AC 2007-2252: MECHANICAL ENGINEERING TECHNOLOGY CURRICULUM ENHANCEMENT: A PROCESS REVIEW OF PROGRAM LEVEL CHANGE

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Mechanical Engineering Technology Curriculum Enhancement: A Process Review of Program Level Change

Abstract

The Mechanical Engineering Technology (MET) program at Montana State University (MSU) has evolved to address the needs of a diverse group of employers representing virtually all aspects of mechanical engineering technology. Although many graduates continue to obtain employment within large manufacturing organizations, the growth in the construction sector, locally and nationally, has provided additional opportunities for these graduates in the thermal sciences related field. Opportunities in heating, ventilation, and air-conditioning system design, as well as project management and systems integration are quite common and growing. Also, many graduates are gaining employment in the applied design, test, and maintenance functions within industry. Rapid changes in technology and management practices are compounding the complexity of this shift, leading employers to continuously provide recommendations and requests related to program content and desired graduate capabilities and attributes. Responsibility for program integrity and success rests with the faculty members. Supporting industry constituents, while also providing the best possible education to the student population, becomes a critical goal. Therefore, in order to effectively support the shift and diversification of employment opportunities, continuously improve the MET program, and enable the program to produce graduates capable succeeding in the future, all aspects of the current MET program were re-evaluated and substantially revised. This paper will outline the process utilized to develop and implement this enhanced MET curriculum. A brief historical perspective will be presented, as well as the methodology utilized to understand the current and future needs of program constituents (industry, students, TAC of ABET, the university, and the college of engineering). The MET program enhancement proposal, as well as matriculation of the proposed changes into the future curriculum will follow. Finally, organizational and implementation issues, as well as future assessment issues will be discussed.

Introduction

The Mechanical Engineering Technology (MET) program at Montana State University (MSU) is housed in the Mechanical and Industrial Engineering (M&IE) Department. This department includes three undergraduate programs: Industrial Engineering (IE), Mechanical Engineering (ME), and Mechanical Engineering Technology (MET). The department also offers masters degrees in Industrial and Management Engineering (I&ME) and Mechanical Engineering, as well as a Ph.D. degree in Engineering. The main goal of the MET curriculum has always been to provide a diverse, engineering applications oriented graduate capable of contributing to industry immediately upon graduation. The current program has evolved to be a traditional MET program with a strong manufacturing emphasis. Many factors have contributed to this evolution. For the first twenty years of the MET program, the employer base has been predominately manufacturing oriented. Also, the organization structure of the housing department has led to the beneficial sharing of resources, thus aligning the MET program closely with the ME program. MSU has had a TAC of ABET accredited MET program since 1974. Pre-TC2K ABET criteria provided strict requirements for accreditation, thus influencing the program greatly. Finally, expertise of the faculty in the department strongly influenced the evolution of the program. Unfortunately, the organization structure and evolution has led to some problems with program identity and ownership. The MET program used long-term adjunct professors to teach the MET courses verses tenure track professors. Consequently, our constituent base perceived a lack of leadership continuity in the program in general. Along with these internal issues, local and global economies continued to change, and thus, job opportunities for graduates were changing also. The U.S. has seen, and continues to see a decline of manufacturing employment opportunities[1]. Fortunately, other sectors of industry have seen significant growth in jobs requiring technology skills[2]. As the U.S. economy adjusts to this continuing decline, our graduates have found employment with a much more diverse cross-section of employers. Job opportunities in construction related industries, as well as mining and transportation have seen steady growth in both Montana[3] and the U.S.[1] in recent years.

The M&IE department has seen significant change in the past few years as well. In AY 2003/2004, the MET program was staffed with the equivalent of one tenured faculty member (who also acted as program coordinator), along with three full-time adjunct faculty. That tenured faculty member announced his intentions to retire at the end of academic year 2004/2005. Subsequently, this departure left the MET program without a strong leader and proponent. Fortunately, the administration at MSU recognized the need this particular program, and proposed an organization structure for the future consisting of three tenure-track faculty in MET. This organization structure was approved and a search for faculty members undertaken. The ME program also saw significant faculty changes in the past two academic years with the retirements and resignations of several long-term faculty members, resulting in the opening of three tenure-track positions in that department as well. The three MET positions, as well as the three ME positions have been filled, resulting in a new culture open to change and program improvements within the M&IE department.

The MET program remains committed to the goal of preparing graduates to immediately contribute to industry upon graduation, as well as to prepare graduates for continued success in their chosen careers. To meet this commitment, the MET program at MSU must continually evolve and improve. This paper will detail the process and outcome of a curriculum reform exercise undertaken to develop a framework for the future MET program designed to better prepare graduates for entry into the evolving job market with the required skills to succeed.

Methodology

The MET program at MSU chose to obtain accreditation under the ABET TC2K criteria in 2002. Preparation for this accreditation review included developing a Continuous Improvement (CI) plan for the MET program. This CI plan outlines the process utilized to insure that program objectives and outcomes are documented, assessed, and the program improved as necessary and applicable. In essence, it provides "An approach to continuous program improvement that asks the right questions and can provide academic administrators, faculty members, and others with the information they need to develop an appropriate, effective, and efficient academic program."[4] Figure 1 provides a schematic of the CI plan and the supported constituents of the MET program.

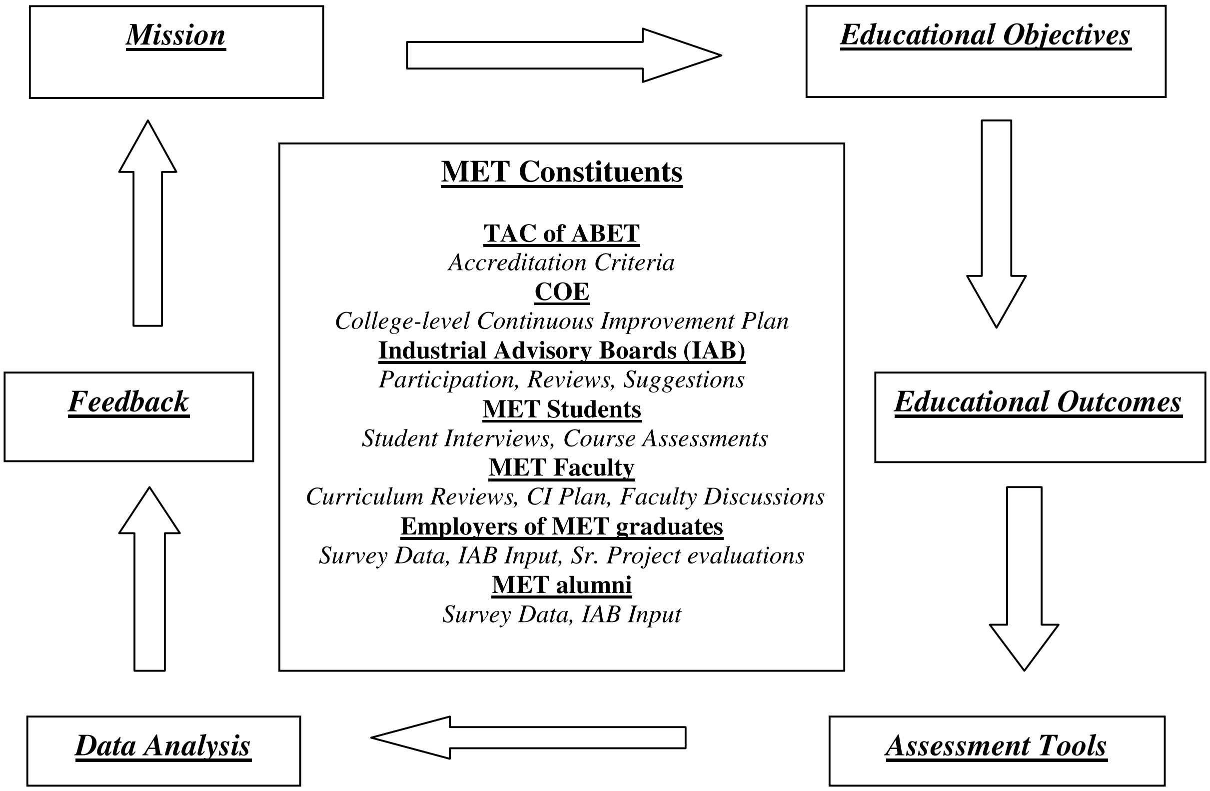

Figure 1. MET Continuous Improvement Plan Schematic

Additionally, the following principles regarding curricular design and revision are recommended by the National Academy for Academic Leadership[5]:

1. **A philosophy.** A curriculum should be founded on a carefully thought-out philosophy of education and should be clearly connected to an institution's mission statement.
2. **Clear purposes and goals.** A curricular mission statement and written curricular goals (intended student development outcomes or intended results) articulate curricular purpose – what graduates should know and be able to do and those attitudes and values a faculty believes are appropriate to well-educated men and women. These goals and their objectives are specified in considerable detail and in behavioral language that will permit assessment of their degree of achievement (the curriculum's actual outcomes).
3. **A theoretically sound process.** Student activities are chosen that are capable of developing the desired outcomes, as indicated by empirical research. Curriculum has its desired effect primarily through instruction. Therefore, the choice of course experiences and the specific quality and efficacy of these experiences in producing the stated intended outcomes for all students is fundamental to the quality of any curriculum. Current empirically based education theory is essential to effective instruction and thus the improvement of curricular quality. For example, there is little evidence that using traditional lectures will develop in students the higher-order

cognitive abilities a faculty may value. Nevertheless, lecturing is still, by far, the predominant method of instruction in most institutions today.

4. **A rational sequence.** Educational activities are carefully ordered in a developmental sequence to form a coherent curriculum based on the stated intended outcomes of both the curriculum and its constituent courses.
5. **Continuous assessment and improvement of quality.** Valid and reliable assessment is preplanned to monitor on a continuing basis the effectiveness of the curriculum in fostering student development and also the actual achievement of defined institutional and curricular outcome goals. In many or most institutions there can be said to exist two potentially quite different curricula: one, an array and sequence of courses offered by the institution and intended by the faculty to be taken and a second, the specific courses actually taken and sequence followed by each student. The intent, content, educational experience, and thus outcomes of the two may be – and, as judged from some of the current research, are – quite different from each other. Careful monitoring of actual student course-taking behavior through transcript analysis can reveal the degree to which students are experiencing the faculty's intended educational process and achieving their intended outcomes.
6. **High-quality academic advising.** An effective curriculum – one that produces the results it claims in all of a college's diverse students – depends for its success upon a high-quality program of academic advising. Modern academic advising is developmental, starting with each student's values and goals, and helps all students design curricular and noncurricular experiences that can help them achieve their own goals and the institution's intended learning outcomes.

These principles, along with our established CI plan and a renewed sense of ownership in the program, provided guidance and direction throughout our curriculum revision exercise.

Mission / Outcomes / Objectives

The mission of the college of engineering at MSU is to "serve the State of Montana and the nation by supporting student achievement, integrating learning and discovery, and developing and sharing technical expertise"[6]. The mission of the Mechanical & Industrial Engineering Department is to "serve the State of Montana, the region, and the nation by providing outstanding leadership and contributions in knowledge discovery, student learning, innovation and entrepreneurship, and service to community and profession"[7]. The mission of the Mechanical Engineering Technology program is to "prepare students for successful Mechanical Engineering Technology careers, responsible citizenship, and continued professional growth"[8]. The MET mission statement still provides an effective direction, or philosophy, and supports the college and department missions.

The MET objectives defined for MET graduates states that "Mechanical Engineering Technology Graduates employed in the field will:[8]

I. Undertake professional careers in engineering technology;
II. Employ effective communication;
III. Work in multidisciplinary professional teams;

IV. Engage in life-long learning, including post-graduate education for some graduates;
V. Contribute to industry and society, in Montana or elsewhere, including involvement in professional and other service activities;
VI. Engage in professional problem-solving activities using applied methods;
VII. Assume ethical leadership roles that contribute to the success of their organization or community; and
VIII. Advance in the profession.

The MET outcomes defined for MET graduates states that "The MET program seeks to produce graduates with a good foundation in engineering fundamentals as well as one strong in applications, design, problem recognition and resolution, project management, communication, and professional and ethical responsibility. MET graduates will:[8]

1. **Fundamentals**: *Demonstrate* math, basic science and engineering science skills necessary for proficiency in MET careers. (contributes to abet criteria a, b, f)
2. **Applications**: *Demonstrate* an ability to integrate basic theoretical, experimental, computer and manufacturing knowledge and experience to produce practical, effective and innovative solutions to problems. (contributes to abet criteria a, b, c, d, f, k)
3. **Design**: *Demonstrate* the ability to apply the engineering design process to solve open-ended problems while integrating knowledge and experience from various disciplines. (contributes to abet criteria a, b, d, e, f, g)
4. **Problem recognition and resolution**: Understand and coordinate interrelationships necessary for successful design-to-build processes, and develop and apply successful problem solving processes. (contributes to abet criteria a, b, c, f, g, h, k)
5. **Project Management**: *Demonstrate* an ability to successfully lead an integrated design team to completion. (contributes to abet criteria b, d, e, g, h, k)
6. **Communication**: Develop written, oral, and technical skills to effectively communicate with individuals having a broad range of backgrounds and experience. (contributes to abet criteria e, g, i, j)
7. **Professional and ethical responsibility**: Consider the actual or potential immediate, short-term and long-term impacts of professional activities, including social, political, economic, and environmental impacts. (contributes to abet criteria i, j)"

These objectives and outcomes continue to provide valid purpose and goals for our program. Our assessment plan details a yearly review of each, and all curricular revisions will serve to strengthen these program objectives and outcomes.

Mechanical Engineering Technology Program Assessment Tools

Assessment activity within the MET program is documented in the MET CI Plan as well. The schedule for data collection, mechanism for data collection, disposition of the collected data, and subsequent documentation and implementation is addressed for each tool. The assessment tools utilized by the MET program are:

- Department level Industrial Advisory Board

- College level Engineering Advisory Council
- MET Alumni Surveys
- MET Employer Surveys
- MET Student Interviews
- FE Exam Results
- MET Faculty Discussions
- Placement of MET Graduates
- MET Capstone Project Reviews
- ABET Reviews
- Facilities Review
- MET Course / Curriculum Reviews
- Faculty Professional Development Plan Reviews

Most of these tools are utilized yearly and the resulting data reviewed yearly as well. The analysis, feedback, and any subsequent changes made to the MET program are summarized in a set of "Assessment and Informational Notebooks" which are updated yearly and reside in the MET Program Coordinators office.

Mechanical Engineering Technology Areas of Expertise

Curricular assessment data and curriculum organization needs to balance the requirements of all constituents involved. The requirements related to ABET accreditation[9] needed to be reviewed and understood. Employer and student requests and concerns also need to be evaluated and balanced with these ABET requirements. Faculty expertise, available resources, and department directives and policies also influence the design of an effective curriculum. Within the context of these constraints, the MET faculty determined three technical areas of expertise in which to focus curriculum reform efforts. These areas are:

1. Thermal Sciences
2. Mechanical Design
3. Manufacturing Applications

In addition, the courses currently offered as part of the MET curriculum were categorized into the most appropriate expertise area prior to further evaluation. These areas build on the technical skills developed from the engineering fundamentals courses and support the current TAC of ABET criteria for Mechanical Engineering Technology programs.[9] Collectively, the engineering fundamentals, manufacturing applications, mechanical design, and thermal sciences areas formulate the technical skills of the MET program.[10] A curriculum must also effectively provide opportunities for students to develop professional skills appropriate to the program. Figure 2 shows the interrelationships and associated courses of each expertise area.

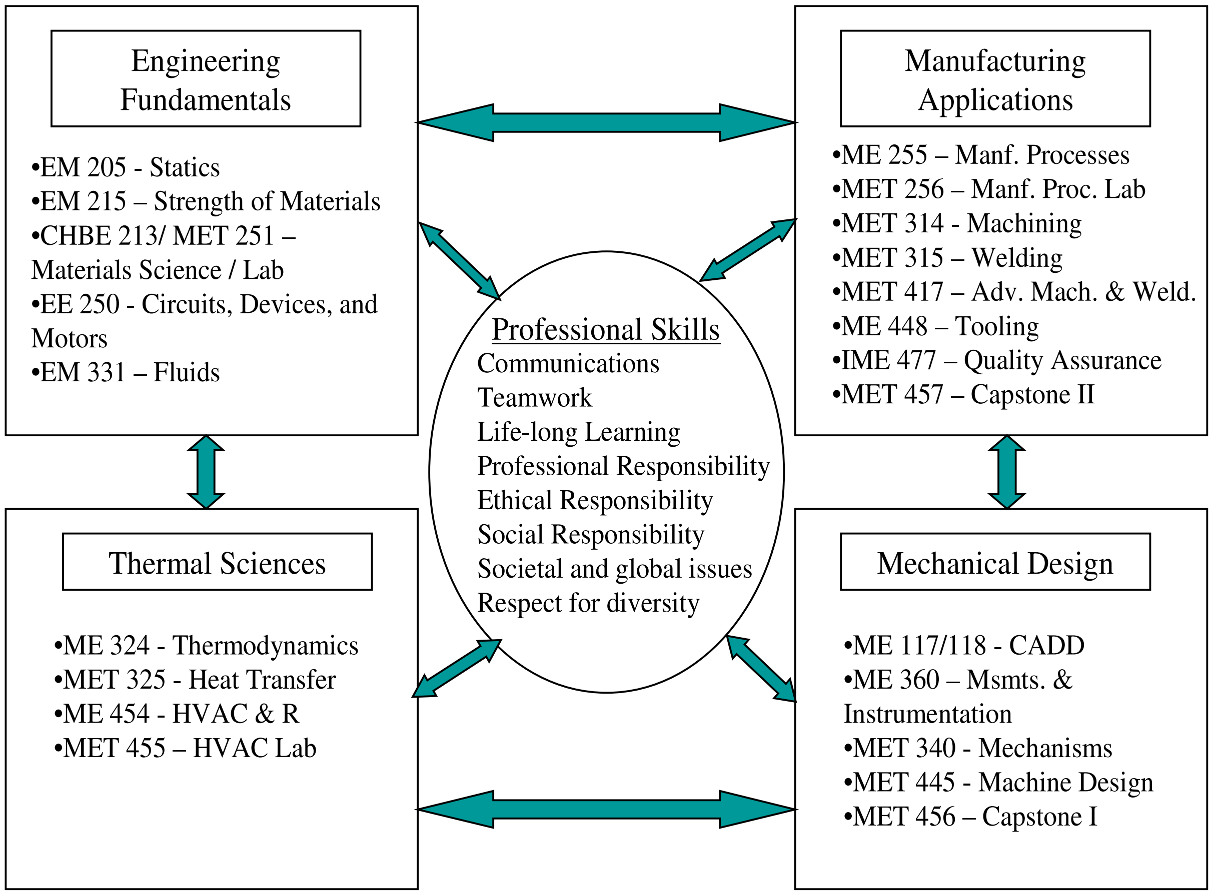

Figure 2. MET Areas of Expertise and Related Courses (Current Curriculum)

Mechanical Engineering Technology Core Competencies

To further define the required skill set of MET graduates from our program, core competencies supporting our mission, outcomes, and objectives, as well as constituent requirements were developed and documented. The core competencies related to *engineering fundamentals* appropriate to the needs of Mechanical Engineering Technology are:

1. Demonstrate proficiency in mathematics – including analytic geometry, differentiation, integration, and differential equations.
2. Demonstrate an understanding of engineering materials and their application.
3. Demonstrate an understanding of statics and dynamics and their associated applications.
4. Demonstrate an understanding of strength of materials and associated applications.
5. Demonstrate an understanding of fluid mechanics and associated applications.
6. Demonstrate an understanding electrical circuit devices and systems and associated applications.

Core competencies relating to *engineering fundamentals* appropriate to the Mechanical Engineering Technology graduate of MSU are mapped with courses that significantly contribute to those competencies in Table 1, below:

Table 1. Engineering Fundamentals core competencies mapped to current courses

Engineering Fundamentals Competency	EM 205	EM 215	CHBE 213	EM 331	EE 250
1. Demonstrate proficiency in mathematics – including analytic geometry, differentiation, Integration, and differential equations.	X	X	X	X	X
2. Demonstrate an understanding of engineering materials and their application.			X		
3. Demonstrate an understanding of statics and dynamics and their associated applications.	X	X			
4. Demonstrate an understanding of strength of materials and associated applications.		X			
5. Demonstrate an understanding of fluid mechanics and associated applications.				X	
6. 6 Demonstrate an understanding electrical circuit devices and systems and associated applications.					X

Similarly, core competencies related to *manufacturing applications, mechanical design,* and *thermal sciences* were developed and documented. Tables 2, 3, and 4 list each core competency and map current courses that contribute to each.

Table 2. Manufacturing Application core competencies mapped to current courses.

Core Manufacturing Application Competency	ME 255	MET 256	MET 314	MET 315	MET 417	ME 448	IME 477
1. Be familiar with the range of current manufacturing technologies and processes – advantages and limitations.	X	X	X	X	X	X	X
2. Understand the chemical and physical interactions that many of the various manufacturing processes have with product specification.	X	X	X	X	X		
3. Be able to utilize the knowledge of the effect on product performance and productivity of different processes and specifications, in modifying, designing, and specifying new procedures and equipment.	X	X				X	
4. Be able to properly design within manufacturing process limitations,	X					X	
5. Understand how design affects manufacturing, assembly, serviceability, and environment.	X					X	
6. Be able to specify existing, or investigate new, manufacturing procedures to solve production problems.	X		X	X	X	X	X
7. Be able to effectively communicate manufacturing procedure design according to industry standards, to production personnel.				X	X		
8. Be able to competently evaluate manufacturing processes for productive efficiency and product quality.	X	X	X	X	X	X	X
9. Have a working knowledge of current computer aided manufacturing (CAM) techniques and programs.	X				X	X	
10. Be familiar with the resources and journals available in order to maintain currency with new technology and apply new methods and techniques to processes and products in industry.					X	X	
11. Have the fundamental knowledge to design experiments on manufacturing procedures and equipment and effectively record data, then report on the results.		X	X				X
12. Understand safety issues in manufacturing.	X	X	X	X	X	X	X
13. Be able to personally utilize basic manufacturing techniques, such as welding and machining.		X	X	X	X	X	X
14. Be able to understand the issues of, and implement the management of, manufacturing process plans and changes.						X	X
15. Understand current trends in manufacturing philosophy – advantages and limitations.	X					X	X
16. Understand the interactive role that various current issues have on manufacturing such as: environmental regulation, globalization and world economies, ethics, and consumer mentality.	X		X			X	

Table 3. Mechanical Design core competencies mapped to current courses.

Core Mechanical Design Competency	ME 117	ME 118	ME 360	MET 340	MET 445	MET 456	MET 101/401
1. Understand and be able to apply the "design process" to solve any design problem posed.				X	X	X	X
2. Be able to competently utilize available design tools, including Engineering Sketches, 2-D CAD drawings, layouts, schematics, etc., 3-D Solid Models, and Computer Aided Analysis Programs to complete engineering designs.	X	X		X	X	X	
3. Be able to apply the design tools efficiently in design	X	X		X	X	X	
4. Develop an understanding of the proper of role of geometric fits and tolerances in graphical design.	X	X					
5. Develop an understanding of common engineering communication (drafting) techniques and standards (ANSI, ISO, AWS, etc), as well as Geometric Dimensioning and Tolerancing (G, D, & T) standards.	X	X				X	
6. Be able to effectively communicate design intent to all levels of production - engineering through production personnel.	X	X	X	X	X	X	
7. Understand the interaction and trade-offs between manufacturing constraints and design.	X	X				X	X
8. Understand the traditional elements of mechanical/machine design (kinematics, gears, cams, linkages, bearings, clutches, brakes, strengths, fluid power, etc) and be able to apply them in design.				X	X		
9. Understand the interdisciplinary nature of systems design.						X	X
10. Be familiar with the design resources and journals available in order to maintain currency with new technology and apply new methods and techniques to design processes and products in industry.				X	X	X	
11. Understand and be able to utilize instrumentation and measurement procedures and equipment in testing products and processes.			X				
12. Have the fundamental knowledge and ability to design experiments on products and processes, effectively record data, then report on the results.			X				
13. Understand human factor and safety issues in design.				X	X	X	X
14. Understand current trends in design philosophy.						X	X
15. Understand the importance of economics and ethics in design.						X	X
16. Demonstrate the ability to work cooperatively and interactively with others in a team environment to complete a given design project.	X	X	X	X	X	X	X

Table 4. Thermal Science core competencies mapped to current courses.

Core Thermal Science Competency	ME 324	MET 325	ME 454	MET 455
1. Understand basic principles of thermodynamics and heat transfer, and be able to apply them to heating, ventilation, air conditioning (HVAC), processing, and measurement needs.	X	X	X	X
2. Understand the applications of HVAC in building systems - including system selection, heating and cooling load calculations, component selection, and system integration.			X	X
3. Understand how to utilize the interaction and integration of the various heating, ventilation, air conditioning, and processing systems on a combined application.	X	X	X	X
4. Understand and be able to incorporate the elements (pumps, fans, compressors, heat exchangers, heaters, refrigerators, etc.) of heating, ventilation, air conditioning, and processing systems into the design of these systems.	X	X	X	X
5. Be able to apply basic controls to these systems to regulate their processes.			X	
6. Understand and be able to utilize instrumentation and measurement procedures and equipment in testing processes.		X		X
7. Have the fundamental knowledge and ability to design experiments on processes, effectively record data, then report on the results.		X		X
8. Be familiar with codes and standards in the HVAC and building industries.			X	
9. Understand safety issues in HVAC and building design.	X	X	X	X
10. Understand the importance of economics and environment in HVAC and building systems.			X	X
11. Be familiar with the resources and journals available in order to maintain currency with new technology and apply new methods and techniques in industry.			X	X

Finally, the core competencies for the professional skills were developed and documented. The core competencies related to *professional skills* appropriate to the needs of Mechanical Engineering Technology are:

1. Demonstrate ability to effectively communicate with others.
2. Demonstrate ability to work cooperatively and interactively with others in a team environment to complete a given project.
3. Develop a clear understanding of the dynamic interactions of humans in society and be able to interact constructively across societal and cultural lines.
4. Develop a clear understanding of the ethical implications of engineering issues and engineering decisions upon humanity, as well as a working knowledge of professional engineering ethical codes and responsibility.

These core competencies relating to *professional skills* appropriate to the needs of Mechanical Engineering Technology are mapped with courses that significantly contribute to those competencies in Table 5, below:

Table 5. Professional Skills core competencies mapped to current courses

Course	1. Demonstrate ability to effectively communicate with others.	2. Demonstrate ability to work cooperatively and interactively with others in a team environment to complete a given project.	3. Develop a clear understanding of the dynamic interactions of humans in society and be able to interact constructively across societal and cultural lines.	4. Develop a clear understanding of the ethical implications of engineering issues and engineering decisions upon humanity, as well as a working knowledge of professional engineering ethical codes and responsibility.
ME 117	X	X		
ME 118	X	X		
EM 205				
EM 215				
CHBE 213				
MET 251	X	X		
MET101/401	X	X	X	X
EE 250				
ME 255				
MET 256	X	X		
ME 324				X
MET 340	X	X		
MET 314	X	X		X
ME 360	X	X		
EM 331	X	X		
MET 315	X	X		
MET 325	X	X		
MET 445	X	X		X
MET 417	X	X		
ME 454	X	X		X
MET 455	X	X		
MET 456	X	X	X	X
ME 448	X			
MET 457	X	X	X	X
IME 477	X	X	X	X

These technical and professional core competency maps define both the desired skill set of an MET graduate and the current state of our MET program. What remained was to review and optimize the "rational sequence"[5] of courses designed to provide students with opportunities to effectively obtain and retain these core competencies. Consequently, a more quantitative review of the current curriculum could effectively be accomplished, and thus, improvement needs and opportunities supporting the development of core competencies within students identified and prioritized.

Identification of Improvement Opportunities

Although all assessment activities implemented as part of our CI plan contribute to the determination of improvement opportunities, individual course reviews were utilized at this stage to identify curriculum change requirements. These course reviews focused on the MET curriculum within the areas of expertise identified previously, and the process utilized is outlined in table 6.

Table 6 – MET course review process

Provide overview of current course

- Review expected outcomes of course
- Review topics currently covered
- Discuss effectiveness of course as designed (Assessment)
- Assess current teaching pedagogy of course

Review assessment data and ABET criteria interactions:

Evaluate related core competencies of course

Assess effectiveness of course

- Outcomes being met?
- Core Competencies effectively supported?

Propose and implement changes as necessary

- Develop implementation schedule
- Assign action
- Follow up and continuously improve the course

As the expected outcomes of each course were reviewed, the current curriculum course topics were documented. These topics generated our "Body of Knowledge"[10], thus describing what is currently being taught within the program. The teaching pedagogy associated with each course was also discussed and compared to effective practices utilized within other engineering programs.[11,12] ABET criteria interactions with each course, as well as any applicable assessment data was also reviewed. Finally, the effectiveness of each course was evaluated. Course outcomes and core competencies were reviewed in relation to the current course topics to assess appropriate coverage. Wherever coverage was deemed inappropriate, specific remedial action was assigned. Figure 3 recaps the process utilized for course review.

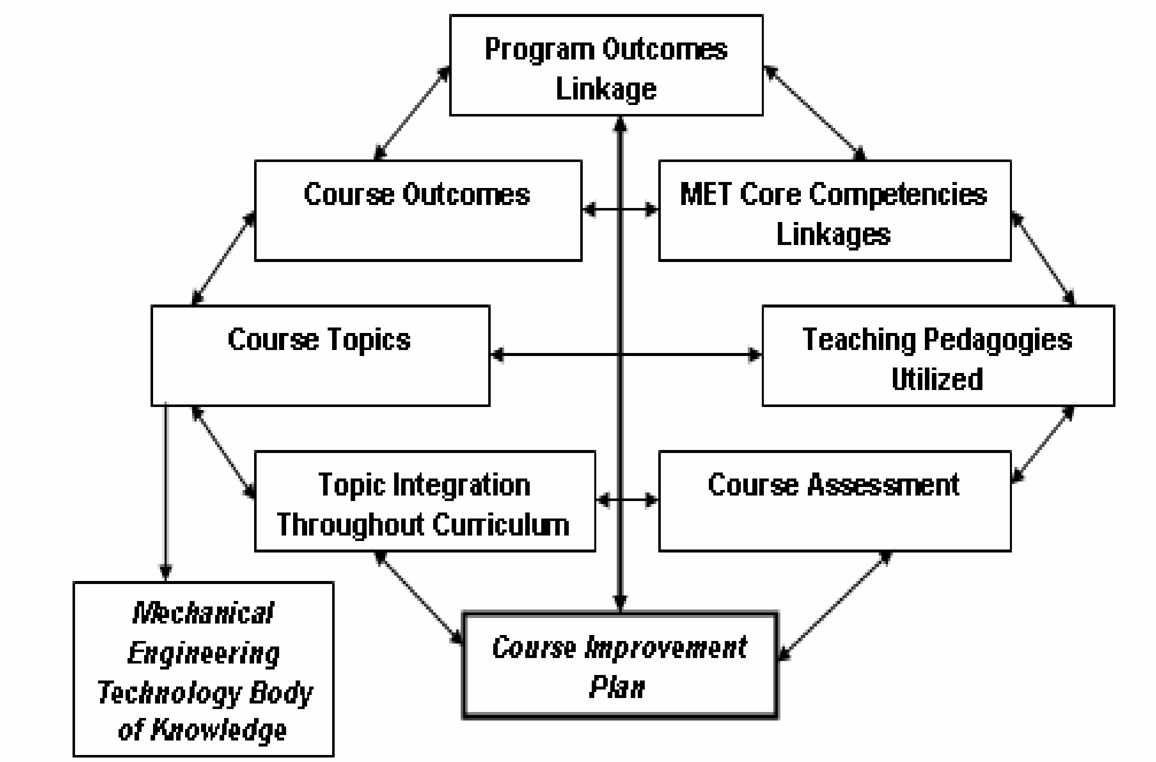

Figure 3. MET Course Review Flowchart

As a result of this curriculum review activity, the following deficiencies in our current MET program were identified:

1. Weakness in Computer Aided Engineering / graphical communication skills
    - Sketching
    - 2-D CAD drawings, layouts, schematics, etc.
    - 3-D solid modeling
    - Utilization of Computer Aided Manufacturing programs
    - Utilization of Computer Aided Analysis programs
2. Weakness in proper implementation of the design process
3. Weakness in ability to apply the design process effectively
4. Lack of integration of core competencies throughout the MET program
5. Deficiencies in technical writing abilities
6. Disjoint between curriculum focus areas and industry needs
7. Lack of Professional Elective courses for MET students
8. Lockstep curriculum that causes scheduling problems
9. Too little focus on thermal science applications
10. Too few MET related experiences in the freshman year
11. Business related course depth constrained
12. Resource constraints limit improvement opportunities

These deficiencies, along with assessment data, were discussed in detail to develop several iterations of curriculum improvement options. These options were then analyzed within the context of resource constraints and administrative policies to develop the final curriculum improvement proposal.

Specific Program Change (Proposal)

The improvements recommended will focus on the MET areas of expertise defined previously. Figure 4 shows the revised course relationships required to effectively support our curriculum reform proposal.

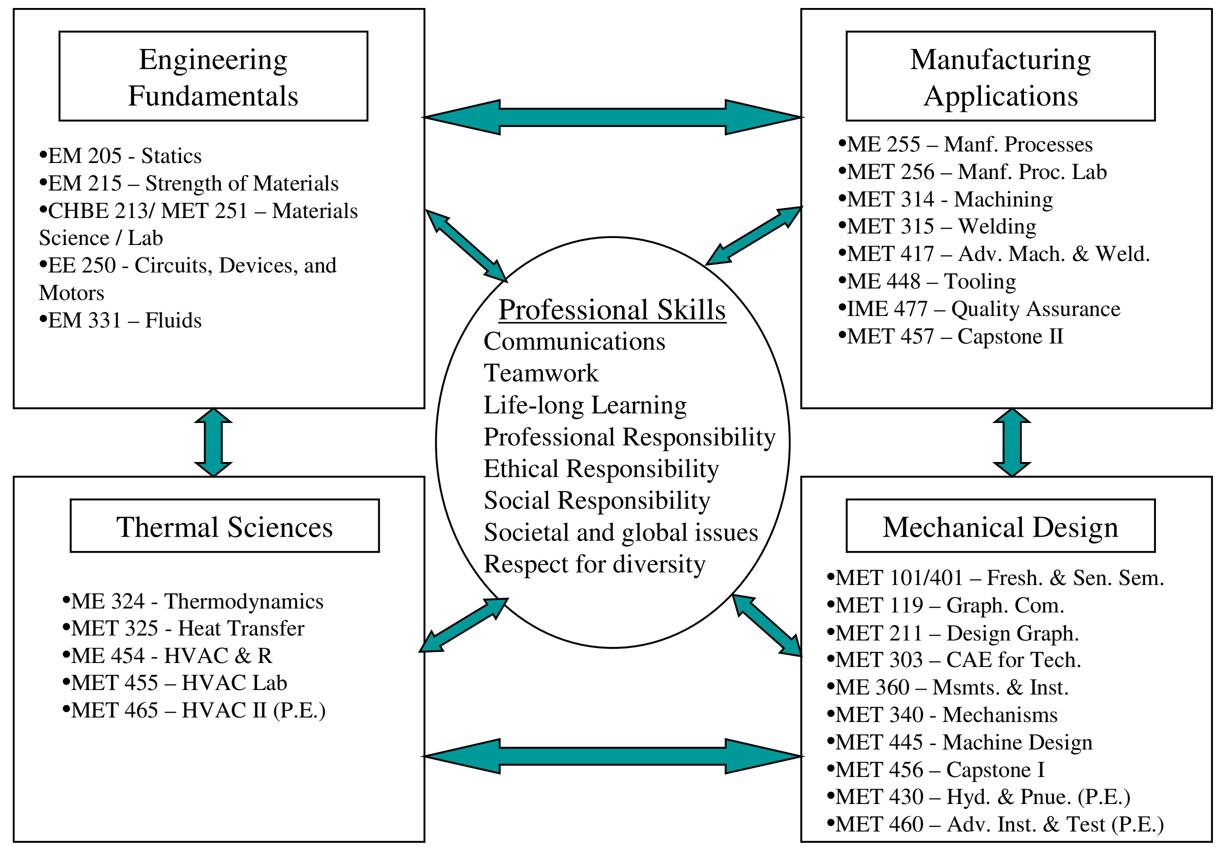

Figure 4. MET Areas of Expertise and Related Courses (Proposed Curriculum)

To successfully address the deficiencies identified, and to create a "rational sequence"[5] of integrated courses that will effectively meet our intended outcomes, as well as promote learning and retention of the core competencies of the program, the following changes are proposed. First, the following new courses will be required of all MET students:

- MET 119 (3 cr.) – Technical Graphics Communication
- MET 211 (3 cr.) – Graphics for Design

- MET 303 (3 cr.) – CAE for Mechanical Engineering Technology

These courses are designed to correct deficiencies in student design capabilities, as well as improve student communication skills. The following professional elective courses, designed to give students options to pursue different specialty areas, will be developed:

- MET 460 (3 cr.) – Advanced Measurements and Test
- MET 430 (3 cr.) – Applied Hydraulics and Pneumatics
- MET 458 (3 cr.) – Advanced HVAC

Several courses will require extensive modification in order to accomplish our revision goals. These are:

- MET 315 (3 cr.) – revise to include all aspects of welding, with an engineering emphasis. Will include advanced welding topics also.
- MET 417 (3 cr.) – revise to provide more advanced manufacturing content and to eliminate the advanced welding component. Also, change from a required course to a professional elective.
- MET 455 (1 cr.) – revise to include heat transfer and HVAC lab components. Also, move to spring semester of senior year.
- ME 448 (3 cr.) – rename as MET 448 – Manufacturing Support Systems and revise to include design for manufacturability topics, lean manufacturing emphasis, as well as tooling and inspection operations.

To balance the addition of new courses, and provide an increase in professional elective opportunities for each student, the following courses will be deleted from the program:

- MATH 160 (4 cr.) – students will be expected to perform at this level upon entering the program.
- 5th Core (3 cr.) – university requires only 4 core courses.
- ME 117 (1 cr.) – replaced by MET 119
- ME 118 (1 cr.) – replaced by MET 119

Additionally, the credit amount of the following courses will be reduced:

- MET 456 (3 cr. to 2 cr.)
- MET 457 (3 cr. to 2 cr.)
- MET 325 (4 cr. to 3 cr.)

Finally, the BUS 201 requirement will be eliminated and replaced with an approved Business course elective. To allow each student the ability to tailor their program through professional elective selection, the P.E. total will be increased to 12 cr. (currently at 6 cr.). Students must follow an approved professional electives policy. Figure 5 outlines the proposed curriculum flow. Courses being added or revised are highlighted.

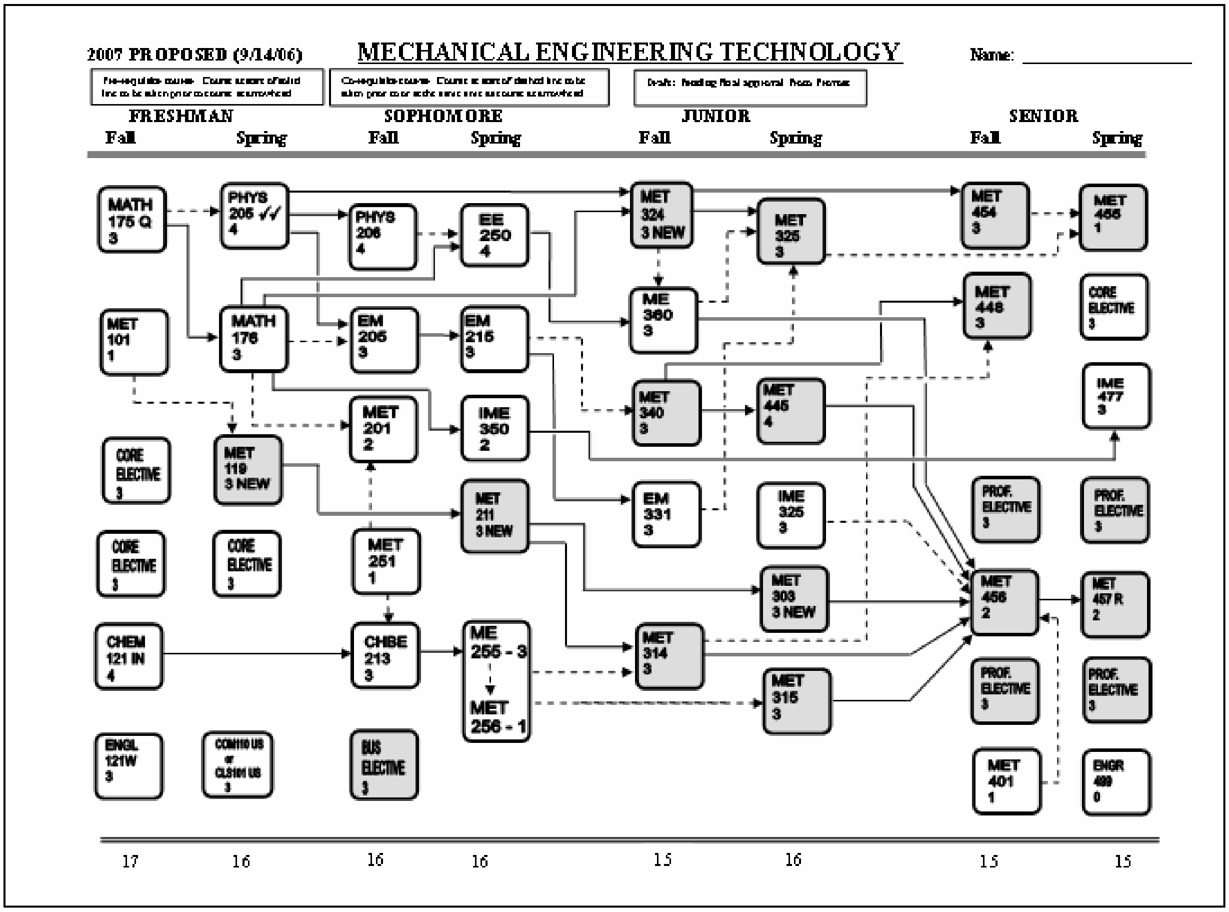

Figure 5 – Proposed MET Curriculum Flow

Administrative policies within Montana State University limit the number of semester credits within our MET program to 126 maximum. Therefore, any changes to the curriculum must result in a net change of zero as far as credits are concerned. This proposal meets that requirement.

Verification

This MET program curriculum revision proposal was presented to the department industrial advisory board and approved with very positive comments. A more in-depth presentation, including MET core competencies and MET body of knowledge was presented to the newly established Mechanical Engineering Technology Industrial Advisory Board. This board was chartered to provide a practicing engineering technologists look at the program and program changes. Membership included working engineering technologists from all three of the program focus areas. This board also approved of the changes with very favorable comments.

Implementation

Implementation of the new curriculum will be designed to support freshman entering the MET program in fall semester of 2006. Administrative paperwork, lab development, course revisions, and course development will be scheduled as follows:

Course	Title	1st Avail.	Comments
MET 119	Technical Graphics Communication	Spring 2007	Objectives complete. Course paperwork complete and in approval process. First offering will be Spring 2007
MET 211	Graphics for Design	Spring 2008	Objectives complete. First offering will be Spring 2008.
MET 303	CAE for Mechanical Engineering Technology	Spring 2009	Objectives complete. First offering will be Spring 2009.
MET 315	Welding Technology I	Spring 2007	Course objectives reviewed Fall 2006. The course will become the primary welding course for the curriculum. Course changes will be completed Fall of 2006. Revised course to be offered Spring 2007.
MET 417	Advanced Manufacturing Applications	Fall 2007 Spring 2008	Course will be reviewed Spring 2007. This course will be a revision to current MET 417 course. The welding content will be moved to MET 315 and this course will focus more on other advanced manufacturing applications. It will also move to spring semester to aid in lab scheduling. First offering will be Spring 2008.
MET 448	Manufacturing Support Systems	Spring 2008	Course review completed Spring 2007. Will be a revision to current ME 448 – Tool Design course. First offering will be Spring 2008, and then move to Fall 2008.
MET 455	Thermal Processes Lab	Spring 2008	Objectives developed in Spring of 2007. Will replace heat transfer lab and HVAC lab. First offering Spring 2008.
MET 456	Capstone Design	Fall 2009	Reduce from 3 cr. to 2 cr.
MET 457	Capstone Design	Fall 2009	Reduce from 3 cr. to 2 cr.
MET 458	Advanced HVAC	Spring 2009	Course development scheduled for Spring 2008 and Fall 2008. Course will build on ME 454 – HVAC course and will also include controls and energy management topics.
MET 460	Advanced Instrumentation	Fall 2008	Course objectives developed. First offering will be Fall 2008.

MET 430	Fluid Power Technology	Spring 2007 Fall 2007	Course objectives developed. First offering will be Spring 2007. Course will then become a fall course.

Conclusion

This curriculum review exercise utilized a continuous improvement approach to evaluate the current state of the MET program at MSU, assess effectiveness of that program, and formulate a specific plan for addressing any deficiencies. This improvement was aimed at providing MET students the proper skill sets required to be successful in a very broad range of job situations immediately upon graduation, as well as into their future careers. By reviewing the mission, outcomes, and objectives of our program, and subsequently developing the required core competencies supporting those criteria, an appropriate mechanical engineering technology "body of knowledge" was developed for MSU MET students. Along with that body of knowledge, learning methods were reviewed and changes made in order to provide ample opportunities for each student to effectively develop these core competencies. The ultimate result was a curriculum reform proposal designed to provide each student with the best possible education within the constraints of the university, department, and constituent needs. This proposal has been reviewed and approved by all constituents of the program, and an implementation plan put in place. Assessment will continue in order to provide feedback to our program constituents, as well as to provide direction in future program development.

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