MIDDLESEX COMMUNITY COLLEGE

ACADEMIC PROGRAM REVIEW

For

Liberal Arts Engineering Science Transfer Program

1998-1999

Liberal Arts Engineering Science Transfer
Program Review

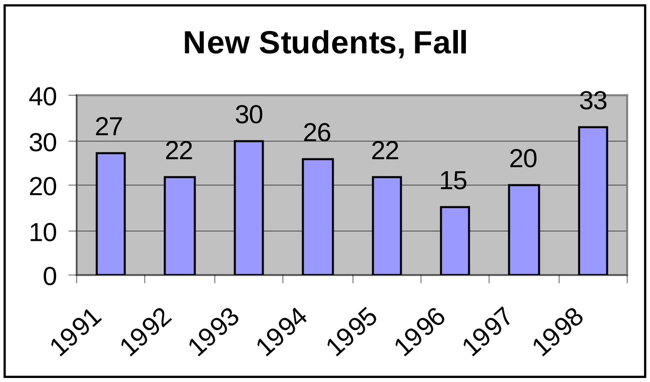
Section I: Data (information provided by the Institutional Research Office)

1. Please note important trends, patterns and issues that emerge through the **Enrollment, Academic Progress and Retention data:**

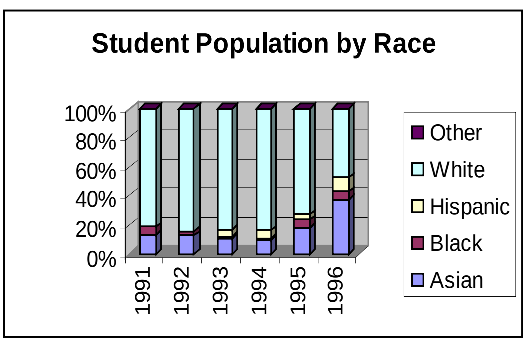
(The data is included in Appendix A of this document.)

From the data provided (1991 – 1998), the following statements can be made:

- *The number of new students enrolled each fall was between 22 – 30 from 1991-1995, but decreased to a low of 15 in 1996. The enrollment has increased the last two years, 1997 and 1998.*



- *The median age of students has increased from the 20-21 range in 1991-1992 to the 22-24 range in 1993-1996.*
- *The students are predominately male, approximately 86% over the six years.*
- *The student population has been predominately white over the six years, but in the last two years there has been an increase in the Asian student population. (see chart)*



- *Most students take two or more classes per semester with some taking as few as 3 credits and others as many as 16 credits.*
- *Over 90% of the students attend day classes.*
- *From 1991-1993, more engineering students (a margin of 2-1) attended classes in Lowell, but from 1994-1996, the split between Bedford and Lowell is fairly even.*
- *Students remained in "good" academic standing and "Dean's List" with less than 25% each year on academic probation or dismissal.*
- *Below is a table showing the number of new students each fall semester and which courses they tested into as a result of the placement exam.*

	Fall 1991	*Fall 1992*	*Fall 1993*	*Fall 1994*	*Fall 1995*	*Fall 1996*	*Fall 1997*	*Fall 1998*
EN 1101	*5*	*7*	*6*	*7*	*7*	*6*	*6*	*15*
EN 1102	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*
EN 1103	*13*	*11*	*16*	*10*	*7*	*2*	*7*	*11*
EN 2120	*0*	*1*	*1*	*1*	*0*	*0*	*1*	*1*
EN 2121	*0*	*1*	*2*	*1*	*0*	*1*	*3*	*5*
EN 2131	*0*	*0*	*0*	*0*	*3*	*2*	*2*	*9*
MA 1101	*2*	*1*	*4*	*1*	*1*	*1*	*4*	*6*
MA 1103	*4*	*8*	*6*	*5*	*6*	*5*	*4*	*7*
MA 1104	*7*	*4*	*7*	*3*	*2*	*3*	*3*	*8*
MA 1106	*5*	*4*	*4*	*6*	*3*	*2*	*1*	*5*
MA 1107							*2*	*2*
MA 1125							*0*	*1*

2. Please comment on significant information that emerges from the **Student Transfer and Employment Follow-up data.**

According to the data from Institutional Research (see Appendix A), between fall of 1993 and fall of 1997, there were 109 new students admitted to the LAES program. Of those 109 students 24 graduated and at least 13 of those 24 are known to have transferred to 4-year institutions. Additionally, 24 students transferred prior to graduation from MCC. Thus, 44% (48/109) either graduated from MCC or transferred to a 4-year school. Some of the remaining 61 are still at MCC in the program.

This data was not easily accessed by Institutional Research, nor is it a comprehensive follow-up study of student transfer and career data. This is *important data to track and for these reasons, we recommend that an annual graduate survey be conducted.*

Section II: Goals, Curriculum and Support (Information Provided by Program Faculty, Staff and, where appropriate, students)

Mission, Goals and Target Populations

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

   The Engineering Science Transfer program provides through the first year of a typical engineering program for students who for economic or academic reasons are unable to enroll in baccalaureate programs at four-year institutions. The curriculum of the program is structured and rigorous, providing students with challenging courses taught by expert faculty (who work together to connect their courses and to provide engineering applications).

   Note: The part in parenthesis is not true presently, 10/98. It is the goal of the engineering program to make that a valid portion of the mission statement. This program review addresses the issues and recommends a plan for achieving this goal.

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?

   The program's mission statement is in line with that of the college.
   The program's mission is to provide the basis of the first year of a typical engineering program:

   - *For students who are economically and/or academically challenged (without regard to age, gender, economic status, or cultural background)*
   - *By offering a challenging curriculum which prepares students for transfer to a baccalaureate program.*

   The college's mission (see college mission statement in Appendix B) states:

   - *"We prepare students for entrance into careers, job advancement, or transfer to baccalaureate level.*
   - *"Access to Educational Opportunities is available to everyone, regardless of age, gender, economic status, cultural background or life experience. MCC welcomes all who value knowledge, offering programs and services that cultivate lifelong learning and accomplishment. Students are both challenged and supported in reaching their maximum potential."*

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

"We prepare students for entrance into careers, job advancement, or transfer to baccalaureate level." (MCC mission statement- Appendix B)

The Engineering Science Transfer program maintains a program that must intersect with transfer programs that are, in large part, controlled by accrediting agencies. Therefore, high standards of academic excellence must be maintained in the traditional college science and mathematics course. Our students initially lack the required knowledge foundation to succeed in first year engineering courses. The uniqueness of the Engineering Science Transfer program at MCC is that a student is able to take the necessary courses and get academic support to build a foundation and better his/her chances of success in the program and ultimately in their pursuit of a baccalaureate degree.

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.

Most of the other community colleges have Engineering Science transfer programs. Their programs take the student through the second year of a typical engineering program. Our program is different because it only takes students through the freshman year of a standard engineering program, thus avoiding the small classes and articulation difficulties which would arise should we offer the specific courses required in some of the diverse engineering disciplines. No other school counted Precalculus towards the Associate Degree, as does Middlesex. This is consistent with our stated purpose of serving students who are unprepared to begin a standard baccalaureate-engineering program.

The following chart illustrates the first year of an Engineering Science BA degree at Boston University and University of Massachusetts at Lowell. (See Appendix C) These are the two 4 year universities with whom we have articulation agreements.

Boston University	*UMass – Lowell*
Calculus I, II	*Calculus I, II*
Chemistry I, II	*Chemistry I, II*
Physics I, II	*Physics I, II*
Engineering Courses	*Engineering Courses*
English Composition	*English Composition*
SO/HU Electives	

The next chart represents the Engineering Science Transfer programs offerings at all the community colleges. Remember that Middlesex is the only community college offering a program that transfers as the FIRST year of the baccalaureate degree. All the other community colleges offer a program that transfers as the FIRST AND SECOND years of the baccalaureate degree. (See Appendix D)

Berkshire Comm. College Calculus I-IV Linear Algebra Differential Equations Chemistry I, II Physics I-IV Programming Language Technical Courses Communication English Composition General Electives	*Bristol Comm. College* Calculus I-III Differential Equations Chemistry I, II Physics I, II CAD course Engineering Courses English Composition General Electives	*Cape Cod Comm. College* Calculus I-III Linear Algebra Differential Equations Chemistry I, II Physics I, II Programming Language Engineering Courses Oral Communication English Composition General Electives
Mass Bay Comm. College Calculus I-III Differential Equations Chemistry I, II Physics I, II Programming Languages Engineering Courses English Composition General Electives	*Middlesex Comm. College* Precalculus I, II Calculus I, II Chemistry I, II Physics I, II Programming Language Intro to Engineering/CAD English Composition General Electives	*Northern Essex C. C.* Calculus I-III Chemistry I, II Physics I, II Programming Language Engineering Courses Communication English Composition General Electives
North Shore Comm. College Calculus I-III Differential Equations Chemistry I, II Physics I, II Programming Language Engineering Courses English Composition General Electives	*Springfield Tech. C. C.* Calculus I-III Linear Algebra Differential Equations Chemistry I, II Physics I, II Programming Languages Engineering Courses English Composition General Electives	Note: All data for this section has been included in Appendix D.

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

Our program serves students who are not ready to take engineering courses at the freshman level (Calculus and Calculus level Physics). It also serves as a second chance for students who are not successful at traditional engineering programs.

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

There are no plans at this time to target new or different groups. Discussions have begun with UMass-Lowell, NECC, and NSCC to develop a program that encourages local high school students to pursue engineering. These recruiting efforts are time-consuming. The LAES does not have a program coordinator dedicated to the LAES program. The Dean of Math, Science and Technology serves as the program coordinator in addition to his responsibilities as Dean of the MST division. His responsibilities as Dean are so time-consuming that a recruiting effort of this magnitude is not possible under the current structure.

7. Please describe mechanisms or procedures currently in place to **monitor changes in the transfer agreements with four year institutions** 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);

1. *Dr. Krishna Vidula from UMass-Lowell is working with Dean Werner and with the Associate Dean of Articulation and Transfer. A revision of the articulation agreement has been developed, agreed to, and is awaiting formal approval.*
2. *Representatives from Northeastern University have also expressed interest in working with us. These meetings have not taken place with any regularity and little progress has been made. Time is a large obstacle in scheduling meetings for the participants.*
3. *There is no advisory group at this time.*
4. *Speakers from business and industry are not part of the program*

Each of the above items is a valuable means of assessing a program's currency and fit. In the current administrative structure, Dean Werner is able to devote only a fraction of his time to the LAES program. Our meetings with UMass-Lowell have been very positive. We need more of them to establish a partnership that is beneficial to all parties involved.

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

The faculty who instruct the students in this program are not engineers. The faculty consists of two Science instructors, two Math instructors, one CAD instructor, one Computer Science instructor, and one Humanities instructor. This is not a cohesive group bound by the threads of engineering. There is little collaboration or infusion of engineering topics at this time.

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

None at this time.

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 number of applicants remains steady over the last five years but has increased this year, 1998-99. That is an indicator of student interest in becoming an engineer. However, there are no interim assessments in place to gauge the program's appeal to the students. Student surveys, focus groups, and an advisory committee would be three effective methods of assessing the program's fit in today's market.

The program must also fit with the expectations of national groups. That is the purpose of this program review. The committee has had meetings where we discuss the ABET standards. (See Appendix E) ABET is the Accreditation Board for Engineering and Technology, Inc. and recognized in the United States as the sole agency responsible for accreditation of educational programs leading to degrees in engineering. Their web site can be accessed at www.abet.ba.md.us. The other references that we are working with are <u>Shaping the Future: New Expectations for Undergraduate Education in Science, mathematics, Engineering, and Technology</u> and <u>From Analysis to Action</u>. The National Research Council produced these for the National Science Foundation.

The report of findings from this program review will be measured against the ABET standards and incorporating the pedagogy suggested by the NRC in <u>Shaping the Future</u> and <u>From Analysis to Action</u>.

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

Presently, faculty do not work with admissions. No faculty member has "ownership" for the program. The faculty who teach courses within the program do not have any specific responsibilities to the engineering program. Recruiting *within the college is done informally by faculty, i.e. one notices a student with propensity to design, math, and science and suggests engineering. Working with UMass-Lowell and other community colleges to get the word out to the high schools is another responsibility for a program coordinator. The Division Dean has represented the program at open houses.*

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

None at this time.

Curriculum

11. 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 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.

Student Outcome/Competency	**Strategies For Attainment**	**Assessment Criteria and Methods**
What should the student be able to do? (Performance/knowledge expectations for program graduates listed in **student outcome terms.)**	In what course or courses will the student be able to develop the competency? What activities/ assignments will enable the student to achieve it?	How do the instructor and student know that the competency has been achieved? How is the student's performance judged?

The Accreditation Board for Engineering and Technology, Inc. (ABET) established the following outcomes as essential to every engineering program. (See Appendix E) These standards are directed at four-year engineering programs. The Middlesex engineering program contributes to the attainment of these skills.

Accreditation Board for Engineering and Technology (ABET) Program Outcomes

Engineering programs must demonstrate that their graduates have:

1. *The ability to apply knowledge of mathematics, science, and engineering.*
2. *The ability to design and conduct experiments, as well as to analyze and interpret data.*
3. *The ability to design a system, component, or process to meet desired needs.*
4. *The ability to function on multi-disciplinary teams.*
5. *The ability to identify, formulate, and solve engineering problems.*
6. *An understanding of professional and ethical responsibility.*
7. *The ability to communicate effectively.*
8. *The broad education necessary to understand the impact of engineering solutions in a global and societal context.*
9. *A recognition of the need for, and an ability to engage in life-long learning.*
10. *A knowledge of contemporary issues.*
11. *The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Objective 1

Graduates of the Engineering Program at MCC should be able to
apply knowledge of mathematics, science, and engineering.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus		
1. Student is able to apply appropriate formulas in problem solving.	*Student is given problem situations where he/she must choose appropriate formulas and apply them to the problem.*	*Student demonstrates appropriate problem solving techniques in class, homework, test situations, and on graphing calculator assignments.*
2. Student is able to solve many different types of equalities and inequalities.	*Student applies algebra and uses the graphing calculator to solve problems throughout Precalculus.*	*Student must explain the procedure, demonstrate the solution on a graphing calculator, and interpret results.*
3. Student is able to discuss and explain the properties of functions on graphing calculator assignments and is required to make the connection between what the equation of a function tells about the graph of the function and what the graph of the function tells about the equation of the function.	*Student examines a variety of algebraic and trigonometric functions for domain, range, symmetry, intercepts, shifts, reflections, behavior at tails, asymptotic behavior, intervals when function is increasing or decreasing or when function is positive or negative, and find relative maximum and minimum points.*	*This is standard practice throughout the precalculus courses by the student working alone and also by students working together. Student demonstrates proficiency using algebraic methods when possible and also by using the functions available on the TI83 graphing calculator.*
4. Student is able to use appropriate functions to model real-life situations.	*Student practices representing and labeling unknowns, setting up appropriate models, and answering questions about the models. Students determine answers to questions asked algebraically, graphically, and numerically.*	*Students must solve applications numerically, algebraically, and/or graphically on tests and on graphing calculator assignments or on in-class exercises. Sometimes students are allowed to determine the method, and other times they are required to use a particular method to solve the problem.*
Calculus		
1. Student is able to take the derivative of a function and	*Student:* *1) Uses the power, product,*	*Student:* *1) Applies the correct*

find the Max/Min in applied situations, i.e., *Maximize Volume of a box, or* *Minimize cost of the materials used in making the box.*	*quotient, chain and trig rules for derivatives.* *2) Solves for the critical points, setting the derivative = 0 or $\nexists$.* *3) Tests the critical points using the 1^{st} or 2^{nd} derivative tests.* *4) Verifies Max/Min on the graphing calculator as the points with a horizontal tangent line on the graphs.*	*derivative rule for the function.* *2) Simplifies the algebra in the derivative to be able to solve for derivative = 0 or $\nexists$, thus finding the critical points.* *3) Applies the 1^{st} or 2^{nd} derivative tests to the critical points and get the appropriate conclusions.* *4) Uses the calculator to graph and locate Max/Min approximately.*
2. Student is able to use derivatives to find instantaneous rates of change of one quantity with respect to another.	*Student uses the power, product, quotient, chain or transcendental rules to calculate a derivative.*	*Student checks that the appropriate derivative rule is used to fit a given function.*
3. Student is able to combine techniques used in calculus & physics to applied situations in motion, requiring derivatives.	*Student:* *1) Solves problems from the text on the board.* *2) Uses a workbook lab where the students create a simulation on their calculators using parametric equations.* *3) Demonstrates the relationship between the distance, the velocity and the acceleration using a CBL motion detector.*	*Student:* *1) Checks the velocity and acceleration as the 1^{st} and 2^{nd} derivatives for motion problems.* *2) Checks that maximum height occurs when velocity = 0.* *3) Checks crash velocity occurs when height = 0.* *4) Distinguishes between velocity and speed.* *5) Checks times and direction when object is at a given height.* *6) Checks how well the user-generated graphs match the graph supplied for velocity on the CBL motion detector.*
4. Student is able to find the related rate of change of one quantity given another rate of change.	*Student:* *1) Identifies the given numerical information, using units to help, and label it correctly as y =f(x)*	*Student:* *1) Assesses if the student can distinguish between the given pieces of numerical information in the problem*

	or $\frac{dy}{dx}$ at $x = a$. *2) Uses a formula to relate the quantities to be compared.* *3) Uses the method of implicit differentiation to take the derivative of the formula.* *4) Subs in the given numerical data and solves for the requested rate of change.*	*and use the correct notation to label them.* *2) Checks the formula that relates the given variables in the situation.* *3) Checks the derivatives, taken implicitly.* *4) Checks the substituting of given numerical information and the algebra solution for the requested rate of change.*
5. Student is able to find the area under a curve or between two curves using calculus in the form of integration.	*Student:* *1) Solves text problems on the board where we use given limits for the integral.* *2) Solves problems on the board where we must determine our own limits from points of intersection.* *3) Determines if we are in (top - bottom) (x-orientation) or (right – left) (y-orientation for area.* *4) Uses the calculator to graph & shade the region we are finding.* *5) Uses the calculator to confirm the results of our integration.* *6) Uses a workbook lab to further explore area.*	*Student:* *1) Checks the graph of the shaded region for area.* *2) Checks the solution to the intersection points used for limits.* *3) Checks the orientation of the problem: whether x-independent or y-independent.* *4) Checks that the integral upper & lower limits match the values of the independent variable.* *5) Checks the antiderivative for accuracy.* *6) Checks the application of the Fundamental Theorem of Calculus in evaluating the antiderivative as (top value) - (bottom value).*
6. Student is able to find the volume of a solid of revolution and draw its graph.	*Student:* *1) Demonstrates with a software package that graphs 3-dimensional drawings for a solid of revolution.* *2) Examines wooden models.* *3) Uses examples in class going from 2-d to 3-d sketches.* *4) Discusses orientation of y vs. x-axis and variables.*	*Student:* *1) Looks for an accurate sketch, beginning in 2-d & transforming into 3-d.* *2) Looks for correct choice of variable orientation.* *3) Looks for correct geometry formula for volume, appropriate to the method of Disks, Shells, Washers & Slices.* *4) Looks for correct limits on*

	5) Applies different methods involving: Disks, Shells, Washers & Slices. *6) Checks the integral with a solution on the graphing calculator.*	*the integral, top & bottom, and correct radii and height.* *5) Looks for correct integration technique.* *6) Looks for calculator check of the integral.*
7. Student is able to combine techniques used in calculus & physics to applied situations in work, requiring integration.	*Student:* *1) Solves text problems that involve constant force as applied over a given distance.* *2) Solves text problems involving a variable force applied over a given distance using Hooke's Law (springs).* *3) Solves text problems involving a force applied over a given distance as a variable weight is lifted up.* *4) Uses the graphing calculator to check the result of the integration.*	*Student:* *1) Checks limits of the integral which are determined by the distance involved in the work problems.* *2) (In spring problems) checks the limits of the integral as well as the spring constant as found by Hooke's Law.* *3) (In lifting problems) checks the limits, the function for variable weight, the density of the substance, and the units in the final answer.*
8. Student is able to apply integration tables & various techniques of integration to evaluate integrals.	*Student:* *1) Demonstrates on the board the use of some integration tables included in the text, determining the correct value of a & u in each.* *2) Demonstrates on the board the method of u-substitution for indefinite integrals & for definite integrals with a corresponding change in the limits.* *3) Demonstrates on the board the method of Integration by Parts.* *4) Demonstrates on the board the techniques for inverse trig functions.* *5) Demonstrates on the board the method of Partial Fraction Decomposition.*	*Student:* *1) Checks the number of the formula used in the text's integration tables, as well as the a & u.* *2) Checks for u for du in a substitution, as well as the change in the limits in the definite integral.* *3) Checks the choice of u & dv in Integration by Parts, as well as the calculation of du & v.* *4) Checks that u, du, v & dv are applied correctly in Integration by Parts.* *5) Checks that the correct inverse trig function is applied to the given problem using u & a.* *6) Checks that the partial*

	6) Checks the integration on the graphing calculators. *7) Uses several workbook labs to have students gain further practice.*	*fraction decomposition template is appropriate for the given type of integrand function.* *7) Checks the solution of the partial fraction system of equations.* *8) Checks the integration of each partial fraction.*
Chemistry		
1. Student is able to apply appropriate formulas in problems.	*Student solves problems involving:* *1). Gas laws* *2). Heat and thermodynamics* *3). Emission spectra*	*Student uses the appropriate formula and performs the calculations correctly.*
2. Student is able to apply rules and concepts to solve non-numeric problems.	*1). Student solves problems involving stoichiometry.* *2). Student identifies trends in the periodic table.* *3). Student sketches pictures of the electron structure of atoms and molecules.*	*Student:* *1). Applies the appropriate rules and concepts to stoichiometric problems.* *2). Describes characteristics of an element based upon its location on the periodic table.* *3). Pictures show appropriate electron structure.*
3. Student is able to gather information learned over the semester that concerns the inner-workings of the Periodic Table. Student predicts trends in physical and chemical properties along groups and periods of elements. After studying the behavior and properties of compounds containing these elements, the student identifies trends, describes effects of trends, and explains reasons for the trend.	*Phenomena are presented in lecture and lab sessions. Sketches and graphs to enhance understanding of trends are shown during lecture and lab.*	*Student submits a written report enhanced by graphical displays that depict the trends. Student uses a prepared "empty" periodic table during the process.*
Physics		
1. Student is able to apply appropriate formulas in problem solving.	*Student is given problem situations where he/she must choose appropriate formulas and apply them to the*	*Student demonstrates appropriate problem solving techniques in class, homework, test situations, and*

	problem.	*on laboratory assignments.*
2. Student uses the decibel equation to relate the rate of change of the decibel reading to the rate of change of the intensity.	*Student:* *1) Differentiates both sides of the decibel equation* *2) Solves for the rate of change of the intensity in terms of the rate of change of the decibel reading.* *3) Substitutes numerical values for the intensity and the rate of change of the decibel reading to obtain a numerical value for the rate of change of the intensity.*	*Student must:* *1) Apply the change of base formula to convert the log base from to e.* *2) Apply the differentiation rules (chain rule and the rule of logs) correctly.* *3) Substitute the numerical values correctly and use appropriate units to express the solution.*
Programming with C		
1. Student is able to apply mathematical formulas into their programming assignments.	*Student must write a C program that:* *1) Calculates the area of a rectangle and the volume of a rectangular solid.* *2) Calculates the conversion of Fahrenheit to Celsius and reverse.* *3) Calculates the conversion of metric units to English and reverse.*	*Student programs must:* *1) Follow directions* *2) Demonstrate proper programming syntax and logic* *3) Produce a cleanly compiled C program.*
Intro to Engineering Design		
1. Student is able to read a micrometer.	*Student completes worksheets in and out of class practicing micrometer readings.*	*Student demonstrates that he/she can read a micrometer.*

Objective 2

Graduates of the Engineering Program at MCC should be able to
design and conduct experiments, as well as to analyze and interpret data.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus		
1. Student is able to analyze data in tables, graphs, and equations.	*Student practices this skill throughout the precalculus courses with a variety of algebraic and trigonometric functions during classwork and on homework assignments.*	*Student must explain the relationship of the data numerically, graphically, and algebraically throughout the precalculus course in class, on tests, and on homework assignments.*
2. Student is able to analyze the appropriate mathematical model and make predictions based upon known characteristics of the model.	*Student determines function values for values of the independent variable. Student predicts values for the model.*	*Student demonstrates this skill on in-class exercises, on graphing calculator assignments, and on tests.*
Calculus		
1. Student is able to find the limit value of given functions or determine when and why the limit doesn't exist.	*Student:* *1) Uses algebra & the graphing calculator to examine new functions in three ways:* *i) graphically using TRACE, root & intersect,* *ii) numerically using the TABLE feature and appropriate values x near a given value a, looking for trends in y's,* *iii) Analytically using algebra techniques that may involve: factoring, expanding, simplifying complex fractions, using a conjugate form of 1 or combining terms & canceling common factors.* *2) Examines the functions approaching x=a from two directions: left & right on the graphs, in the tables*	*Student:* *1) Shows trends for y-values on a graph using tick marks to indicate where the x's & y's are going.* *2) Checks for proper one-sided limit notation from the left and right directions.* *3) Checks that the general limit exists only if the left limit = the right limit.* *4) Checks the table values which the students find for y's at appropriate x's in the two directions.* *5) Checks the algebra techniques.* *6) Checks the graphs accompanying the problems, particularly the piece-wise graphs as to whether the pieces join or not, and what effect, if any, this has on the limit.*

	and in the algebra, learning to use one-sided limit notation in the process. *3) Examines piece-wise defined functions at the points where the rules change for trends in y's.*	
2. Student is able to approximate the area under a curve by finding the sum of the area of rectangles that closely fill out the region.	*Student:* *1) Downloads a program into the graphing calculator that will use either inscribed, midpoint, or circumscribed rectangles to fill out the region, sum their areas and approximate the exact area under the curve.* *2) Acquires closer approximations for exact area by increasing the number of rectangles in the calculator program.* *3) Sets up general sigma notation for the sum of the areas of the rectangles & use sum formulas.* *4) Uses limits to get exact areas under the curve by letting the number of rectangles approach ∞.*	*Student:* *1) Checks the number of rectangles and the method used, either inscribed midpoint or circumscribed and its resulting area approximation.* *2) Checks the notation used to signify the height and width of a general rectangle for the sum used to represent the areas of the rectangles.* *3) Checks the sum formula used in the problem.* *4) Checks how the algebra is simplified in the sum.* *5) Checks that the proper index variable is used in the sum.* *6) Checks the limit as the number of rectangles approaches ∞ and look for the limit variable.*

Chemistry		
1. Student is able to conduct experiments following protocol.	*Each chemistry lab requires the student to follow a protocol, record data, and interpret the results.*	*Student lab procedures are appropriate according to the protocol of the experiment and the safety protocol of all laboratory experiments. Student lab reports reflect correct results and thoughtful analysis of the data.*
2. Student is able to prepare geometric models of molecular compounds using simple materials. Student is able to write an interpretation and examples of compounds fitting the models.	*Lecture and lab discussing VSEPR prepares the student for the task. Student builds 3-dimensional models in class.*	*Accuracy of angles in the modes and written text giving examples and interpretations are used to assess.*
Physics		
1. Student explains in writing the method of determining the slope of an inclined plane.	*Student:* *1) Selects a trigonometric function of the angle of elevation.* *2) Makes the necessary measurements to compute the value of the angle.* *3) Describes in writing reasons for selecting that trigonometric function and how it determines the angle of elevation.*	*Student must:* *1) Check the trigonometric calculations for accuracy with the experiment's apparatus.* *2) Check their work for a set of clear, logical sequence of steps from the original measurements to the final determination of the angle.* *3) Check the numerical calculation for accuracy and appropriate units of measure.*
Programming with C		
1. Student is able to determine output of C from visual inspection (reading) source code.	*Students are given handouts and discuss/work in groups to determine program output.*	*Given a source code, a student can correctly determine the program's output. (Tested on Exam)*

Objective 3

Graduates of the Engineering Program at MCC should be able to
design a system, component, or process to meet desired needs.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry	*N/A*	
Physics	*N/A*	
Programming with C		
1. Student is able to create a C program that meets the given criteria.	*Student writes a program that utilizes arrays. Student stores his/her grades in an array and directs the program to calculate the semester average.*	*Student programs must:* *1) Follow directions* *2) Demonstrate proper programming syntax and logic* *3) Produce a cleanly compiled C program.*
Intro to Engineering Design		
1. Student is able to design objects using appropriate applications of non-permanent fasteners.	*Given a rotating shaft with multiple applications, student determines types of fasteners, their specifications and locations, and makes drawings.*	*Student drawings must reflect appropriate data from the industrial handbook charts and drawing is to specifications in the tables.*

Objective 4

Graduates of the Engineering Program at MCC should be able to
function on multi-disciplinary teams.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry	*N/A*	
Physics	*N/A*	
Programming with C		
1. Student is able to collaborate with others (CS majors, Eng. Transfer majors, and LA majors) in the class to produce a C program that uses repetition.	*Student is required to identify the correct repetition to use with a specific problem and in a group, produce the code to solve the problem.*	*Each group produces a cleanly compiled C program that demonstrates proper syntax and logic.*
Technology and Society	*N/A*	
Intro to Engineering Design		
Proposed Objective - *1. Students work as individuals in a group to produce a team project.*	*Proposed Activity –* *The sum of the individual and interdependent assignments would come together as one unified project. Each person would have an essential role in the design and the creation of the final project.*	*Proposed Assessment –* *To be determined.*

Objective 5

Graduates of the Engineering Program at MCC should be able to
identify, formulate, and solve engineering problems.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry	*N/A*	
Physics	*N/A*	
Programming with C	*N/A*	
Technology and Society	*N/A*	
Intro to Engineering Design		
1. Student is able to design/draw with understanding of machining arts and processes.	*Student uses AutoCAD v.14: command structure to assess dimensions, areas, and sizing.*	*Student work is checked against dimensioning practices.*
2. Student is able to determine appropriate material, material properties, and machining processes to create desired objects.	*Given an object and reference data/charts, the student determines the type of steel needed.*	*Student presents his/her choice of steel to the class and defends his/her choice by answering questions from peers.*
3. Given design constraints, student is able to select materials for fabrication.	*Student determines the optimum materials for objects such as gears and shafts.*	*Student explains his/her choice using supportive data and analysis.*

Objective 6

Graduates of the Engineering Program at MCC should be
professionally and ethically responsible.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry	*N/A*	
Physics	*N/A*	
Programming with C		
1. Student has an ethical responsibility to produce a unique program.	*Class discussion regarding programming projects focuses on the difference between giving assistance and giving answers to classmates.*	*Each student produces a unique cleanly compiled program that demonstrates proper programming syntax and logic.*
Technology and Society		
1. Student understands the role codes of ethics play in professional organizations	*Student does readings that describe and explain the role codes of ethics play in professional organizations.*	*Student can describe and explain the role codes of ethics play in professional organizations.*

2. Student understands the role of personal conscience and accepted professional practice in work situations.	*Student does readings that describe and explain the role of personal conscience and accepted professional practice in work situations.*	*Student can describe and explain the role of personal conscience and accepted professional practice in work situations.*
3. Student understands the rokle of professional standards in responding to situations where safety and risk are issues (e.g. air and water pollution).	*Student does readings that describe and explain the role of professional standards in responding to situations where safety and risk are issues (e.g. air and water pollution).*	*Student can describe and explain the role of professional standards in responding to situations where safety and risk are issues (e.g. air and water pollution).*
4. Student understands the social, political, economic, and environmental impact of engineering decisions.	*Student does readings that describe and explain the social, political, economic, and environmental impact of engineering decisions.*	*Student can describe and explain the social, political, economic, and environmental impact of engineering decisions.*
5. Student understands the major ethical issues enountered in the patent system and the diffusion of technology (including intellectual property rights).	*Student does readings describing and explaining the major ethical issues encountered in the patent system and the diffusion of technology (including intellectual property rights).*	*Student can describe and explain the major ethical issues encountered in the patent system and the diffusion of technology (including intellectual property rights).*
6. Student understands the major ethical issues encountered in doing research, e.g. ommitting data, taking unauthorized credit for authorship.	*Student does readings that describe and explain the major ethical issues encountered in doing research, e.g. omitting data, taking unauthorized credit for authorship*	*Student can describe and explain the major ethical issues encountered in doing research, e.g. omitting data, taking unauthorized credit for authorship.*
Intro to Engineering Design	*N/A*	

Objective 7

Graduates of the Engineering Program at MCC should be able to
communicate effectively.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus and Calculus		
1. Student is able to explain mathematical concepts using appropriate mathematical vocabulary.	*Student must explain his/her answer to a problem, the process of solving that problem, and the procedure for using the graphing calculator to determine if the answer is correct or incorrect.*	*Student is asked to explain mathematical concepts on graphing calculator assignments and on tests. Student also explains the method of solution.*
Chemistry		
1. Student is able to clearly describe procedures and results of laboratory experiments and draw conclusions based on the data.	*Student prepares a written report for each laboratory experiment.*	*Student reports are clear and organized. Grammatical usage and spelling are correct.*
2. Student is able to write several 1-2 page essays describing a chemical element and its compounds.	*Student chooses an element and describes how each chapter applies to that element and to its compounds.*	*Student essays are clear and organized. Correct grammar and spelling is apparent.*
3. Student is able to describe the scale-up of a commercial chemical process and the societal impact of the process.	*Student writes a 4-5 page paper describing the technical detail of a chosen process and its impact on society.*	*Student paperss are clear and organized. Detail of the process must be clearly stated. Correct grammar and spelling is apparent.*
4. Student is able to research the history of science discoveries and write and essay describing their research.	*Student writes a 4-5 page paper on how several scientists who worked together to develop quantum theory interacted.*	*Student papers are clear and organized. Correct grammar and spelling is apparent.*
Physics		
1. Student is able to clearly describe procedures and results of laboratory experiments and draw conclusions based on the data.	*Student prepares a written report for each laboratory experiment.*	*Student reports are accurate, clear, and organized. Grammatical usage and spelling are correct.*

Programming with C		
1. Student is able to describe the process of writing their programming project.	*For all programming projects, the student states the purpose of the program, the time spent creating the program, and the aspect of the project they found most difficult.*	*Student can clearly describe the purpose, time spent, and difficult aspect.*
Technology and Society		
1. Student is able to describe and explain the impact of technology on today's society.	*Student participates in class discussions, writes journal entries, and writes explanations via essays and exams.*	*Student writing contains a topic and supporting statements. The writing is clear and organized with correct grammar usage and spelling.*
Intro to Engineering Design		
1. Student is able to use terminology and nomenclature esoteric to the engineering fields.	*Student is immersed throughout the semester using engineering terminology to communicate.*	*Portfolio drawings that require the application of ANSI requirements.*
2. Student is able to communicate dimensions in English and metric systems.	*Student is given a dimension drawing in one system and must replicate that drawing in the opposite system.*	*Student's drawings are cross-checked for accuracy.*

Objective 8

Graduates of the Engineering Program at MCC should be able to
discuss the impact of engineering solutions in a global and societal context.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry		
1. Student is able to describe the scale-up of a commercial chemical process and the societal impact of the process.	*Student writes a 4-5 page paper describing the technical detail of a chosen process and its impact on society.*	*Student essays are clear and organized. Detail of the process must be clearly stated. The impact of the process on society must be described in detail.*
Physics	*N/A*	
Programming with C		
1. Student is able to define character storage sizes and understand the limitations of the C programming language in a global environment.	*Student is questioned as to why with the development of the Web, the requirements for storage of character data from 1 byte (255 characters) to 2 bytes. Different speaking languages require more characters.*	*During in class discussions, student describes the need for accommodating more characters because of the global nature of the Web. English is no longer the only language a programmer in the U.S. needs to consider.*

Technology and Society		
1. Student understands the major arguments for and against technological change.	*Student does readings that describe and explain major arguments for and against technological change.*	*Student can describe and explain the major arguments for and against technological change.*
2. Student understands the social context of technological development and change (e.g. the ways technology changes human values).	*Student does readings that describe and explain the social context of technological development and change (e.g. the ways technology changes human values).*	*Student can describe and explain the social context of technological development and change (e.g. the ways technology changes human values).*
3. Student understands the global context of technological development and change (e.g. the way communications technology changes human values worldwide).	*Student does readings that describe and explain the global context of technological development and change (e.g. the way communications technology changes human values worldwide).*	*Student can describe and explain the global context of technological development and change (e.g. the way communications technology changes human values worldwide).*
4. Student understands the economic context of technological development and change (e.g. the way economic demand stimulates research).	*Student does readings that describe and explain the economic context of technological development and change (e.g. the way economic demand stimulates research).*	*Student can describe and explain the economic context of technological development and change (e.g. the way economic demand stimulates research).*
5. Student understands the economic context of Technological development and change (e.g. the impact of automated technologies on the workplace).	*Student does readings that describe and explain the work and employment context of technological development and change (e.g. the impact of automated technologies on the workplace).*	*Student can describe and explain the work and employment context of technological development and change (e.g. the impact of automated technologies on the workplace).*
6. Student understands the political context of technological development and change (e.g. the role of government regulation in controlling technologies).	*Student does readings that describe and explain the political context of technological development and change (e.g. the role of government regulation in controlling technologies).*	*Student can describe and explain the political context of technological development and change (e.g. the role of government regulation in controlling technologies).*
7. Student understands technology transfer and the global impact of technological development and change (e.g. the ways technology is	*Student does readings that describe and explain technology transfer and the global impact of technological development and change (e.g.*	*Student can describe and explain technology transfer and the global impact of technological development and change (e.g. the ways*

modified when it is introduced into a new social and cultural environment	*the ways technology is modified when it is introduced into a new social and cultural environment).*	*technology is modified when it is introduced into a new social and cultural environment).*
Intro to Engineering Design	*N/A*	

Objective 9

Graduates of the Engineering Program at MCC should ***recognize the need for and engage in life-long learning****.*

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus		
1. Student is able to use the graphing calculator as a tool of today's technology.	*Graphing calculators are required in Intermediate Algebra, the Precalculus courses, and Calculus. Student must master many calculator functions that will prepare him/her to use the tools of technology of the future.*	*All tests and graphing calculator assignments require the student to demonstrate proficiency with the graphing calculator.*
2. Student is able to explain processes and to make connections between different topics and different courses.	*Tests and graphing calculator assignments require the student to recall and use previously learned material in new settings. Student is required to demonstrate that they can be independent learners and that he/she must assume responsibility for his/her own progress.*	*Student is given models on tests and on graphing calculator assignments from different disciplines. Student must solve the application problems correctly and explain his/her results.*
3. Student is able to identify patterns and threads which cross chapter and discipline lines.	*Student is required to apply mathematical functions to model information from science, business, social science, health, and economics.*	*Student is given models on tests and on graphing calculator assignments from different disciplines. Student must solve the application problems correctly and explain his/her results.*

Calculus	*N/A*	
Chemistry	*N/A*	
Physics	*N/A*	
Programming with C		
1. Student is able to recognize the need to remain current in their knowledge of programming languages.	*Discussion focuses on the programming of ten years ago is not the programming that is used today, nor is it likely that programming today will be used in ten years.*	*Student can discuss in class and on exams the need to remain current in a profession that keeps pace with rapidly changing technology.*
Technology and Society	*N/A*	
Intro to Engineering Design	*N/A*	

Objective 10

Graduates of the Engineering Program at MCC should be able to
recognize and discuss contemporary issues*.*

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***
Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry	*N/A*	
Physics	*N/A*	
Programming with C	*N/A*	
Technology and Society	*N/A*	
Intro to Engineering Design	*N/A*	

Objective 11

Graduates of the Engineering Program at MCC should be able to ***use the techniques, skills, and modern engineering tools necessary for engineering practice***.

Student Outcomes/ Competencies	***Strategies for Attainment***	***Assessment Criteria and Methods***

Precalculus	*N/A*	
Calculus	*N/A*	
Chemistry		
1. Student is able to retrieve and interpret specific data holding chemical interest from the Handbook of Physics and Chemistry (CRC).	*Use of question and answer during lecture enables the student to identify the questions students need to research and interpret in the Handbook. The Handbook is used many times during the lab sessions.*	*Student delivers a well-written account of their findings. Next year, the student will also add graphical interpretation of these data, using computer skills.*
Physics		
1. Student is able to gather data using a computer for on line measurement and data analysis.	*Using Pasco software, the student uses the computer to take data, to perform calculations, and to present the results in graphical or tabular form.*	*Student product is a lab report that includes print-outs of the computer generated data, analysis of the data, and summary and conclusions of the experiment. Student calculations must be consistent with the data and answers must be expressed in appropriate units.*
2. Student is able to use tools such as a calculator and computer for daily class activities and lab reports.	*Students must use graphing calculators for daily class problem sets and in laboratory experiments. Lab reports are word-processed on a computer.*	*Student work must show calculations to appropriate accuracy and lab reports are accurate and follow the guidelines set for the course.*
Programming with C		
1. Student is able to program with the C programming language.	*Student spends a semester learning variable types, storage requirements, decision structures, repetition loops, modules, pointers, arrays, files, and structs.*	*Student programs must:* *1) Follow directions* *2) Demonstrate proper programming syntax and logic* *3) Produce a cleanly compiled C program.*
Technology and Society	*N/A*	
Intro to Engineering Design		
1. Student is able to read blueprints developed to ANSI standards.	*Student must extrapolate information and correct/adjust data to complete the drawings.*	*Student use worksheets that require research from engineering data sheets and resources.*
2. Student is able to use skills to develop electronic schematics.	*Student must create breadboard schematics.*	*Schematics use correct wiring and symbols.*

3. Student is able to develop a printed circuit board from an electronic schematic.	*Student must draw in Power Logic software, export to power PCB software, design the circuit board, and place the components on the PCB board.*	*Student develops a simple PC board from a schematic transferred from Power Logic.*
4. Student is able to develop drawings with CAD/CAM methods.	*Student must use Cartesian coordinates to dimension drawings compatible with machining processes.*	*Tolerances must reflect the limitations of parameters of machining processes.*
5. Student is able to apply CAD software commands in 2-dimensional drawing.	*Student uses AutoCAD R14 menus and commands to draw mechanical objects.*	*Student produces drawings of "portfolio-quality".*

12. Is there a desire to introduce any new or revised student outcomes for this program? Please specify.

There is a desire to modify the program.

Current research indicates that engineering education is undergoing radical changes. Documents, such as Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology by the Advisory Committee to the National Science Foundation, report that many programs have made impressive modifications. These are only a few chosen from many that were cited:

- *Incorporating new knowledge into lower level courses more rapidly and more thoroughly;*
- *Focusing on processes at least as much as on the transmission of facts;*
- *Ensuring that students have frequent access to active learning experiences, in class and outside of class;*
- *Improving ancillary skills (communication, teamwork, respect for ideas of others, cognitive skills, etc.) as a critical byproduct of modern approaches to teaching and learning;*
- *Ensuring that students have ready access to people who can provide them with reasonable assistance;*
- *Demonstrating respect for students' genuine efforts to learn, understanding that many learn through initial failures, and encouraging further efforts to learn;*
- *Mentoring students, when this is possible; and*
- *Devoting more energy to advising students about course selections and career options. (Shaping the Future, pp. 17-18)*

Proposed New or Revised Student Outcomes or Competencies For the MCC LAES Program	**Strategies for Attainment**	**Assessment Criteria**
Oral Communication		
Technical Writing		
Interviewing Skills		
Engineering Applications and Projects		
Workplace Skills and Behaviors		
Interdisciplinary Opportunities		

13. At present which courses within this program meet the following **core curriculum intensive value requirements** (please use specific course title where they can be identified)?

1. Multicultural Perspective
   There are two SO and one HU Electives in the program where students must select one that satisfies the Multicultural Perspective Intensive.

2. Global Understanding
   There are two SO and one HU Electives in the program where students must select one that satisfies the Global Understanding Intensive.

3. Written Communication
   SC 3133 – Inorganic Chemistry I
   ****SC 3134 – Inorganic Chemistry II is being proposed to satisfy the Writing Intensive as well.*

4. Computer Literacy
   MA 2300 – Programming I with C/C++

5. Values, Ethics, or Social Policy
   There are two SO and one HU Electives in the program where students must select one that satisfies the Values, Ethics, or Social Policy Intensive.
   ****HU 5127 – Technology and Society – is being proposed to satisfy this intensive. (12/98)*

6. Impact of Technology, Environmental Issues, or Health
   HU 5127 – Technology and Society

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

There are no interdisciplinary courses at this time. However, current research by the National Science Foundation indicates that this is an area that should be developed.. <u>Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology</u>, reports that "… an impressive number of curricular and pedagogical improvements in undergraduate SME&T education (has occurred) in recent years." They cite: " … developing curricula that expose students to key interdisciplinary connections, and multidisciplinary perspectives stressing concepts as much as facts…" (<u>Shaping The Future</u>, p.17)

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.

There are no work based learning opportunities for the program.
One recommendation of this program review is to include seminars for students to bring in the business and industry people and job shadowing to get the students out into the businesses.
Another recommendation is to integrate workplace behaviors and skills into existing courses. (Communication, teamwork, leadership, problem solving, technology, etc.)

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?

The courses we have are for the most part satisfactory. Engineering applications are missing from the courses. This is apparent when reading the itemization of curricula in Section II.11. The instructors are willing to infuse engineering applications but need examples that are entry level engineering. Since no one has an engineering background, that is a difficult task. The need for professional development is obvious. That will be discussed further in question #23 and in section III.

Noting what the other colleges (2 and 4 year) have for engineering and what is expected from ABET and <u>Shaping the Future</u>, it is clear that Middlesex is lacking in a few areas.

- *Engineering students should be required to take a course in Oral Communication or oral presentation should be a considerable component of the courses they do take. Interviewing skills would be a possible topic for the course.*
- *Engineering students should be required to take a Technical Writing course or technical writing should have considerable emphasis in the courses that they do take.*
- *The Engineering students at Middlesex are not "experiencing" engineering or learning about the fields of engineering. A course where several seminars are organized would be of benefit. Students and faculty would hear from engineers about engineering work and engineering opportunities. Assignments that involved research about the kind of engineering the speaker represented and about the*

company the speaker represents would be great assignments. The end result of this would be students and faculty who know about engineering. As an aside, videotaping these seminars would provide a library of experiences in engineering.

- *Engineering students should have opportunities to job shadow engineers.*
- *The advisory board members may be the beginning of partnerships that would include job shadowing for students.*
- *Workplace behaviors and skills should be integrated into the curriculum. (Things like communication, working in teams, leadership, problem solving, technology, etc.)*

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?

Students in this program often need developmental courses and then require a great deal of time to complete the program. This is particularly true because of the math requirements. That is the purpose of having this program, to allow access to students who for one reason or another would not have been able to begin course work at a 4-year institution or to pursue a career in engineering.

The table below is illustrating the number of new students each fall semester who tested into developmental courses in English, Reading, and Math.
(See Appendix A)

	Fall 1991	*Fall 1992*	*Fall 1993*	*Fall 1994*	*Fall 1995*	*Fall 1996*	*Fall 1997*	*Fall 1998*
Total New Admits	*27*	*22*	*30*	*26*	*22*	*15*	*20*	*33*
EN 1101	*5*	*7*	*6*	*7*	*7*	*6*	*6*	*15*
EN 1102	*0*	*1*	*0*	*0*	*0*	*0*	*0*	*0*
EN 2120	*0*	*1*	*1*	*1*	*0*	*0*	*1*	*1*
EN 2121	*0*	*1*	*2*	*1*	*0*	*1*	*3*	*5*
EN 2131	*0*	*0*	*0*	*0*	*3*	*2*	*2*	*9*
MA 1101	*2*	*1*	*4*	*1*	*1*	*1*	*4*	*6*
MA 1103	*4*	*8*	*6*	*5*	*6*	*5*	*4*	*7*
MA 1104	*7*	*4*	*7*	*3*	*2*	*3*	*3*	*8*

In 1991-1994, the college admitted 105 Engineering Science majors. The data show that 9 students who were admitted into LAES between 1991 and 1994 placed into MA 1101 and 23 students placed into MA 1103. Of these none of the students placing into MA 1101 and only 4 of those placing into MA 1103 had graduated by June of 1998. (See next chart) Thus any student who initially places into developmental math has little likelihood of completing Engineering.

GRADUATION DATA

The data that follows was extracted from the transcripts of students who were listed on the graduation programs from 1993-1998. There were a total of 39 transcripts, 35 of those students did graduate.
The questions that we wanted answered were:

1. *What was the first math class taken at MCC by these students?*
2. *How many of these students placed below EN 1103 – English Composition?*

Course	1993	1994	1995	1996	1997	1998
MA 1103	0	0	0	2	1	1**
MA 1104	0	0	0	0	0	0
MA 1106	0	1	1+1***	0	0	1
MA 1108	1	0	5	1	0	1
MA 1110	1	1	0	0	1	1*
MA 1125	1	2	5	0	1	1
MA 1126	0	0	0	2	0	0
>MA 1126	2	2	1	1	0	1
EN 1101	0	0	1***	0	0	1*
ES 1104	0	0	0	0	0	1**
N = 39	5	6	13	6	3	6
Graduated	5	6	10	6	2	6

*, **, *** These symbols indicate that the student was in the math AND English course.

The table shows that 3 students who graduated from LAES began with Algebra I, 4 with Intermediate Algebra, and all others at Precalculus and above. Seven students transferred to MCC having already taken Calculus II, therefore taking no math at MCC. Three students did not test into a minimum level of English Composition.

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

This program review has prompted us to examine the content and pedagogy of first year courses at 4-year schools to see if the Introduction to Engineering (EG 1101) course and the C (MA2300) programming course are similar to first year courses at the 4-year schools. Below is a summary of the findings. Syllabi for the courses and schools mentioned are in Appendix F.

HISTORY –
When the Engineering articulation agreement was signed with UMass-Lowell, the UMass-Lowell freshman year curriculum had a two credit course in engineering graphics in the first semester and a three credit course in engineering programming (FORTRAN) in the second semester. Our curriculum structure matched theirs.

UMASS-LOWELL –
The UMass-Lowell program has changed. The first semester course (25.107) appears to be a basic computer skills course that includes a lot of different computer applications used in engineering. The students spend a week on CADKEY, three weeks on FORTRAN, two weeks on Visual Basic, and one week on Word and Excel. The second course called Introduction to Engineering II (25.108) separates the students by engineering discipline and has them work in teams to design and build real objects.

UMASS-AMHERST –
The Introduction to Engineering (EN113) course at UMass-Amherst includes: lectures, computer lab assignments in AutoCAD and Excel, design and redesign project, group dynamics, and oral presentations. For the project, the student chooses an object, creates the design and parts list, describes the assembly process, and suggests a redesign to reduce assembly costs. The second course in the sequence (ENGIN 191) separates the students by engineering disciplines and is a project-oriented course involving computer languages, the use of computer applications, modeling and analysis. Students work in teams to design and build real objects.

MCC -
This past year the MCC curriculum changed. A C programming class (MA 2300) replaced the FORTRAN class. However, the C programming class is designed primarily for the Computer Science program and does not include engineering applications as a major emphasis. The C programming course could be strengthened by integrating engineering applications and by adding another computer applications course for engineers. These applications could include MathCAD, Word, Excel, and writing Visual Basic applications to Excel. Students already take Visual Basic as a prerequisite for the C programming class, so this

new course would be taken at the end of that sequence. There currently is no instructor at the college qualified to teach such a class.

The engineering design course (EG 1101) now has two threads: the first is the manufacturing processes and the engineering design process and the second is a solid introduction to design software such as AutoCAD, PowerLOGIC, and PowerPCB. The course is not now modeled after the project-based courses of UMass-Lowell and UMass-Amherst. Emphasis on projects that integrate software, design, marketing, and presentation is the pedagogy recommended by ABET, Shaping the Future, and From Analysis to Action. It would be beneficial for the faculty of EG 1101 to partner with UMass-Lowell faculty and to observe Introduction to Engineering classes at UMass-Lowell

19. Describe any **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.

MA 1108, MA 1110 Precalculus I and II –
Graphing calculator projects are assigned. These projects are opportunities for the students to convey their understanding of concepts and to communicate that breadth of knowledge to the instructor. Very often a student who is unable to perform as well as he/she would like to in a standard testing situation can produce a quality project when given more time to consider his/her responses. These assignments pull together several concepts and for a more unified whole, the "bigger picture." These projects require the students to solve problems graphically and/or numerically. Students frequently remark how the projects helped them to "pull the concepts together."

MA 1125, MA 1126 Calculus I and II –
Graphing calculator projects are assigned. During class, some exploration using the graphing calculators is done in groups. Students must also work on these independently outside of class. They use the features of the graphing calculators to examine complex problems. The projects also allow the students to approach and solve the problems in three ways, graphically, numerically, and analytically.

MA 2300 Programming with C –
Engineering students need to learn to program so they can use the computer as a problem-solving tool. Students are required to write computer programs that perform certain mathematical calculations. For example, students may have to write a program that calculates averages or a program that converts Celsius to Fahrenheit temperatures. The projects are graded as follows: 25% of the grade is following directions (Does the program do what it is supposed to do?), 25% of the grade is the programming style (Is the program efficient by programming standards?), and 50% of the grade is based on the program executing properly.

SC 3201, SC 3202 Physics I and II for Engineering Science –
Students use computers and Pasco software and equipment to gather data during their labs. Although the experiments are similar to those in previous years, the difference is the on-line data gathering. The data is more accurate than hand recorded data. Students are assessed on their analysis of the data. Students must explain what their results mean and what events may have prevented them from achieving the ideal results.

SC 3133, SC 3134 Inorganic Chemistry I and II –
Writing assignments have been infused into Inorganic Chemistry since fall of 1997. The laboratory sessions include construction of spatially correctly arranged models of unit cells of crystals. Certain structures of molecules can be visualized in this fashion using play-clay and wooden skewers of various lengths. More computer-based labs are intended for spring of 1999.
Students choose their element the first day of class. Students use information collected from the internet, library, and the Handbook for Physics and Chemistry (CRC) to prepare a well composed essay about their element.
Then with each new topic, students investigate newly presented material in a chapter by using their chosen element as a reference substance. The students use their element as a reference substance and put it through the paces of a chemical reaction. They must write an equation for the reaction and identify the correct classification.
Infusions of various themes into the body of Chemistry vary according to the chapter contents. Technology, Ecology, Geology, and Mineralogy often present themselves through chemical processes.

HU 5127 Technology and Society –
Students are required to keep a journal. The criteria for grading the journals includes that students submit a journal of at least 10 pages in quantity, that there be comments on a minimum of four readings/chapters, that students express opinions and support those opinions with sound statements. Students are penalized in grade for merely recapping the article. They must state opinions and offer justifications for their opinions. The journals must be submitted in a timely manner. (See Appendix G)

EG 1101 Introduction to Engineering Design –
A portfolio is required of each student in the class. The portfolio is intended to accomplish several goals: to document the continuum of new learning in successive projects, to instill pride in student achievements, to display competency in various software packages used in engineering, and to encourage students to strive beyond minimal standards by including special interest work. The criteria for grading are: the completeness of the portfolio, that is, all of the assignments are present, the projects complement the lectures, projects demonstrate that students have followed directions, and students have followed ANSI presentation techniques in their work.

Instructional Support

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

    Staffing level to teach the courses in the program is adequate. However advising is inadequate. There is no faculty coordinator for the program and no person to give the students the individual attention and guidance. Few faculty advisors understand the engineering program. Currently, Dean Werner advises many of the students and this has an up side and a down side for the students. Dean Werner, who has an Engineering Physics degree, has first-hand knowledge of the rigors of engineering and advises the students during the advising period but he is not available as a mentor and confidante of the students during the semester. Dr. Werner's administrative schedule often makes him unavailable for these advisees. For that reason, we feel a faculty coordinator would be a tremendous benefit for the students in the program.

21. 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).

    There is tutoring available for the students in Math, Chemistry, and Physics. The program relies on general college support services. These services are an absolute necessity for these students. To date, students in the program find the services adequate and helpful. The labs have always arranged tutor schedules to fit the needs of the students.

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

    Program facilities in the form of drafting, CAD, and the science labs are quite adequate and up to date with the latest computer facilities and equipment.

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

    Faculty lack the engineering background to recognize and integrate engineering applications into their courses. Faculty lack the expertise to integrate the "soft skills" of the workplace.

Faculty need professional development in the areas of:

How can the faculty of EG1101 integrate manufacturing and design in a manner that is project-based and includes marketing analysis and presentation skills?
What are the engineering applications in the courses they teach?
How do they integrate these applications in their courses when the class is comprised of more than just engineering students?
How do they connect their courses to other courses?
How can the faculty connect with one another to provide multi-disciplinary projects?
What types of projects are appropriate for the engineering courses?
How do they integrate the workplace behaviors and skills in their courses?

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

    There is no specific budget for the LAES program. Money is provided to the various departments as requests arise. There is no reason to suggest any change in the current system of allocation of funds to the LAES program.

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

    - *A coordinator for the LAES program*
    - *Speakers from the industry or four-year engineering schools*
    - *Attendance at conferences for faculty*
    - *Professional development for faculty for all of the items listed in #23*
    - *Mechanism for coordinating courses in the program*

Additional Questions

Please list and address any **additional questions** that you consider important in assessing this program.

Section III: 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 **Section II.**

A. Major Program Strengths

- *Faculty who are expert in their fields.*
- *Students are able to finish the program and transfer. (Section I.2)*
- *Program is efficient in that it does not provide for second year of curriculum which would require small classes and articulation difficulties. (Section II.4)*
- *Laboratory equipment and computer facilities are up to date. (Section II.22)*

B. Program Weaknesses or Needs for Improvement

- *Lack of a faculty coordinator.*
- *There is no advisory board. (Section II.7)*
- *Needs professional development to help faculty see what is required of an engineer and see best practices of education in their disciplines as it relates to engineering education. (Section II.11 and 23)*
- *Needs professional development to see how to connect courses. (Section II.23)*
- *The faculty in this program need to connect with one another. (Section II.23)*
- *EG 1101 does not resemble a project-based first year engineering course at a 4 year school as defined by the ABET standards and <u>Shaping the Future</u>. (Section II.18)*
- *Other than EG 1101, there are no courses solely for engineering students so courses cannot be tailored for only the engineering students. (Section II.16)*
- *There are no interdisciplinary opportunities within the program. (Section II.14)*
- *Students do not "experience" Engineering at MCC. (Section II..18)*
- *It is not made clear to evening students that the required Calculus, Chemistry, and Physics courses are only available in the day sessions.*
- *Students who place into MA 1101 or MA 1103 are not given a realistic view of their chances of completion. (Section II.17)*
- *The student schedule lacks: (Section II.16)*
  Oral communication
  Technical Writing
  Interview Skills

Engineering Seminars (speakers, follow-up discussions, researching the companies, job shadowing)
Workplace skills and behaviors
Engineering Projects

C. Plans for improving or correcting identified weaknesses

- *A faculty coordinator would have the following responsibilities:*
    - ❖ *connect and advise the engineering students*
    - ❖ *form an advisory board*
    - ❖ *convene regular meetings with the faculty and advisory board*
    - ❖ *do graduate surveys and other data collection*
    - ❖ *form partnerships with UMass-Lowell and the other community colleges to visit high schools and inform students about engineering as a career choice*
    - ❖ *arrange speakers and presentations*
    - ❖ *arrange the videotaping of the presentations*
    - ❖ *arrange visits to industry for faculty and students*
    - ❖ *monitor the changes in curriculum and pedagogy at 4-year institutions and facilitate the changes in the MCC curriculum*
    - ❖ *monitor the changes in industry that affect the MCC program and recommend changes as appropriate*
    - ❖ *create a Professional Development Plan for the engineering faculty*
    - ❖ *suggest and arrange professional development activities as needed*

- *The formation of an advisory board which met on a regular basis. (Section II.7)*
- *A Professional Development Plan specifically designed to increase faculty awareness and infusion of engineering applications. (Section II. 11 and 23)*
- *A Professional Development Plan that allows for release time for each faculty member to "sit-in" on a project-based Introduction to Engineering course, on other courses taken by engineering students, and on classes at UMass-Lowell. (Section II.23)*
- *At least one meeting per semester of the faculty who teach students in the Engineering program as well as representatives from UMass-Lowell and Northeastern University Engineering departments. (Section II.7)*
- *EG 1101 should be examined for content and pedagogy that is optimal for engineering students and complies with the ABET standards and <u>Shaping the Future</u>. (Section II.18)*

- *Faculty of EG 1101 should partner with faculty at UMass-Lowell and observe Introduction to Engineering classes at UMass-Lowell. (Section II.18)*
- *Engineering students should have opportunities to include interdisciplinary courses in their program. (Section II.14)*
- *Revise the catalog description of the program to indicate which courses are and are not available in the evening sessions.*
- *Provide initial advising to students who place into MA 1101 and MA 1103 that inform them of alternative technology programs. (Section II.17)*
- *The program requirements should integrate and include Oral Communication, Technical Writing, Interview skills, and Engineering experience. (Section II.16)(Engineering experience could be the seminars and job shadowing.)*
- *Engineering students need to "experience" engineering through project-based learning, seminars, speakers, visits to industry, job shadow, etc. (Section II.18)*
- *The computer-programming requirement should include engineering problems and applications. (Section II.16)*
- *Workplace skills and behaviors should be infused into courses in the program, stated as course objectives with supporting activities and assessment techniques that measure competency in these areas. (Section II.16)*
- *The course HU 5127 Technology and Society should be considered for the Ethics and Social Policy Intensive. Julien Farland has agreed that this is a possibility for the course, but that some course content restructuring would need to occur. (Section II.13)*