AC 2010-1539: IMPLEMENTING A FORMAL COLLABORATIVE MECHANICAL ENGINEERING TECHNOLOGY INTERNSHIP PROGRAM WITH CAMPUS RESEARCH ACTIVITIES

Kevin Cook, Montana State University

Kevin Cook is an Assistant Professor of Mechanical Engineering Technology (MET) at Montana State University. He is also the Program Coordinator of the MET Program. Mr. Cook holds a B.S. degree in MET and a M.S. degree in Industrial and Management Engineering, both from Montana State University. Mr. Cook has significant industrial experience and is a registered Professional Engineer in the state of Montana. His research interests relate to education methods research, as well as curriculum design and integration.

Salman Adam, Montana State University

Salman Adam is a senior undergraduate student in Mechanical Engineering Technology (MET) at Montana State University. He recently completed an internship and continues to work for the Center for Biofilm Engineering as a research assistant.

Steven Anderson, Montana State University

Steven Anderson is a senior undergraduate student in Mechanical Engineering Technology (MET) at Montana State University. He recently completed an internship and continues to work for the Center for Biofilm Engineering as a research assistant.

Darla Goeres, Montana State University

Dr. Goeres is an Assistant Research Professor in Chemical and Biological Engineering at Montana State University. She has extensive experience researching biofilm bacteria in industrial systems. Currently, Dr. Goeres leads the Standardized Biofilm Methods Laboratory at the Center for Biofilm Engineering. The mission of this laboratory is the development and validation of quantitative standard methods for growing, treating, sampling and analyzing biofilm bacteria. Her goal is to promote collaboration among the various entities interested in biofilm methods.

Diane Walker, Montana State University

Diane Walker is a Research Engineer with the Center for Biofilm Engineering (CBE) at Montana State University. One of her responsibilities is to mentor student interns within the Standardized Biofilm Methods Laboratory (SBML) at the CBE. Ms. Walker holds B.S. degrees in both Biology and Bio-Resources Engineering and an M.S. degree in Environmental Engineering, all from Montana State University. In addition, Diane oversees and conducts testing projects for industry and provides quality assurance for a federally-funded contract held by the SBML.

Alfred Cunningham, Montana State University

Dr. Cunningham is a Professor of Civil Engineering at Montana State University. He is a founding member of the Center for Biofilm Engineering (CBE) and coordinates CBE's industrial research and education programs as part of the Center's 23 member Industrial Associates Program. Integration of graduate and undergraduate students into industrially sponsored projects is a critical activity.

Implementing a Formal Collaborative Mechanical Engineering Technology Internship Program with Campus Research Activities

Abstract

Mechanical Engineering Technology (MET) students have enhanced their educational experiences through industrial-based internships and undergraduate research activities within the university for many years. These experiences are especially important for MET students, as they generally respond better to the applications oriented learning pedagogy inherent in internship and research activities. While these activities vary in complexity and span the entire range of the mechanical engineering spectrum, they are almost always considered a "good learning experience". They learn by doing, thus it is important for them to be submersed in an environment where they can effectively learn the vocabulary and become intimately familiar with the needs and restraints for that environment. What is not well understood is how much these learning experiences contribute to skills development of the individuals involved. In addition, it is challenging to assess how effectively these students are supporting the goals of the researchers or technical faculty involved with the internship. This paper provides a description of a unique educational opportunity provided to Montana State University (MSU) MET students in collaboration with the Center for Biofilm Engineering, an NSF Engineering Research Center at MSU. This highly interdisciplinary collaboration provided an opportunity to improve, evaluate and assess the effectiveness of MET undergraduate internships and research support activities. Specifically, the focus was to share the skills and abilities of each discipline (Mechanical Engineering, Microbiology, Biofilm Engineering) and bridge the gap between research personnel in the design, prototyping, testing, manufacturing, and marketing of novel laboratory biofilm-related research equipment. The paper will present the project development history, goals of the project, and improvement activities implemented as a result of the project. In addition, details of the assessment plan, including MET program assessment goals, as well as the research and technical faculty assessment goals will be presented. Finally, the format for this type of internship or undergraduate research activity will be formalized and plans for expanding this activity campus wide will be presented.

Introduction

Traditional internship programs have long been an integral part of college engineering and engineering technology programs. These "traditional" internships involve students working directly with industry engineers, performing actual day-to-day "engineering" tasks in an industrial setting. These experiences provide students an opportunity to learn and develop skills in a setting that generally cannot be duplicated in the academic environment. In addition, graduates who complete an internship prior to graduation generally have a much more successful job hunting experience than those who do not complete an internship. According to the National Association of Colleges and Employers (NACE), 23 percent of graduates with internships had accepted jobs, where only 14 percent of graduates without internships had found jobs as of April 2009[1]. Employers are confident that graduates have better communication skills and problem solving skills, and have integrated many technical and non-technical skills into their problem solving abilities if they have completed internships prior to graduation.

Due to the urban location of Montana State University (MSU) and the general lack of engineering companies in the area, internships have been difficult for students to obtain locally or even state-wide. Most internship opportunities have been with larger companies outside the state. Application procedures have also been more formalized through the internet, thus making the application process less personal and the competition pool much larger. These problems illustrate the challenges that face universities like MSU that other less rural universities may not face.

To provide more local opportunities for students and to provide an increased number of internship opportunities in the Mechanical Engineering Technology (MET) program, a new approach to creatively utilize the limited resources available was warranted. This method involves breaking away from the traditional internship model where the student works under an engineer in their particular field of study and providing an internship where the student works for a research scientist / engineer and a faculty intern coordinator. Fortunately, Montana State University has been very successful in obtaining research funding and has many world-renowned research centers and labs. Opportunities to provide mechanical design and build support to these labs on a formal basis with student interns would support an important goal of MSU - defined in the "Vision and Strategic Plan"[2] as being involved in: "World-changing research that enhances the student experience, advances economic prosperity in the state, and enables the nation to meet the challenges of the 21st century." All departments within the university are encouraged to involve undergraduate and graduate students in research activities. Formal MET internships within research centers would make the best use of the resources the university location does offer in Montana.

To provide an example of how the method mentioned above has worked at MSU, the MET program at MSU has been involved in a new, collaborative internship program with the Center for Biofilm Engineering (CBE), a graduated NSF Engineering Research Center at MSU. This highly interdisciplinary collaboration provided an opportunity to develop a framework for formal internship experiences designed to support research activities with MET expertise, specifically, with student design and build expertise that could lead to advanced efficiencies in typical and specific research activities. This paper provides a description of the internship process development and results of this activity.

Background

Mechanical Engineering Technology Program Outcomes and Assessment

In September of 2006, the Mechanical Engineering Technology (MET) program at Montana State University (MSU) embarked on a project to evaluate the current state of the curriculum, assess its effectiveness, and implement subsequent improvements to better support the program constituents[3]. The MET program is accredited by the Technology Accreditation Commission of ABET[4]. This accreditation process requires definition, assessment, and evaluation of defined program outcomes - statements that describe what students are expected to know and be able to do by the time of graduation - as well as continuous improvement of the program. To effectively guide these improvements, the MET faculty utilizes a Continuous Improvement (CI) Plan[5]. Defined MSU MET program outcomes are summarized in table 1.

Table 1: MSU Mechanical Engineering Technology Program Outcomes

Topic	**Outcome**
Fundamentals	Demonstrate math, basic science and engineering science skills necessary for proficiency in MET careers.
Applications	Demonstrate an ability to integrate basic theoretical, experimental, computer and manufacturing knowledge and experience to produce practical, effective and innovative solutions to problems.
Design	Demonstrate the ability to apply the engineering design process to solve open-ended problems while integrating knowledge and experience from various disciplines.
Problem Recognition and Resolution	Understand and coordinate interrelationships necessary for successful design-to-build processes, and develop and apply successful problem solving processes.
Project Management	Demonstrate an ability to successfully lead an integrated design team to completion.
Communication	Develop written, oral, and technical skills to effectively communicate with individuals having a broad range of backgrounds and experience.
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.

All courses within the curriculum provide valuable contributions to meeting these outcomes. Assessment of how well the graduating MET students are meeting these outcomes is done with several assessment tools as summarized in figure 1[5].

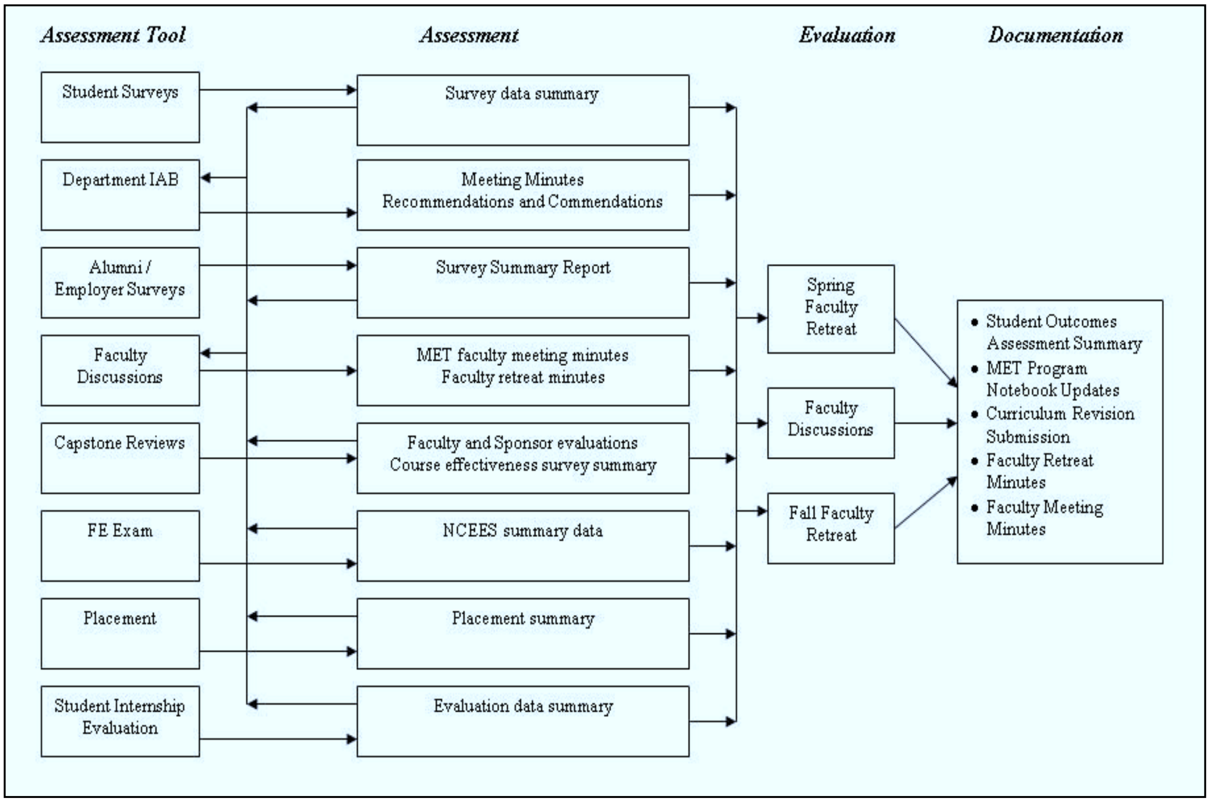

Figure 1: MET Program Assessment, Evaluation, and Documentation Flowchart

One assessment tool that plays prominently in the overall evaluation of the MET program at MSU is the student internship evaluation. The specific internship course is an optional professional elective for all MET students. The number of students registering for this course varies from year to year, but is typically very low. Evaluation of students by the internship supervisor provides very useful data and information related to the effectiveness of our program, as well an extremely important and beneficial experience for the student. These internships provide both the student and the MET program an opportunity to gage the readiness of our students to enter the workforce. For these reasons, the MET program would like to promote more activity in the internship program.

Collaboration between CBE and MET

In March of 2008, an opportunity to collaborate with the Center for Biofilm Engineering Research Center at MSU in a unique interdisciplinary research grant became available. The goal of this grant "Research Support for Standardizing a Comprehensive Biofilm Efficacy Test System" is to "design, build and test a comprehensive biofilm efficacy test system, also known as a coupon manipulation system (CMS) that would enable Standardized Biofilm Methods Laboratory (SBML) personnel to more efficiently conduct biofilm efficacy testing."[6] In addition to supporting biofilm research, this project has an added goal of producing market-ready products that could be sold by BioSurfaces Technology Corp. (BST), a local biofilm equipment and supply company. To best support this development activity, the research center sought the help of the Department of Mechanical and Industrial Engineering (M&IE). Specifically, the

MET faculty and students within that department were asked to provide the necessary product design and manufacturing expertise that typically does not exist in scientific research centers. The defined research objectives of the grant are:

- Implement an effective design and build process that results in a test system which meets all the functional requirements and is cost-effective to manufacture and thus affordable.
- Conduct laboratory experiments to verify the results achieved using the test system are statistically equivalent to the results achieved using standard laboratory equipment with regards to the measured biofilm log density and reduction, repeatability, sensitivity, and ruggedness.
- Provide BST with a market ready product.

Three phases were identified to best support the implementation of the project. Implementation phase I took place as a senior capstone design/build project during academic year 2008/2009. Implementation phase II took place as summer internships during summer of 2009 and implementation phase III is a senior capstone design/build project due to complete at the end of academic year 2009/2010.

Implementation Phase I

Figure 2 shows how the SBML laboratory and BST integrated into the design-to-build process used in the M&IE capstone course. Summarizing the process:

1. The M&IE instructors established a capstone senior design project to develop a comprehensive biofilm efficacy test system.
2. BST and the SBML team developed a list of functional requirements the test system must achieve based upon the steps specified in the biofilm standard methods and their experience in conducting biofilm efficacy tests and/or marketing biofilm reactors.
3. The M&IE students and instructors met with the SBML team to learn about biofilm and efficacy testing and walk through the procedure with an experienced laboratory technician, then both teams discussed the reasons behind the list of functional requirements the test system must achieve. (Note, for safety reasons the M&IE students were not allowed to directly work with bacteria, but instead utilized the biofilm equipment set-up with water.)
4. The M&IE students completed the preliminary and detailed design process.
5. BST and the SBML team participated in design reviews and provided comments.
6. The M&IE students fabricated the test system prototypes.
7. The SBML took the prototypes into the laboratory and conducted a set of parallel experiments where the biofilm standard method was run using both standard laboratory equipment and the test system prototype. Testing the prototype in parallel with the standard laboratory equipment enabled the team to subtract out any experiment-to-experiment variability.

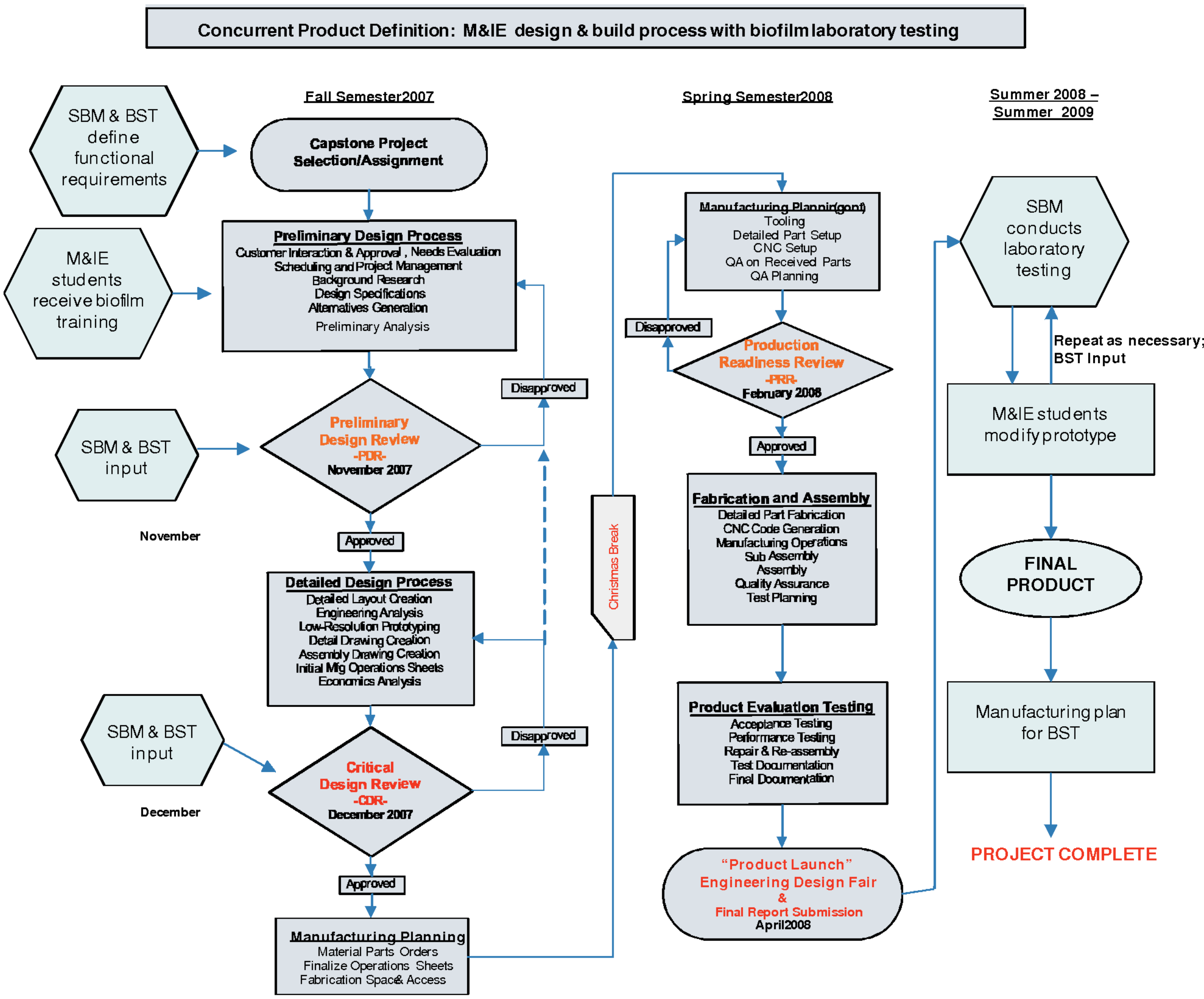

Figure 2. Schematic Illustration - Concurrent Product Definition Process

<u>Phase I Results and Lessons-learned</u>

Several prototypes were manufactured and tested in the SBML lab. BST, SBML personnel and the M&IE team reviewed the laboratory results and determined that the products did not effectively meet the defined functional requirements, nor were they economical to manufacture. Further assessment of the project revealed that the students were not able to understand the needs of the SBML personnel because they did not understand the terminology or protocol of the lab procedures at sufficient depth. Therefore, they never fully understood the functional requirements required to support biofilm research. In other words, their scientific lab expertise was not at a sufficient level that they could effectively design laboratory equipment. To address this issue, a decision was made to hire two MET students as SBML interns so that they could dedicate more concentrated time to the project and receive pay for their contributions. These students would spend an adequate amount of time to learn and understand the entire process of conducting experiments, utilizing defined standard operating procedures, as well as to understand how results are obtained and how to interpret those results so they can understand where problems may occur in the scientific process. With this experience, they would then apply their design and build skills to develop prototypes that successfully meet all of the functional requirements of the project. This approach would allow them to develop an appreciation for the entire process and how their designs contribute to the success of the procedure.

Implementation Phase II

The internships of summer 2009 were approximately twelve weeks in duration. An internship contract was prepared listing the following tasks. Each intern was to:

- Become familiar with the CBE and the Standardized Biofilm Methods Laboratory (SBML) to understand general lab operations.
- Collect experimental data, record and maintain in a lab notebook and excel spreadsheets.
- Follow standard operating procedures (SOP's) for experimentation.
- Attend regular meetings to discuss and monitor progress, as well as obtain guidance.
- Attend biosafety training and keep a tidy and orderly lab.
- Help to further the development toward increasing efficiency in laboratory reactor sampling processes through design, prototyping, and testing of lab equipment.
- Present results in the form of prototypes, posters and/or powerpoint presentations.
- Further enhance project management abilities.
- Further enhance general design and manufacturing skills.

To best accomplish these tasks, the work was divided into two segments. The first part of the summer (approximately 4 weeks) was focused primarily on lab work for the CBE. The dedicated emphasis on lab methods ensured that both MET interns were adequately trained on the ASTM standard method for growing a biofilm. Biofilm forms when bacteria adhere to surfaces in aqueous environments and begin to excrete a slimy, glue-like substance that can anchor them to all kinds of material – such as metals, plastics, soil particles, medical implant materials, and tissue.[7] Training was carried out until both MET interns were proficient in growing a repeatable biofilm. With this skill, the interns developed the ability to view the problems from the lab workers perspective, and then develop ideas for products, or tools that could be designed and manufactured to solve some of the problems and difficulties inherent in the procedure.

In the second part of the summer (the next 8 weeks), biofilm growth experiments continued to be performed by the interns, but the focus was shifted to the "mechanical engineering" tasks of the project. A rapid design / prototype / test method was implemented where the interns designed, manufactured, and tested several prototypes of products in a short amount of time.

Phase II Results and Lessons-learned

MET interns became proficient in a process outside of their academic field. They learned the vocabulary and developed an intimate understanding of what tools the researchers need to be efficient and effective. They also learned that a standard method precedes achievement of statistically relevant results. Therefore, effective tools are required in order to achieve the results, and subsequently lay the framework for future improvements in the standard methods. In addition, they learned valuable communication tools that enabled them to bridge the gap between the researcher and the engineer. This internship provided a unique learning experience that allowed MET students to explore a different field and use their engineering knowledge to solve very specific and unique problems. Although a market-ready product was not completed during this activity, the framework for development of that product was put in place.

Implementation Phase III

The two MET student interns continued working on the project as their senior capstone design-to-build project during academic year 2009/2010. The framework for this phase was essentially the same as described in phase I except that this phase will progress using the rapid design / prototype / test methodology implemented in the summer of 2009. As with any "real world" project, and as a result of the work completed in the summer, functional requirements evolve and change. New functional requirements were identified and incorporated into the phase III work.

Phase III Results and Lessons-learned

This phase is still progressing, but has already resulted in a prototype that is currently being tested. The students have been able to respond rapidly to the changes in functional requirements because they understand the processes involved and are able to communicate effectively and efficiently with the laboratory personnel in the research lab. Additionally, they have enhanced their manufacturing skills to a point where they are able to rapidly manufacture products. One example of their success is a product designed to manipulate coupons utilized in the biofilm growth process. With the functional requirements set, the students created a 3-D model of the design in SolidWorks, and then manufactured a plastic prototype using a rapid prototyping machine. This prototype was reviewed by the research personnel, changes identified and incorporated into the design, and a new prototype manufactured out of stainless steel. The students utilized a CNC mill, as well as basic manufacturing tooling to bend the steel to design specifications, and finally spot welded to complete the fabrication of this prototype. The stainless steel prototype coupon holder was shown at the 5th American Society of Microbiology (ASM) Biofilm conference in Cancun Mexico in November of 2009 where it was evaluated by a national audience. This audience was excited about the tool and provided a final evaluation that resulted in specific changes being incorporated into the final design. This is exactly the type of experience that the MET program wants their students to have prior to graduating from the program.

The success of this interaction with the research center resulted in an idea to utilize the standard continuous improvement model to develop and implement a formal collaborative internship program that mimics and builds upon the strategies described in implementation phase II and III. The current model does not clearly define responsibilities of those involved in this type of internship, nor is assessment data collected and used to effectively evaluate the success of these internships in meeting program outcomes. Therefore, a new model was required to address this unique opportunity.

Formal Collaborative Mechanical Engineering Technology Internship Program

Many sources exist that provide guidelines for curriculum development[8,9,10,11]. Each of these sources discuss the development process in great detail, with the focus of each based around three critical components of the process – teaching, learning, and evaluating success. The MET program at MSU has utilized these sources to develop and implement a continuous improvement model [3,5,12]. The basic curriculum review process utilized is shown in Figure 3 below.

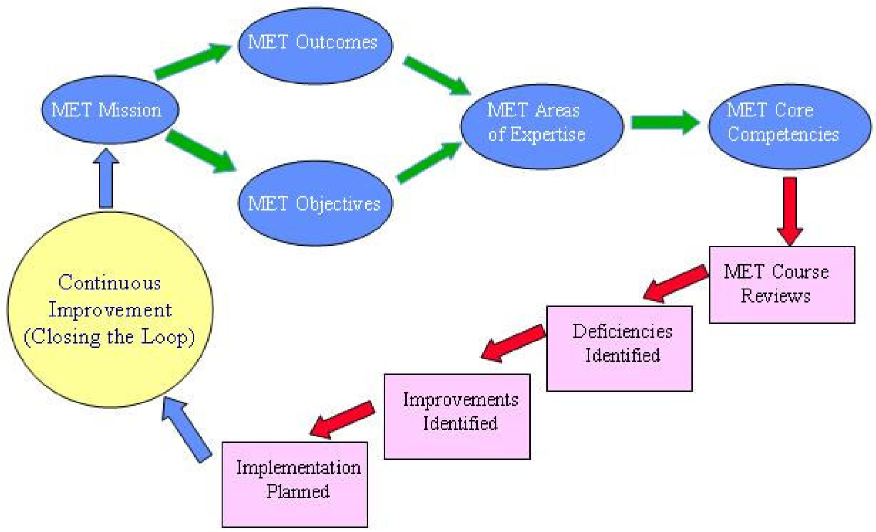

Figure 3: MET Curriculum Review Process

The course level review process, which was implemented here for the MET Internship course, is summarized in table 2.

Table 2: 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

Because this course is a work-based internship, the standard course review model was adapted to the following:

- Step 1: Identify problems with current model and specify goals for designing new model.
- Step 2: Identify the expected course / internship activity outcomes.
- Step 3: Examine the requirements of the research centers and the necessary skills and attributes of potential interns.
- Step 4: Define the model that will allow interns to master the outcomes and successfully support the research center.
- Step 5: Develop a method to assess effectiveness of the internship model.

Utilizing the experience gained through the collaborative experience with the Center for Biofilm Engineering, as well as the sources cited above, a new MET internship model was developed. This model is designed to lead to successful outcomes development for students, as well as provide a valuable service to the CBE research activity. Each step in the model development process is summarized next.

Step 1: Identify problems with current model and specify goals for designing new model

Current MET Internship Program

The current internship program within the mechanical engineering technology (MET) curriculum at Montana State University (MSU) is designed to provide MET students with an opportunity to gain "real-world" engineering experience while working full time directly with an engineer in an industrial setting. These internships are generally 10 to 15 weeks in length, and are completed during the Summer term between the Junior and Senior year of the program. Spring or Fall term internships are also possible, but must meet specific working time criteria. Individual internships and work assignments are reviewed and approved based on the following criteria:

- The company must employ engineers
- The intern must work under the supervision of an engineer
- The company and the faculty intern coordinator must identify/develop suitable job descriptions
- The work assignments must be of an engineering nature and consistent with education and experience of the intern

The internship program is designed to draw on the skills the potential intern has gained from completed coursework, as well as to provide an appropriate technical challenge. During the development of each individual internship, the MET faculty internship coordinator works with internship sponsors to ensure that specific activities will be included in the internship experience. These activities are:

- problem recognition and problem solving
- information gathering and assessment
- development of alternatives
- engineering decision making, based on engineering knowledge

- regular exposure and interaction with engineers performing engineering activities

Prior to approval of the internship, an internship contract detailing work assignments and responsibilities must be completed and approved by the employer, student, and faculty internship coordinator. While involved in the internship, each intern is required to submit a bi-weekly report to the faculty internship coordinator, as well as a final report. Finally, the employer will provide an evaluation of the intern and provide that to the faculty internship coordinator. This formal assessment provides evaluations of level of performance related to technical ability, planning ability, interpersonal skills, decision making ability, creativity, productivity, initiative, communications, teamworking ability, and safety. They also provide specific performance feedback related to assigned tasks and positive feedback and suggestions for performance improvement and professional growth of the intern.

Problems Identified

As a result of the internship course review, the following problems/concerns were identified:

- The current internship model specifies an industrial experience in which a student works directly with an engineer.
- Given this programs stated goals and requirements, very few local or state-wide opportunities are available to MSU MET students.
- Internships are not usually interdisciplinary in nature
- Interns communication and teamworking skills could use improvement
- Communications lines between the intern sponsor and the faculty internship coordinator are not well defined.
- Assessment of the overall benefit of the internship to the student by the MET program is difficult

Step 2: Identify the expected course / internship activity outcomes

The course outcomes - what students are expected to know and be able to apply by the time they complete the internship – are listed below. Each MET graduate must be able to:

- Demonstrate math, basic science and engineering science skills necessary to successfully complete internship assignments.
- Demonstrate an ability to integrate basic theoretical, experimental, computer and manufacturing knowledge and experience to produce practical, effective and innovative solutions to problems encountered during the internship assignment.
- Demonstrate the ability to apply the engineering design process to solve open-ended problems while integrating knowledge and experience from various disciplines.
- Understand and coordinate interrelationships necessary to successfully solve complex problems, as well as successfully complete the design-to-build process.
- Demonstrate an ability to successfully manage assignments and tasks as well as demonstrate the ability to work cooperatively and interactively with others in a team environment.

- Develop written, oral, and technical skills to effectively communicate with individuals having a broad range of backgrounds and experience.
- Develop a clear understanding of the dynamic interactions of humans in society and be able to interact constructively across societal and cultural lines.
- 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.

Step 3: Examine the requirements of the research centers and the necessary skills and attributes of potential interns

Research becomes more productive when the scientists have a collection of tools that are specifically designed for the task at hand. The CBE is a leading edge research center currently developing new testing methods and procedures. These methods and procedures require mechanical lab equipment that often does not exist. In addition, these centers do not have trained mechanical engineers on staff that can effectively develop this equipment. To fill that need, the expected abilities of potential MET interns working in the research lab are:

- An ability to communicate effectively with individuals with a wide range of skills and backgrounds
- A good grasp of the design process
- An ability to communicate design principles through engineering methods
- An ability to utilized basic manufacturing processes to build products.
- An understanding of materials and their properties
- An understanding of design for manufacturability principles
- An understanding of processes and process control

The students that have completed their 3rd year courses have the technical skills – design and build – necessary to fill that need for the research center. However, these MET students often do not have the scientific research experience that provides the necessary expertise to successfully complete research experiments. Therefore, the research personnel would provide the training leading to:

- Development of a clear understanding of general lab operations and specific standardized lab operations.
- The ability to effectively and efficiently collect experimental data, record and maintain properly in lab notebook and excel spreadsheets.
- The ability to properly follow standard operating procedures (SOP's) for experimentation

Step 4: Define the model that will allow interns to master the outcomes and successfully support the research center.

As previously stated, the internship course model is designed to provide opportunities to draw on the skills the potential intern has gained from completed coursework and apply those skills through practical application in a work environment. Individual internships must be tailored to the specific work environment. During the development of individual internship positions, the

MET faculty internship coordinator works with internship sponsors to ensure that specific tasks and activities leading to successful outcomes development as well as to best support the sponsor's workplace needs will be included in the internship experience. For this formal internship model, the internship sponsor, intern, and MET faculty internship coordinator each have specific responsibilities. These responsibilities are outlined in Table 3.

Table 3: M&IE Department Internship Program Responsibilities

Internship sponsors will provide	**Internship students will**	**The MET faculty internship coordinator will:**
position descriptions for each internship	apply only to assignments for which they have a serious interest	review and approve internship work for academic credit
work opportunities that contribute to successful outcomes	perform work of professional quality and effort	register students in three credits of internship coursework
supervision from a trained professional (for the laboratory, design, and test work)	follow sponsors policies and procedures	supervise and monitor progress of interns during work assignment (for the design, prototype, and test work)
evaluation of the student's performance at the end of the work period	complete all reporting requirements for sponsor and faculty coordinator	evaluate final report and assign grade

To successfully contribute to the research environment, and to meet the outcomes defined, potential interns must meet the following minimum core competency [3] requirements:

- Demonstrate proficiency / understanding in engineering fundamentals (mathematics, engineering materials, statics, dynamics, strengths of materials, fluid mechanics, and electrical circuits, devices, and systems)
- Understand how design affects manufacturing, assembly, serviceability, and environment.
- Be familiar with the range of current manufacturing technologies and processes – advantages and limitations.
- Be able to properly design within manufacturing process limitations.
- Be able to specify existing, or investigate new, manufacturing procedures to solve production problems.
- Be able to competently evaluate manufacturing processes for productivity efficiency and product quality.
- Understand and be able to apply the "design process" to solve any design problem posed.
- 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.

- Understand common engineering communication (drafting) techniques and standards (ANSI, ISO, AWS, etc), as well as Geometric Dimensioning and Tolerancing (G, D, & T) standards.
- Be able to effectively communicate design intent to all levels of production - engineering through production personnel.
- 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.
- Understand the interdisciplinary nature of systems design.
- Understand human factor and safety issues in design.
- Demonstrate basic machine shop expertise (milling, turning, drilling, sheet metal forming, inspection, etc.)
- Understand and be able to utilize instrumentation and measurement procedures and equipment in testing products and processes.
- Have the fundamental knowledge and ability to design experiments on products and processes, effectively record data, then report on the results.
- Understand current trends in design philosophy
- Demonstrate the ability to work cooperatively and interactively with others in a team environment to complete a given design project.

These core competencies are met at an acceptable level through Junior standing (completion of 60 credits) and completion of the following courses:

- Graphics for Design
- Manufacturing Processes
- Manufacturing Processes Lab
- Machining and Safety
- Welding Technology
- Mechanisms
- Machine Design
- CAE Tools in Mechanical Design
- Measurements and Instrumentation
- Applied Engineering Data Analysis
- Introduction to Engineering Design

Prior to approval of the internship, an internship contract detailing work assignments and responsibilities must be completed by the intern sponsor, intern, and faculty internship coordinator. While involved in the internship, each intern will be required to meet with the intern sponsor and faculty internship coordinator bi-weekly, as well as submit a bi-weekly report to the intern sponsor and faculty internship coordinator. A final report summarizing the internship experience must also be submitted to the faculty internship coordinator.

Step 5: Develop a method to assess effectiveness of the internship model

The fundamental continuous improvement process requires assessment and evaluation on a recurring basis. This iterative process is essential to development and implementation of improvements and changes that will ultimately lead to improved learning and increased employability of undergraduate students. Assessment can happen at the curriculum level as well as the course level. To verify the effectiveness of the new internship model, the following assessment plan will be implemented:

- Bi-weekly meetings will be held between the intern, intern sponsor, and the MET faculty intern coordinator to measure progress to meeting the defined outcomes of the internship. A formal assessment tool is utilized to guide the discussion and to measure progress towards meeting program outcomes. The data collected from this tool will guide any "in-progress" modifications or adjustments that need to be made to ensure the internship is effective.
- The intern sponsor and the internship coordinator will provide an assessment of the overall effectiveness of the internship at the conclusion of the activity. These independent assessments will be utilized as part of the MET program assessment plan[5]. A formal assessment tool will be utilized to collect assessment data and measure progress towards meeting course/internship outcomes.
- Finally, the intern will perform a self-evaluation to provide the students perspective. This tool will be utilized to make changes that could increase the effectiveness of the program. A formal assessment tool will be utilized to collect assessment data and measure progress towards meeting course/internship outcomes from the students perspective.

All assessment data will be utilized to evaluate the effectiveness of the internship program, as well as overall MET program performance. Results are documented in an evaluation data summary, and reviewed by the MET faculty, as well as the department Industrial Advisory Board. The evaluation process may contribute to changes in the internship process, the MET program outcomes or objectives, specific curricular changes or facilities improvements.

Conclusion / Recommendations

Generally, biofilm lab work is done predominately by microbiologists who lack the training and skills to build new equipment, and so the researchers end up just modifying existing equipment, or just making due with that equipment. Many research engineers believe this limits the field. Many "big" discoveries happen only when the right tools are in place. Integration of MET students into these labs can break down some of these limitations. The process used to train the MET interns in standard laboratory processes used in the research lab prior to asking them to identify, design, and build products that would lead to improvements in efficiency provided an appreciation for the entire process and how the products they designed contributes to the success of the procedure. When the students were given the opportunity to really understand how their work contributes, they perform better and feel more ownership in the results. They were able to enhance their design and manufacturing skills as well as contribute something important to the research lab.

This paper has described how the interaction of mechanical engineering technology students and faculty with a research center on the MSU campus resulted in an idea to utilize the standard continuous improvement model to develop and implement a formal collaborative internship program within the MET program. This model will provide benefits to both the MET students and the research and lab personnel of campus research centers. In addition, this project has led to an improved assessment method that will aid in accreditation of the MET program, as well as overall program improvements in future years. Ultimately, the goal of this activity is to establish this kind of a relationship with other departments and research centers on the MSU campus so they can see how this type of interaction can be a win/win relationship for all involved, as well as increase the opportunities available to our students. For this model to be successful, financial support for interns, as well as summer support for the faculty internship coordinator will have to be written into future research proposals. When an internship is interdisciplinary, the chance for success is improved. The team members can contribute unique skills and ideas that open doors for other members to think outside their academic "box" as to what is possible. This type of activity is especially important as we prepare our students for successful entry into the workforce.

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