March 12, 2015

TO: Sarah Mangelsdorf, Provost
FROM: Ian Robertson, Dean
RE: Proposal to create new Undergraduate Certificate in Manufacturing Engineering

On February 11, 2015, the College of Engineering Academic Planning Council unanimously approved the attached proposal to create an undergraduate certificate in Manufacturing Engineering.

The development of this certificate is in response to the rapidly increasing interest in manufacturing engineering as a result of the current national focus on advanced manufacturing and the anticipated growth in U.S. manufacturing. Specialized certification is valued by employers and industry.

This undergraduate certificate is specifically designed for existing students in Mechanical Engineering and Industrial and Systems Engineering, who can complete it within their major’s degree requirements. 23 existing technical electives related to manufacturing have been identified within the College of Engineering and are available to the students to choose from. The Certificate in Manufacturing Engineering will provide the students in the program the opportunity to highlight their focused coursework in manufacturing engineering.

I recommend the proposal to create the Undergraduate Certificate in Manufacturing Engineering.
Proposed Undergraduate Certificate in Manufacturing Engineering

Version 2.5
23 April 2015

Certificate Name: Manufacturing Engineering

Sponsoring Units: Department of Mechanical Engineering, College of Engineering
Department of Industrial & Systems Engineering, College of Engineering

Interim Director of Certificate Program: Frank Pfefferkorn, Ph.D., Mechanical Engineering

Contact: Frank Pfefferkorn, Ph.D.
Associate Professor, Dept. of Mechanical Engineering
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E-mail: pfefferk@engr.wisc.edu

Key Program Faculty:

- Department of Mechanical Engineering (ME)
  - Kim Manner, Senior Lecturer
  - Tim Osswald, Ph.D., Professor
  - Frank E. Pfefferkorn, Ph.D., Associate Professor
  - Natalie Rudolph, Dr.-Ing., Assistant Professor
  - Lih-Sheng (Tom) Turng, Ph.D., Professor

- Department of Industrial & Systems Engineering (ISyE)
  - Ananth Krishnamurthy, Ph.D., Associate Professor
  - Jingshan Li, Ph.D., Professor
  - Kaibo Liu, Ph.D., Assistant Professor
  - Leyuan Shi, Ph.D., Professor
  - Shiyu Zhou, Ph.D., Professor

A proposal follows for a new certificate program in Manufacturing Engineering administered by the Department of Mechanical Engineering in the College of Engineering. The proposal follows the guidelines provided at: http://apir.wisc.edu/certificates.htm.

Timeline
Implement in Fall 2015.

Governance
The student services coordinators responsible for the Department of Mechanical Engineering will handle the admissions and graduation paperwork. They will use ISIS eDeclaration to declare and cancel students in the certificate.

The Key Program Faculty will elect a Certificate Program Director based on a simple majority. The Certificate Program Director will serve for a term of 2 years. The Certificate Program Director may serve for an unlimited number of terms, however, s/he may not serve more than two consecutive terms.
The Executive Committee will serve as the curriculum committee, assessment committee and oversee program review. The Executive Committee will consist of the Certificate Program Director and two Key Program Faculty. The Key Program Faculty will elect two of its members to the Certificate Program’s Executive Committee based on a simple majority. The executive committee members will serve for a two year term and may be re-elected for an unlimited number of terms.

**Justification**

Undergraduate students want guidance on how to focus their studies and let future employers know about their focus. The interest in studying manufacturing and pursuing engineering careers in the field has been increasing rapidly among undergraduate students in the Departments of Mechanical Engineering and Industrial and Systems Engineering at UW-Madison. This is partially fueled by the national discussion of the importance in manufacturing, the discussion of the anticipated growth in US manufacturing due to the nation’s lower energy costs and potential for future energy independence, and the increased demand for manufacturing engineers from industry. This certificate provides a guide on how to organize a program of study to emphasize/specialize in manufacturing and gives students recognition for doing it. This certificate will officially advertise the strong emphasis on manufacturing that does exist in our undergraduate technical electives. This certificate will help attract existing students into careers in manufacturing. This certificate will show the nation/world that UW-Madison is relevant in the current national discussion about advanced manufacturing and is trying to train more manufacturing-oriented engineers. The Department of Mechanical Engineering’s Industrial Advisory Board wants to see more certificates and particularly endorsed one focused on manufacturing.

The University of Wisconsin-Madison does not currently offer any undergraduate degrees or certificates in manufacturing or manufacturing engineering. While 23 courses in the subject area of manufacturing have been identified in the College of Engineering, the majority of these are technical electives (not required for majors), and there is currently no mechanism for students to declare an emphasis in this subject.

This undergraduate certificate is opened to all undergraduate students at the University of Wisconsin-Madison. Mechanical Engineering and Industrial and Systems Engineering students can complete this certificate without adding time to degree. It is not yet determined if students with other majors can complete this certificate without adding time to degree. At most, 2 of 6 courses (33.3%) will overlap between this certificate and required courses in the B.S. in Mechanical Engineering major or the B.S. in Industrial and Systems Engineering major. None of the core or elective courses in the proposed undergraduate certificate in Manufacturing Engineering are required in any other undergraduate major.
Learning Outcomes
Table 1 lists the learning outcomes for students completing the undergraduate certificate in Manufacturing Engineering.

Table 1: Learning outcomes for UG Certificate in Mfg. Engr.

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>Course / Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Demonstrate knowledge of the fundamental concepts of manufacturing discrete parts</td>
<td>ME 313, ISyE 315, Electives</td>
</tr>
<tr>
<td>2. Utilize skills related to manufacturing engineering</td>
<td>Green Shop Pass, CNC 1 upgrade, Electives</td>
</tr>
<tr>
<td>3. Communicate effectively in the methods related to manufacturing engineering</td>
<td>Green Shop Pass, CNC 1 upgrade, ME 313, ME 314, ISyE 315, ISyE 415, Electives</td>
</tr>
<tr>
<td>4. Generate solutions to problems that may arise in manufacturing engineering</td>
<td>ME 314, ISyE 415, Electives</td>
</tr>
</tbody>
</table>

Curriculum
Total of 18 credits

University policy requires undergraduate certificates to have 15-18 credits with up to 21 credits in exceptional circumstances. 15 credits is now typical. Existing certificates with a greater number of credits are “grandfathered exceptions.” For example, the Certificate in Engineering Thermal Energy Systems requires 18 credits, and the Certificate in International Engineering requires 16 credits. (http://www.engr.wisc.edu/majorsandcertificates.html).

The core courses were chosen to include two manufacturing process focused courses as well as two manufacturing systems focused courses. A manufacturing engineer must be multi-disciplinary because of the complex and broad nature of manufacturing as an application of many engineering principles. The objective of the core course requirements is to provide students with some basic understanding of manufacturing systems and some basic understanding of physical manufacturing processes.

This undergraduate certificate is opened to all undergraduate students at the University of Wisconsin-Madison. Mechanical Engineering and Industrial and Systems Engineering students can complete this certificate without adding time to degree. It is not yet determined if students with other majors can complete this certificate without adding time to degree. At most, 2 of 6 courses (33.3%) will overlap between this certificate and required courses in the B.S. in Mechanical Engineering major or the B.S. in Industrial and Systems Engineering major. None of the core or elective courses in the proposed undergraduate certificate in Manufacturing Engineering are required in any other undergraduate major.

The student must successfully acquire a Green Shop Pass from the College of Engineering Student Shops and successfully complete the CNC 1 Upgrade in order to be accepted into the certificate.
9 credits (3 courses) must be from the following Core Courses with a grade of BC or better:

- ME 313: Manufacturing Processes
- ME 314: Manufacturing Fundamentals
- ISyE 315: Production Planning and Control
- ISyE 415: Introduction to Manufacturing Systems, Design and Analysis

An additional 9 credits (3 courses) must be from any of the following Elective Courses, with a grade of BC or better, with at least one course from each of the two categories:

Note: “Double dipping” is not allowed. If ME 314 and/or ISyE 415 are taken as part of the Core Course Requirement, then they cannot also count as an elective.


- ME 314: Manufacturing Fundamentals
- ME 417: Introduction to Polymer Processing
- ME 418: Engineering Design with Polymers
- ME 419: Fundamentals of Injection Molding
- ME 420: Introduction to Polymer Composite Processing
- ME 429: Metal Cutting
- ME 439: Introduction to Robotics
- ME 447: Computer Control of Machines and Processes
- ME 449: Redesign and Prototype Fabrication
- ME 454: Rapid Prototyping and Manufacturing
- MSE 435: Joining of Materials: Structural, Electronic, Bio and Nano Materials
- MSE 462: Welding Metallurgy


- ISyE 415: Introduction to Manufacturing Systems, Design and Analysis
- ISyE 510: Facilities Design
- ISyE/ME 512: Inspection, Quality Control and Reliability
- ISyE 564: Occupational Ergonomics and Biomechanics
- ISyE 575: Introduction to Quality Engineering or Stat/ME 424: Design of experiments
- ISyE 605: Computer integrated manufacturing
- ISyE/ME 641: Design and Analysis of Manufacturing Systems
- ISyE 615: Production Systems Control
- ISyE 643: Performance Analysis of Manufacturing Systems

No exceptions or substitutions to the core courses are allowed.

Elective Courses not listed must be specifically approved by the curriculum committee of the department teaching the course. The request must include the course number, course name, name and contact information for the professor currently teaching or planning to teach the course, syllabus, and which category it should be listed under. Courses that are approved by the curriculum committee of the department teaching the course must be sent the Certificate Program Director. Only formal courses will be considered.

Only courses taken for a letter grade count towards this certificate. Only courses in which a grade of BC or better is received count towards this certificate. Courses taken, as credit/no credit or pass/fail may not be counted towards this certificate. Courses taken at other institutions may be counted towards this certificate if they have been identified as equivalent through the existing process. At least 50% of the courses (i.e., 3 courses) for this certificate must be earned in residence on the UW-Madison campus.
Students must maintain a cumulative GPA of 3.0 or better for the courses taken for this certificate. If a course is repeated the average of the grades received in the course will be used in calculating the cumulative GPA.

**Overlap Limits**
The University of Wisconsin-Madison does not currently offer any undergraduate degrees or certificates in manufacturing or manufacturing engineering. The UW-Madison website listing Undergraduate Majors and Certificates ([http://www.wisc.edu/academics/majors.php](http://www.wisc.edu/academics/majors.php)) does not contain any major or certificate with “manufacturing” in the name. None of the listed undergraduate engineering certificates have any overlap with the proposed certificate in Manufacturing Engineering.

While there are numerous courses in the subject area of manufacturing offered in the College of Engineering, the majority of these are technical electives (not required for majors), and there is currently no mechanism for students to declare an emphasis in this subject.

At most, 2 of 6 courses (33.3%) will overlap between this certificate and required courses in the B.S. in Mechanical Engineering major or the B.S. in Industrial and Systems Engineering major. None of the core or elective courses in the proposed undergraduate certificate in Manufacturing Engineering are required in any other engineering major. Any curricular changes that occur in the future will ensure that the overlap between this certificate and engineering majors never exceeds 50%.

**Assessment and Program Review**
The Department of Mechanical Engineering understands that this certificate program is required to be reviewed after 5 years of its implementation, and then every 10 years.

The Executive Committee will evaluate student learning outcomes on a yearly basis with help from Undergraduate Students Services.

Curricular changes will be proposed by the executive committee. Any changes to the listed courses will be sent to the curriculum committee of the department(s) teaching the affected course(s) for approval. Then the proposed change will be sent to the Key Program Faculty for approval: a simple majority is required to approve.

**Assessment Methods**
The Manufacturing Engineering certificate program will use the following assessment methods:

- A. Exit interviews
- B. Job/graduate school placement statistics
- C. Certificate program completion and retention rates
- D. Statistics on manufacturing-related internships, job placement, and graduate school research
- E. Surveys sent to alumni and employers that assess the perceptions of the certificate
Admission
Admission into the undergraduate certificate in Manufacturing Engineering requires:

- Undergraduate standing at UW-Madison
- Cumulative GPA (at UW-Madison) greater than or equal to 3.0
- Green Shop Pass with CNC 1 upgrade (College of Engineering Student Shop)
- Completion of the admissions form
- Meeting with a faculty advisor

Students must complete an admissions form, get the required signatures, and then bring it to one of the student services coordinators for the Department of Mechanical Engineering. The form will be used to ensure that students have completed the Green Shop Pass and CNC 1 upgrade in the College of Engineering Student Shop, meet the GPA requirement for admission, meet the course grade requirement for courses already completed, and list courses that are planned in order to satisfy the certificate program. The form will contain fields for the following information:

- Study plan (courses that they have taken, are taking, and plan to take)
  - Core courses
  - Elective courses
  - Grades for any courses that have already been taken
  - When future courses will be taken
- Cumulative GPA at time of admission
- Expected graduation date
- Major
- Signature from Student Shop indicating successful completion of the Green Shop Pass and CNC 1 upgrade
- Signature from a key program faculty member indicating that the student meets the admission requirements and has discussed their study plan with a faculty advisor

The student services coordinators within the Department of Mechanical Engineering will use ISIS eDeclaration to declare and cancel students in the certificate.

Completion
In order to successfully complete the Undergraduate Certificate in Manufacturing Engineering students must:

- Have been admitted to the certificate
- Maintain a cumulative GPA of 3.0 or greater for the courses taken for the certificate. If a course is repeated the average of the grades received in the course will be used in calculating the cumulative GPA.
- Have received a grade of BC or higher in all courses taken for the certificate. If a course is repeated the highest grade received in the course is used for this criteria.
Enrollment
This undergraduate certificate is open to all undergraduate students at the University of Wisconsin-Madison. Mechanical Engineering and Industrial and Systems Engineering students can complete this certificate without adding time to degree. It is not yet determined if students with other majors can complete this certificate without adding time to degree.

It is anticipated that 12-24 students will be admitted into the certificate every academic year. Hence, a total enrollment during any term is expected to be between 24 and 48 students, because students are not expected to enroll until their junior or senior year. It is anticipated that the majority of students in the certificate will major in Mechanical Engineering and Industrial and Systems Engineering. As the national discussion of the importance in manufacturing continues, the anticipated growth in US manufacturing due to the nation’s greater energy independence materializes, and the increased need for manufacturing engineers in industry grows the enrollment in this certificate program will also grow.

With the current undergraduate enrollment (ME = 653; ISyE = 246; Total = 899), instructional resources, and staffing in the student services hub (responsible for Mechanical Engineering) a maximum enrollment of 48 students can be sustained. The current (Spring 2015) enrollment in the core courses is: 121 in ME 313, 95 in ME 314, 47 in ISyE 315, and 58 in ISyE 415. These core courses are taught every Fall and Spring semester. A maximum enrollment of 48 students is anticipated to cause an 8% increase in enrollment in ISyE 315 & 415 and a 2% increase in enrollment in ME 313 & 314 over an academic year. These maximum anticipated enrollment increases are manageable. These estimates are based on the following assumptions:

- 48 students are enrolled in the certificate during any given academic year.
- All of the enrolled students are ME or ISyE majors.
- 33 of 48 certificate students are ME majors and 15 of 48 are ISyE majors.
- Students are enrolled in the certificate for two academic years (junior and senior).
- Each student takes one of the core courses from outside their major, hence half of the maximum enrolled students take this course each academic year.
- Pre-certificate yearly enrollment in the core courses is twice the Spring 2015 enrollment numbers:
  - ME 313 = 242 students/year
  - ME 314 = 190 students/year
  - ISyE 315 = 94 students/year
  - ISyE 415 = 116 students/year
- Additional ME students in ISyE core courses = 33/2 = 16 per year. ISyE 315 and 415 combined (210 students) will experience an 8% increase in enrollment.
- Additional ISyE students in ME core courses = 15/2 = 8 per year. ME 313 and 314 combined (432 students) will experience a 2% increase in enrollment.

The technical electives that have been identified will be able to absorb the enrollment from certificate students.

There are two contingency plans for higher than anticipated enrollment or challenges in sustaining the support:

1. More student services staff and faculty are hired because increased certificate enrollment tracks with overall enrollment in the college of engineering.
2. Admission requirements are increased. The certificate’s executive committee will determine how to make the admissions requirements more stringent. This can include: raising the GPA and grades achieved in courses taken for the certificate.
Advising
This undergraduate certificate is opened to all undergraduate students at the University of Wisconsin-Madison. Mechanical Engineering and Industrial and Systems Engineering students can complete this certificate without adding time to degree. The primary responsibility for advising students will be carried by undergraduate student services for the Department of Mechanical Engineering and the key program faculty. It is anticipated that most of the students enrolled in this certificate program will be pursuing B.S. degrees in Mechanical Engineering and Industrial and Systems Engineering. All but two of the courses listed in the certificate are taught in the Departments of Mechanical Engineering and Industrial & Systems Engineering. Hence, the key program faculty are from these departments and can act as points of contact during each departments professional development (i.e., advising) days during the school year.

At most, 2 of 6 courses (33.3%) will overlap between this certificate and required courses in the B.S. in Mechanical Engineering major or the B.S. in Industrial and Systems Engineering major. None of the core or elective courses in the proposed undergraduate certificate in Manufacturing Engineering are required in any other engineering major. Any curricular changes that occur in the future will ensure that the overlap between this certificate and engineering majors never exceeds 50%.

Two of the four core courses are required in both undergraduate degree programs (ME 313 and ME 314 for the B.S.M.E.; ISyE 315 and ISyE 415 for the B.S.ISyE). These are the only courses in this certificate that are required by any engineering major. The B.S.M.E. degree includes 15 technical elective credits, which provides sufficient leeway to take 3 credits from the core and 9 additional manufacturing credits. The B.S.ISyE degree includes 12 elective credits, which provides sufficient leeway to take 3 credits from the core and 9 additional manufacturing credits.

The Certificate Program Director has sign-off authority on substitution requests, after consulting with the Executive Committee. Substitution requests will only be made in the cases where the course is added to the certificate program. Students requesting a substitution must first get approval from the curriculum committee of the department teaching the course. The request must include the course number, course name, name and contact information for the professor currently teaching or planning to teach the course, syllabus, and which category it should be listed under. Only formal courses will be considered.

Enrollment of University Special Students
Not permitted.

Resources and Ongoing Commitment
There is very little additional advising workload associated with this certificate because the majority of the students can meet the requirements within the framework of their B.S. degrees in Mechanical Engineering and Industrial & Systems Engineering. In addition, the number of students in this certificate will make up a small fraction of the 900 undergraduate students currently enrolled in B.S. ME and B.S. ISyE majors.

The additional workload will primarily involve tracking who in enrolled in the program, enrolling students in the program, and checking that they have satisfied the degree requirements. This checking will be done through eDeclaration and DARS. The Departments of Mechanical Engineering and Industrial & Systems Engineering support this program with the necessary resources.
MEMORANDUM

To:       
From: Jaal Ghandhi  
Date: Dec. 19, 2015 
Subject: Manufacturing Certificate 

The Mechanical Engineering faculty discussed the proposed Undergraduate Certificate in Manufacturing Engineering at its December 4, 2014 department meeting. There was widespread support for this certificate program from the faculty.

A certificate designation on a student’s transcript is a good way to signal to potential employers an academic concentration on behalf of the student. In recent years, there has been a resurgence in interest in manufacturing, thus, the establishment of this certificate is timely. I think that ME students will view this as a great opportunity, and the department will be proactive in promoting this as an option for students to consider. Mechanical Engineering hosts a Professional Development Day every fall where students are required to meet with a faculty advisor. These individual discussion are the best venue for us to spread the word, and we will work with the faculty to make sure that they have the necessary information about the Manufacturing Certificate on hand for those discussions.

Certificate opportunities were one area that the ME Department’s Industrial Advisory Board identified for expansion, so I am confident that the people involved in hiring in industry will look favorably on this addition to our program. I am also in favor of exposing non-ME students to our manufacturing-focused courses.

If you have any other questions, feel free to contact me.
10 December, 2014

Frank Pfefferkorn, PhD
Professor, Department of Mechanical Engineering
College of Engineering
University of Wisconsin-Madison

Dear Frank:

On November 21, 2014, the faculty of the Department of Industrial and Systems Engineering considered a motion to support your proposed Certificate in Manufacturing Engineering, and approved it unanimously. There were 13 people present. There is no significant overlap between the proposed certificate and the other certificates commonly taken by students in our department.

We are pleased to support the proposed certificate. On behalf of the Department of Industrial and Systems Engineering,

Vicki Bier, PhD
Professor and Chair
Department of Industrial and Systems Engineering
College of Engineering
University of Wisconsin-Madison