule internal professional development opportunities during the summer months.

The CAD program could be enhanced by the addition of measurement capabilities and materials through which students can have hands-on experience on some of the theories being presented to them in the classroom. This would have most impact in the GD&T class where students have difficulties in grasping the concepts and connecting them to their designs. This is very important in light of the recent resurgence of GD&T in the industry. This issue is currently being supported by the division and lab materials should be available before the next semester should a purchase request be forwarded.

The program would also benefit from rapid prototyping and rapid manufacturing capabilities. These technologies are currently being used in the industry and are available in most of our vocational high school partners. This would enable students to produce objects that they have designed. The cost of such 3D printing capability is beyond the resources of the division. Many engineering programs have implemented design-built projects into their programs in which a project is designed and then built. This practice could be adopted in the CAD program if the program could acquire the manufacturing capabilities.

In previous years students had an opportunity to enroll in a CAD internship. The CAD department became unable to offer this opportunity when the size of the full-time faculty dropped from four to two. Although the college has a limited infrastructure to support internship projects, the reduction in the CAD full-time faculty makes it difficult existing faculty to administer such project.

Last year the practicum project worked with the Nursing department to design hospital beds to federal standards. The CAD students interacted somewhat with nursing faculty members to obtain specifications. This practice could be continued and even

enhanced by developing cross-departmental courses and/or projects involving different stakeholders. The CAD department should investigate how to implement such current industry practices.

Each year when hardware upgrades are implemented in the CAD labs, the implementations are held off until either just before the start of the semester or even after the start of the semester. This can have a disruptive effect on classes. It also requires Professor Boyle to provide extensive time for the configuration of the server and the software.

C. Plans for improving or correcting identified weaknesses

The CAD department needs to:

- *Identify available professional development trainings and to request a budget from the college through the professional development process.*
- *Schedule faculty training and upgrades during the summer.*
- *Be more aggressive with establishing industry partners to help with attaining equipment and training.*
- *Use our Advisory Board to establish wider industry connections.*
- *Articulate a vision for the future, present it to the college and determine the personnel and resources required*
- *Survey industry to determine demand for training in CAD software upgrades and offer courses (credit and/or non-credit) as needed.*
- *Order the measurement equipment needed to enhance the instruction of mechanical concepts in the program.*
- *Investigate how to obtain a rapid prototyping printer and a funding source to maintain it.*
- *Develop a plan for the above with responsibilities and timelines clearly delineated.*
- *Have a schedule for obtaining hardware upgrades that matches the instructional needs of the program.*

Appendix A

MIDDLESEX COMMUNITY COLLEGE
CAD TECHNOLOGY ADVISORY BOARD
SPRING 2007

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Appendix B

CAD Technology Advisory Board Minutes

Patrick Boyle
April 26, 2006

All,

I'd like again, to extend my thanks to you for attending our CAD Advisory Board meeting. This year's meeting had to be one of our most successful and informative. Your comments, ideas and guidance will help our college make positive decisions for our students and faculty. In the next several months, the faculty and deans will be meeting to review and implement many of your suggestions. It was good to hear confirmation of our program from professionals outside the college. I may be asking several of you to review possible changes, ask for suggestions and I will keep you informed of any suggested changes to our program via email. Any decision will be presented at our next meeting.

Meeting commenced at 6:45:

Introductions

Barry Werner:

Overview on the College and the Technology efforts. Explained the BATEC grant and it's funding for use in technology, the new RFID program and Computer Forensics

Patrick Boyle:

PowerPoint Presentation of CAD Technology overview

Explained changes to our program

- Elimination of PCBII
- Addition of Architectural CAD
- Overview of 2006 CAD Practicum
- Wish List:
  - 30 Chairs
  - Upgrade workstations to 2GIG RAM
  - B Size Laser Printer
  - Measurement Lab
  - CAD/CAM Lab for light machining
  - 3D Printer

Reviewed samples of students work

Will be asking for comments on program review

Students need more practical knowledge: Suggestions were asked.

Discussed issue of students being "rusty" with AutoCAD because AutoCAD is not taught in the last semester.

No one has asked for Pro-E students for 5 years

Most students are still getting jobs because of their AutoCAD skills

We attract lots of students because of our Articulation Agreement with High Schools

Jacque-Antoine Jean

Recommended to use AutoCAD during the last 2 weeks of GD&T

Adam Waniek

Suggested that we teach Cable Packaging.
Market is somewhat slow
AutoCAD 3D is more common now
Inventor is being requested more and more
Solidworks training leveling off as many are now trained.
PCB is very slow

Dan Jenkins:

PCB and Mechanical Engineers doing their own design

Rick Castillo:

Inventor has much to offer for Design for Manufacturing

Patrick Boyle:

Asked for comments on Architectural CAD

Jobs available, why not include it

Joe St.Cyr:

Commented on Industrial Design

Liam O'Connell:

Mentioned a new program called "Sketch Up" is a hot product and suggested we look into using it. Used for Landscape Design

Tony Theos:

Comment on the increasing popularity of Revit.

Barry Werner/Patrick Boyle:

Interdisciplinary lacking. Possible service learning component for future.

Herb McEvoy:

Students should be taught how to swap files between various software like Solidworks and Inventor

Barry Werner:

Asked for comments on where technology is going to be in 5 years.

Toby Ringdahl: Ergonomics, etc
Joe St.Cyr: Rapid Design, etc

Discussed Service Learning with other schools.

Toby Ringdahl:

Sketching tools. New Tablet type

Other open topics:

PCB demand is down
Job market not great but better
MCC only school teaching GD&T
Mechanical Components is still lacking in our curriculum
Design for Manufacturing must be considered

Special thanks to Bryan Leary for taking the meeting notes.

Meeting adjourned at 8:55PM

Appendix C

Articulation High Schools

Chelmsford High School

Dracut High School

Greater Lawrence Technical High School

Greater Lowell Technical High School

Leominster High School Center for Technical Education

Lowell High School

Minuteman Regional Technical High School

Montachusett Regional Technical School

Nashoba Valley Technical High School

Northeast Metropolitan Regional High School

Shawsheen Valley Technical High School

Whittier Regional Vocational Technical School

CAD A.S. Degree
CAD TECHNOLOGY

	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Head Count Applicants	68	56	68	75	38	48
Head Count New Students Enrolled	43	37	40	40	24	26
Head Count Credit Enrollment	92	95	94	81	82	67
Full Time Equivalent New Students	35.66	25.4	29.2	29.8	18.33	17.2
Full Time Equivalent Enrolled Students	71	68	71	60	59	46
Head Count Graduates	23	13	21	20	19	11
Average GPA at Graduation	3.12	3.18	3.15	3.16	3.16	3.14

AGE GROUP	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Less Than 18	25	3	2	2	0	0
18 to 19	23	27	30	32	32	24
20 to 21	15	24	26	20	22	19
22 to 24	9	14	14	11	12	9
25 to 29	4	10	8	7	2	6
30 to 39	8	9	5	4	8	4
40 to 49	6	7	8	5	6	4
50 to 59	2	1	1	0	0	0
65 Plus	0	0	0	0	0	1
Not Indicated	0	0	0	0	0	0
TOTAL	**92**	**95**	**94**	**81**	**82**	**67**

GENDER	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Female	15	18	12	13	11	7
Male	77	77	82	68	71	60
Not Indicated	0	0	0	0	0	0
TOTAL	**92**	**95**	**94**	**81**	**82**	**67**

RACE	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Asian	5	8	7	11	8	6
Black	0	0	4	3	0	0
Hispanic	5	5	8	8	10	12
Native American	1	0	0	1	1	1
White	79	80	74	55	59	47

Other	2	2	1	3	4	1
TOTAL	**92**	**95**	**94**	**81**	**82**	**67**

CAMPUS LOCATION	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Bedford Campus	87	88	87	77	79	64
Lowell Campus	21	22	25	30	34	21
Both	16	15	18	26	31	18
TOTAL	**92**	**95**	**94**	**81**	**82**	**67**

ENGLISH PLACEMENT NEW STUDENTS	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
English Fundamentals	1	1	3	2	3	2
Basic Writing	14	16	18	19	13	13
English Composition	16	11	12	8	6	7
TOTAL	**31**	**28**	**33**	**29**	**22**	**22**

MATH PLACEMENT NEW STUDENTS	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Fundamentals of Mathmatics	11	13	14	14	4	7
Algebra I	12	12	10	6	9	3
Algebra II	4	7	5	7	3	6
Intermediate Algebra	7	1	2	5	1	1
Precalculus for Business & Social Sciences	2	1	0	3	0	0
TOTAL	**36**	**5**	**31**	**35**	**17**	**17**

READING PLACEMENT NEW STUDENTS	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Recommended Reading	6	7	9	5	5	6
Required Reading	12	9	6	15	3	5
TOTAL	**18**	**16**	**15**	**20**	**8**	**11**

CREDIT ENROLLMENT STATUS	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
3 Credits	4	7	7	5	7	6
4 Credits	0	0	0	0	1	0
6 Credits	11	16	11	7	8	11
7 Credits	0	2	0	1	0	1
8 Credits	0	0	0	0	0	0
9 Credits	16	10	10	14	10	12
10 Credits	0	1	0	1	0	1
11 Credits	0	0	1	0	0	0
12 Credits	25	30	32	33	40	20
13 Credits	1	1	3	2	2	1
15 Credits	33	28	30	17	11	15
16 Credits	0	0	0	0	3	0
18 Credits	2	0	0	1	0	0
	92	**95**	**94**	**81**	**82**	**67**

	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Day	61	62	56	59	42	40
Evening	9	15	9	4	10	5
Both	22	18	29	18	30	22
TOTAL	**92**	**95**	**94**	**81**	**82**	**67**

ACADEMIC STANDING	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Dean's List	32	32	23	13	16	16
Good Standing	44	53	57	53	48	42
Probation	14	6	12	13	12	6
Dismissed	1	2	2	1	4	1
Restricted Probation	1	2	0	1	2	2
TOTAL	**92**	**95**	**94**	**81**	**82**	**67**

GRADE DISTRIBUTION	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
CD 1101 Mechanical Drafting I						
A	5	4	3	1	4	1
A-	6	7	3	3	2	5
AU	0	0	0	0	0	0
B+	0	5	2	0	0	4
B	5	8	1	0	1	1
B-	0	1	2	0	1	2
C+	1	0	1	1	0	0
C	3	0	3	1	1	0
C-	1	0	0	3	1	0
D+	0	0	0	1	1	1
D	0	0	0	2	2	0
D-	0	0	0	4	2	0
F	0	5	3	1	0	0
W	3	2	4	7	5	0
TOTAL	**24**	**32**	**22**	**24**	**20**	**14**

CD 1102 Mechanical Drafting II	Spring 2000	Spring 2001	Spring 2002	Spring 2003	Spring 2004	Spring 2005
A	10	18	6	1	4	6
A-	5	1	3	1	4	0
AU	0	0	0	0	0	0
B+	3	2	5	3	0	1
B	2	2	3	1	1	4
B-	1	0	2	0	1	2
C+	1	1	0	1	3	2
C	0	0	0	1	3	1
C-	0	1	1	2	1	2
D+	0	0	0	3	2	2
D	0	2	0	2	0	0
D-	0	0	0	1	0	0
F	3	3	2	0	0	0
W	1	1	1	1	3	1
TOTAL	**26**	**31**	**23**	**17**	**22**	**21**

CD 1105 Mechanical Components	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
A	14	23	N/A	N/A	N/A	N/A
A-	9	5	N/A	N/A	N/A	N/A
AU	0	0	N/A	N/A	N/A	N/A
B+	3	2	N/A	N/A	N/A	N/A
B	5	2	N/A	N/A	N/A	N/A
B-	0	2	N/A	N/A	N/A	N/A
C+	1	0	N/A	N/A	N/A	N/A
C	1	1	N/A	N/A	N/A	N/A
C-	1	0	N/A	N/A	N/A	N/A
D+	0	0	N/A	N/A	N/A	N/A
D	1	0	N/A	N/A	N/A	N/A
D-	0	0	N/A	N/A	N/A	N/A
F	2	5	N/A	N/A	N/A	N/A
W	3	2	N/A	N/A	N/A	N/A
TOTAL	**40**	**42**	**0**	**0**	**0**	**0**

CD 1115 Introduction to CAD	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
A	11	8	2	3	4	3
A-	6	7	4	1	3	3
AU	0	0	0	0	0	0
B+	1	5	4	2	3	2
B	1	3	2	4	3	2
B-	1	3	3	0	1	1
C+	1	0	3	1	0	2
C	0	0	0	2	1	2
C-	1	0	0	0	1	0
D+	1	0	0	1	1	0
D	0	0	0	1	0	1
D-	1	0	0	1	1	0
F	2	4	1	0	0	0
W	3	1	4	7	7	1
TOTAL	**29**	**31**	**23**	**23**	**25**	**17**

CD 1117 Micricomputers for CAD	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
A	8	7	N/A	N/A	N/A	N/A
A-	3	8	N/A	N/A	N/A	N/A
AU	0	0	N/A	N/A	N/A	N/A
B+	4	6	N/A	N/A	N/A	N/A
B	6	2	N/A	N/A	N/A	N/A
B-	2	1	N/A	N/A	N/A	N/A
C+	2	0	N/A	N/A	N/A	N/A
C	1	0	N/A	N/A	N/A	N/A
C-	0	0	N/A	N/A	N/A	N/A
D+	1	0	N/A	N/A	N/A	N/A
D	0	0	N/A	N/A	N/A	N/A
D-	0	0	N/A	N/A	N/A	N/A
F	2	2	N/A	N/A	N/A	N/A
W	1	1	N/A	N/A	N/A	N/A
TOTAL	**30**	**27**	**0**	**0**	**0**	**0**

CD 1169 3D CAD	Spring 2000	FALL 2000	Spring 2002	FALL 2002	Spring 2004	Spring 2005
A	11	8	18	3	12	9
A-	8	1	4	3	6	5
AU	1	0	0	0	0	0
B+	4	1	2	2	1	2
B	5	1	2	0	0	3
B-	3	0	3	0	0	1
C+	1	0	2	0	1	0
C	1	0	1	0	0	1
C-	0	2	0	0	1	0
D+	0	0	1	0	0	0
D	0	0	0	0	0	0
D-	0	0	0	0	0	0
F	4	0	1	0	2	1
W	1	0	4	1	1	1
TOTAL	**39**	**13**	**38**	**9**	**24**	**23**

CD 1202 Printed Circuit Design II/CAD	FALL 1999	FALL 2000	Spring 2002	Spring 2003	Spring 2004	Spring 2005
A	7	4	12	4	7	5
A-	3	7	8	7	3	3
AU	1	0	0	0	0	0
B+	5	3	5	4	1	5
B	6	5	7	1	6	4
B-	2	1	3	0	1	2
C+	0	0	1	0	0	0
C	1	0	2	0	1	0
C-	1	0	2	1	1	0
D+	0	0	0	2	1	0
D	1	0	0	0	0	0
D-	0	0	1	0	0	0
F	0	0	2	0	0	0
W	1	0	3	2	2	1
TOTAL	**28**	**20**	**46**	**21**	**23**	**20**

CD 1205 Geometric Dimensioning and Tolerancing	FALL 1999	FALL 2000	FALL 2001	Spring 2003	Spring 2004	Spring 2005
A	15	7	5	7	3	6
A-	2	4	4	2	0	1
AU	0	0	0	0	1	0
B+	6	3	8	3	1	1
B	4	4	3	2	2	3
B-	3	3	2	2	3	0
C+	1	0	2	1	1	0
C	0	1	1	2	1	1
C-	1	0	1	2	1	1
D+	0	1	0	1	0	1
D	0	0	0	0	0	1
D-	1	0	1	3	1	2
F	0	0	0	0	1	0
W	1	0	1	1	2	3
TOTAL	**34**	**23**	**28**	**26**	**17**	**20**

CD 1225 Mechanical Drafting III/CAD	Spring 2000	Spring 2001	Spring 2002	Spring 2003	Spring 2004	Fall 2004
A	6	12	6	8	9	11
A-	10	4	5	1	3	3
AU	0	0	0	0	0	0
B+	6	2	8	6	0	4
B	0	3	2	3	2	0
B-	4	2	0	0	2	0
C+	0	0	3	0	0	1
C	0	0	0	0	1	0
C-	0	0	0	1	1	0
D+	0	0	0	0	0	0
D	0	0	1	0	0	0
D-	0	0	1	0	0	0
F	1	0	0	0	0	0
W	2	1	0	1	2	1
TOTAL	**29**	**24**	**26**	**20**	**20**	**20**

CD 1227 Advanced CAD Applications	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
A	13	6	8	8	6	11
A-	4	5	4	1	2	2
AU	0	0	0	0	0	0
B+	2	3	6	9	1	5
B	4	1	4	1	1	0
B-	2	2	1	1	3	0
C+	1	2	2	0	2	0
C	0	0	1	2	0	1
C-	0	0	1	0	0	0
D+	0	1	0	0	0	0
D	0	0	1	0	1	0
D-	0	0	2	0	0	0
F	3	0	0	0	0	0
W	1	0	0	0	2	2
TOTAL	**30**	**20**	**30**	**22**	**18**	**21**

CD 1228 CAD Practicum	Spring 2000	Spring 2001	Spring 2002	Spring 2003	Spring 2004	Spring 2005
A	15	5	14	5	10	7
A-	3	8	6	7	1	3
AU	0	0	0	0	0	0
B+	3	1	1	2	0	3
B	2	8	1	4	2	1
B-	1	0	2	4	0	1
C+	0	0	0	1	0	3
C	0	0	0	0	0	0
C-	0	0	0	0	0	0
D+	0	0	0	0	0	0
D	0	0	0	0	0	0
D-	0	0	1	0	2	0
F	1	0	0	0	0	0
W	2	1	0	0	2	1
TOTAL	**27**	**23**	**25**	**23**	**17**	**19**

CAD Certificate Program

CAD TECHNOLOGY

Certificate

	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
Head Count Applicants	15	16	17	13	10	13
Head Count New Students Enrolled	14	11	11	8	5	10
Head Count Credit Enrollment	21	16	20	18	11	23
Full Time Equivalent New Students	6.26	4.6	4.66	4.86	2	4.66
Full Time Equivalent Enrolled Students	9.3	5.3	7.5	8.6	3.6	8.9
Head Count Graduates	9	11	7	6	10	8
Average GPA at Graduation	3.12	3.18	3.15	3.16	3.16	3.14

	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
AGE GROUP						
Less Than 18	1	0	1	0	0	0
18 to 19	1	1	1	2	0	2
20 to 21	1	0	3	4	0	1
22 to 24	4	2	3	1	3	3
25 to 29	4	4	3	3	1	2
30 to 39	5	2	3	3	1	6
40 to 49	3	3	4	3	5	7
50 to 59	2	4	2	2	0	1
60 Plus	0	0	0	0	0	1
Not Indicated	0	0	0	0	1	0
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
GENDER						
Female	6	3	5	4	3	4
Male	15	13	15	14	8	19
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
RACE						
Asian	2	1	2	1	1	1
Black	2	0	2	2	1	4
Hispanic	2	1	1	0	1	2
Native American	0	0	0	0	0	0

White	15	13	15	15	8	16
Not Indicated	0	1	0	0	0	0
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

CAMPUS LOCATION	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Bedford Campus	18	15	20	18	11	23
Lowell Campus	7	3	0	2	0	4
Both	4	2	0	2	0	4
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

ENGLISH PLACEMENT NEW STUDENTS	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Basic Writing	1	3	3	1	3	3
English Composition	6	5	2	2	1	3
TOTAL PLACEMENTS	**7**	**8**	**5**	**3**	**4**	**6**

MATH PLACEMENT NEW STUDENTS						
Fundamentals Of Mathematics	4	2	0	1	2	2
Algebra I	2	4	3	1	0	1
Algebra II	2	2	0	1	1	0
Intermediate Algebra	1	0	1	1	0	2
TOTAL PLACEMENTS	**9**	**8**	**4**	**4**	**3**	**5**

READING PLACEMENT NEW STUDENTS						
Recommended Reading	1	3	0	0	0	1
Required Reading	2	0	1	1	0	0
TOTAL PLACEMENTS	**3**	**3**	**1**	**1**	**0**	**1**

CREDIT ENROLLMENT STATUS	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
3 Credits	9	8	8	7	6	12
6 Credits	6	5	8	3	4	5
7 Credits	0	1	1	0	0	0
9 Credits	1	2	2	4	0	1
10 Credits	0	0	0	0	0	1
12 Credits	2	0	0	2	1	4

13 Credits	1	0	0	0	0	0
15 Credits	2	0	1	2	0	0
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

	FALL 1999	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Day	4	3	3	2	1	5
Evening	12	12	17	10	7	12
Both	5	1	0	6	3	6
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

ACADEMIC STANDING	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
Dean's List	8	0	0	3	2	8
Good Standing	10	15	19	13	9	15
Probation	3	1	1	1	0	0
Restricted Probation	0	0	0	1	0	0
Dismissed	0	0	0	0	0	0
TOTAL	**21**	**16**	**20**	**18**	**11**	**23**

GRADE DISTRIBUTION CD 1133 Mechanical Drafting I	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
A	8	11	10	10	5	5
A-	3	0	3	1	3	2
AU	0	0	0	0	0	0
B+	2	2	5	1	1	2
B	1	1	2	2	2	1
B-	1	1	0	0	1	2
C+	0	0	2	0	0	1
C	0	0	0	1	0	0
C-	0	0	0	0	0	0
D+	0	0	0	0	0	0
D	0	0	0	0	0	0
D-	0	0	1	0	0	0
F	0	0	2	0	0	0
W	2	3	2	1	1	2
TOTAL	**17**	**18**	**27**	**16**	**13**	**15**

CD 1134 Mechanical Drafting II	SPRING 2000	SPRING 2001	SPRING 2002	SPRING 2003	SPRING 2004	SPRING 2005
A	7	6	10	13	6	NA
A-	1	1	4	1	1	NA
AU	0	0	0	0	0	NA
B+	1	1	0	0	2	NA
B	0	1	0	0	2	NA
B-	0	1	1	1	0	NA
C+	1	1	0	0	0	NA
C	1	1	0	1	0	NA
C-	0	1	0	0	1	NA
D+	0	1	0	0	0	NA
D	0	0	0	0	0	NA
D-	0	0	0	1	1	NA
F	0	0	0	0	0	NA
W	3	0	0	0	0	NA
TOTAL	**14**	**14**	**15**	**17**	**13**	**0**

CD 1143 PCB I Electronic Design/CAD	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
A	3	4	9	3	3	7
A-	4	6	6	5	4	6
AU	0	0	0	0	0	0
B+	3	5	2	3	2	1
B	5	2	3	2	3	0
B-	1	0	1	1	2	0
C+	0	0	1	0	0	0
C	0	0	1	0	0	0
C-	0	0	2	1	0	0
D+	0	0	0	0	0	0
D	0	0	0	0	1	0
D-	0	0	0	0	0	0
F	0	0	0	0	0	0
W	2	2	4	1	2	2

TOTAL	**11**	**9**	**14**	**8**	**10**	**3**

CD 1144 Printed Circuit Board Design II/Electronic CAD	**SPRING 2000**	**SPRING 2001**	**SPRING 2002**	**SPRING 2003**	**SPRING 2004**	**SPRING 2005**
A	5	5	5	3	N/A	N/A
A-	3	3	5	2	N/A	N/A
AU	0	0	0	0	N/A	N/A
B+	2	3	1	1	N/A	N/A
B	2	0	0	2	N/A	N/A
B-	1	2	0	1	N/A	N/A
C+	0	0	0	0	N/A	N/A
C	0	0	1	0	N/A	N/A
C-	0	1	0	0	N/A	N/A
D+	0	0	0	0	N/A	N/A
D	0	0	0	0	N/A	N/A
D-	0	0	0	0	N/A	N/A
F	0	1	0	0	N/A	N/A
W	1	0	0	0	N/A	N/A
TOTAL	**14**	**15**	**12**	**9**	**0**	**0**

CD 1151 Computer Aided Drafting I	**FALL 1999**	**FALL 2000**	**FALL 2001**	**FALL 2002**	**FALL 2003**	**FALL 2004**
A	7	3	3	7	7	4
A-	1	6	3	0	1	1
AU	1	0	0	0	0	0
B+	2	1	1	0	3	1
B	0	1	0	0	0	2
B-	1	1	0	0	1	0
C+	0	0	1	0	0	0
C	0	0	1	0	0	0
C-	0	0	0	0	0	0
D+	0	0	0	0	0	0
D	0	0	1	0	0	0
D-	0	0	0	0	0	0
F	1	1	0	0	0	2
W	0	1	4	2	3	0
TOTAL	**13**	**14**	**14**	**9**	**15**	**10**

CD 1168 Basic 3D CAD	FALL 1999	FALL 2000	FALL 2001	FALL 2002	FALL 2003	FALL 2004
A	N/A	N/A	N/A	N/A	7	7
A-	N/A	N/A	N/A	N/A	1	3
AU	N/A	N/A	N/A	N/A	0	0
B+	N/A	N/A	N/A	N/A	1	2
B	N/A	N/A	N/A	N/A	3	0
B-	N/A	N/A	N/A	N/A	0	0
C+	N/A	N/A	N/A	N/A	0	0
C	N/A	N/A	N/A	N/A	0	0
C-	N/A	N/A	N/A	N/A	0	0
D+	N/A	N/A	N/A	N/A	0	0
D	N/A	N/A	N/A	N/A	0	0
D-	N/A	N/A	N/A	N/A	0	0
F	N/A	N/A	N/A	N/A	0	0
W	N/A	N/A	N/A	N/A	1	2
TOTAL	**0**	**0**	**0**	**0**	**13**	**14**