ABET
Self-Study Report

for the

Manufacturing Engineering program

at

Western Washington University

Bellingham, Washington

June 16, 2022

CONFIDENTIAL

Program Self-Study Report
for
EAC of ABET
Accreditation or Reaccreditation

BACKGROUND INFORMATION

A. Contact Information

Primary contact: Dr. Sura Al-Qudah, Program Director
Engineering & Design Department, MS 9086
Western Washington University
516 High St.
Bellingham, WA 98225-9086
Ph: 360-650-7703
E-mail: alqudas@wwu.edu

Secondary contact: Dr. Jeff Newcomer, Chair
Engineering & Design Department, MS 9086
Western Washington University
516 High St.
Bellingham, WA 98225-9086
Ph: 360-650-7239
E-mail: newcomj@wwu.edu

B. Program History

The Manufacturing Engineering program began in fall 2014 and had its first graduates in Spring 2016. The initial and most recent general review of the program was conducted during the 2016-17 academic year, with the site visit occurring in October 2016. The program evolved out of an ETAC-ABET accredited Engineering Technology program (ET). The ET version of the program was first TAC-ABET accredited in 1989 and was terminated in summer 2016.

Major program changes since the last review are:

A summary of the major changes that have been made to the MFGE program since the last accreditation review for each of the criteria is provided below:

Criterion 1

- A 500-word essay was added to the materials required for application to the major in 2016-17.
- PHYS 162 Physics with Calculus II and MATH 204 Linear Algebra were added to the admissions requirements for application to the MFGE major in 2019-20.

Criterion 2

- No changes were made.

Criterion 3

- Transitioned from EAC Student Outcomes (a) – (k) to 1 – 7. The transition started in the 2018-19 academic year following a three cycle: SLOs 3 and 4 in year 1 (2018-19), SLOs 5 and 7 in year 2 (2019-20), and SLOs 1, 2 and 6 in year 3 (2020-21).

Criterion 4

- Created and applied new performance indicators and rubrics to assess each of the new 1-7 student learning outcomes.

Criterion 5

These changes added two credits to the program (from 149-153 to 151-155):

Year	+	-	Mod	Description	Credit Impact
21-22	ENGR 101 ENGR 115	ENGR 104		Enhancements of the pre-major curriculum by expanding ENGR 104 Introduction to Engineering and Design (3 credits) into ENGR 101 Engineering, Design and Society (2 credits), and ENGR 115 Innovation and Design (4 credits).	+3
			ENGR 225	Reduced from 5 to 4 credits with the credit saved used to support the change of ENGR 104 to ENGR 101 and 115.	-1
			MFGE Program	Expansion of the program from 149-153 credits to 151-155 credits. The 2 additional credits were created to support the change of ENGR 104 to ENGR 101 and 115.	+2

These changes did not impact the credit count of the MFGE program:

Year	+	-	Mod	Description	Credit Impact
			MFGE Program	Made MFGE 453 Introduction to Robotics a required class for all majors to ensure exposure to this subject for all graduates.	0
	MFGE 454			Added a new technical elective class on Systems Integration to support students wishing to further specialize in robotics and automation.	0
	MFGE 365	MFGE 465	MFGE Program	Moved MFGE 465 Machine Design from the senior to the junior year renumbered as MFGE 365. This is a more foundational subject, and this change introduces it sooner in the curriculum and closer to its engineering science prerequisite ENGR 225 Mechanics of Materials.	0
	MFGE 462	MFGE 362	MFGE Program	Moved MFGE 362 Advanced CAD Modeling and Analysis from the junior to	

21-22				the senior year renumbered as MFGE 462. It was felt that this topic is better suited to specialization in the senior year.	0
			MFGE Program	Increased technical elective opportunities for majors though some of the changes described above. Majors are now required to take one of MFGE 434 Advanced CAM and CNC, MFGE 462 Advanced CAD Modeling and Analysis, and MFGE 454 Systems Integration. A major may take at least one of the other two classes for their technical elective's requirement (4 – 6 credits), and possibly both.	0
			MFGE Program	Moved PCE 372 introduction to Composites Materials and Processes to the from the junior to the senior year. This helped create the room to move machine design to the junior year as MFGE 365. It was felt that PCE 372 better served senior-year specialization of those majors wishing to focus on composites manufacturing.	0
	PCE 342	MFGE 342	MFGE & PCE Programs	Passed ownership of Design of Experiments to the Plastics and Composites program. Remains a requirement for MFGE majors and content is unchanged.	0
20-21			MFGE 491 & 492	Rebalanced content between the first and second classes in the Capstone Senior Project sequence moving content on Project planning from 491 (4 to 3 credits) to 492 (2 to 3 credits)	0
18-19	MFGE 340	CSCI 140	MFGE Program	Replaced the computer science Introduction to Programming class with a required applied numerical methods class (MFGE 340) that in addition to introducing programming concepts provides exposure to numerical methods and their application in engineering.	0
	MFGE 350		MFGE Program	Added a new class MFGE 350 developed to introduce newly admitted majors to the fundamentals of automation. This was renumbered to MFGE 250 in 2021-22 to reflect placement in the spring of the sophomore year	+4
		OPS 460	MFGE Program	Removed OPS 460 Designing and Improving Lean Operations from the program. Review of this course's content by the faculty and feedback	

				from students showed that this course increasingly duplicated content in MFGE 341 Quality and Continuous Improvement (though with a business focus) as the latter course evolves.	-4

Criterion 6

- Dr. April Bryan resigned her appointment on the faculty in 2016.
- Dr. Tarek Algeddawy was hired to fill the vacancy created by Dr. Bryan for the start of the 2018-19 academic year. He received his Ph.D. at the University of Windsor and had been serving for the previous 5 years on the faculty of the Mechanical and Industrial Engineering Department at the University of Minnesota, Duluth.
- The hire of Jill Davishahl as First Year Program Director at the start of the 2019-20 academic year impacts the MFGE program through her instruction and program development in pre-major courses. These include ENGR 101, 115, and 214.

Criterion 7

- Additional Program or shared space:
  - ET 134 was added to the MFGE lab suite as Fabrication Lab. Its major piece of equipment is an OMAX waterjet cutter.
  - ET 138 was converted from a CNC workcell to the Learning Factory (LeaF), a flexible assembly system.
  - The old Vehicle Design lab spaces, ET 135, ET 151, ET 152, ET 154, and ET 155 were converted into a Project Lab suite. ET 135 is used for hot metals work, including course labs, and the rest of the space is used to support long-term projects, primarily senior projects and FSAE.
  - ET 140 was converted from a lounge into a 3D Printer room that is open for all students to use. The room now contains ten 3D printers.
  - ET 251A was converted into a Makerspace that is available to all students, but is primarily designed to support pre-major students.
- Computers in ET 262, ET 308, and teaching stations in classrooms were replaced in summer 2017 and will be replaced again in summer 2022.

Criterion 8

- Personnel changes:
  - Dr. Sura Al-Qudah replaced Dr. Derek Yip-Hoi as MFGE Program Director in fall 2021.
  - Dr. Brad Johnson replaced Dr. Catherine Clark as Dean of CSE in spring 2017.
  - Dr. Jackie Caplan-Auerbach became Associate Dean of CSE in fall 2017.
  - Ben Kaas was hired as the ICST for MFGE in summer 2019, and the position was reclassified from ICST3 to ICST4. This position is also currently undergoing review for reclassification.
- Major equipment acquisitions:
  - OMAX Waterjet Cutter
  - Three Universal UR5e Cobots

- Three articulated FANUC robots, one LR MATE 200iC and two LR MATE 200iD, all with vision systems.
- Two Epson robots, one articulated and one SCARA, both used
- Two Flexlink conveyor belts
- Four Cognex cameras
- SNAP DM200 Video Measurement System
- Haas Mini Mills
- Haas CL-1 Lathe
- Haas ST-10Y Turning Center
- Haas VF-2TR Machining Center

C. Options

There are no options, tracks, or concentrations in the Manufacturing Engineering program.

D. Program Delivery Modes

Up until winter quarter 2020, all classes and laboratories were only offered in face-to-face format on weekdays. Due to the COVID-19 pandemic, the end of winter quarter 2020 and all of spring quarter 2020 were offered remotely, including laboratories, primarily asynchronously. During the 2020-21 academic year, lectures were offered remotely, primarily synchronously, but 50-60% of laboratories were offered in a face-to-face format on campus, with the remainder occurring remotely. For the 2021-22 academic year, all laboratories and almost all classes returned to a face-to-face format on campus. A limited number of nonlaboratory classes were offered in a remote or hybrid format.

E. Program Locations

The Manufacturing Engineering program is offered at Western Washington University's Main Campus, located at 516 High St., Bellingham, WA. All classes taught by the Engineering and Design department are conducted in the Ross Engineering Technology building. All supporting courses are also offered on the Main Campus in Bellingham.

F. Public Disclosure

Program Education Objectives (PEOs), Student Outcomes (SOs), annual student enrollment, and graduation data specific to the program are posted at: https://engineeringdesign.wwu.edu/assessment-and-accreditation.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

There were no Deficiencies, Weaknesses, or Concerns remaining from the most recent ABET Final Statement.

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

Admission to the Manufacturing Engineering (MFGE) major is a two-phase process. After acceptance to WWU, students declare as an MFGE pre-major and then apply to the full major once requirements are met. MFGE pre-majors must complete a set of foundational courses in math, physics, chemistry, and engineering principles listed below. Depending on when students are able to begin calculus, these foundational courses take up to 5 quarters to complete at WWU. Foundational coursework may also be taken at community colleges or other institutions. Information on the acceptance of transfer courses is in Section 1.C. These foundational courses are the minimum required courses to apply to the MFGE major. The MFGE program accepts applications during winter quarter every year. Upper division coursework begins in spring quarter and is restricted to students who have been accepted into the full major.

Required courses to apply:

- MATH 124 - Calculus I
- MATH 125 - Calculus II
- MATH 224 - Multivariable Calculus & Geometry
- MATH 204 - Linear Algebra
- CHEM 161 - General Chemistry I
- PHYS 161 - Physics w/ Calculus I
- PHYS 162 - Physics w/ Calculus II
- ENGR 101 - Engineering, Design, and Society
- ENGR 115 - Intro to Engineering & Design
- ENGR 170 - Intro to Materials Science & Engineering
- ENGR 214 - Statics

Students may be currently enrolled in no more than four of the required courses when they apply for major admission. A final decision on applications may be delayed until receipt of final grades for in-progress courses. Students must obtain at least a C- in the above courses and an overall GPA in them of 2.0 or higher to be considered. AP scores are converted to GPA as follows: 5 = A; 4 = B; 3 = C.

Recommended coursework, but not required to apply:

- MATH 331 - Differential Equations
- MATH 345 or 341 - Engineering Statistics
- PHYS 163 - Physics w/ Calculus III
- ENGR 225 - Mechanics of Materials

Admission to full major status is determined by academic performance as a pre-major, an essay on why a student wants to be a Manufacturing Engineer, and other factors. Admission to the major is competitive. Neither completion of the foundational courses nor attainment of any specific GPA guarantees admission. This admissions information is also available on the MFGE Admissions web page.

Applications are reviewed by all tenured and tenure-track MFGE faculty members, and selections are made based on the above criteria. Students are notified of acceptance via email and are required to complete the major declaration process. Twenty-four students are typically accepted into the program each year and they begin major courses spring quarter. Admission decisions are based primarily on cumulative GPA in the foundational courses, less PHYS 162, and are also influenced by the essay, successful completion of other required major courses, GPA in the major, and overall GPA are also considerations.

B. Evaluating Student Performance

Student performance in all courses is evaluated and graded on an A through F scale or as Satisfactory/Unsatisfactory (S/U) or Pass/No Pass (P/NP). Under normal circumstances, all courses that are required for the MFGE program are graded on the A through F scale, and a student must receive a grade of C- or better to receive credit for having completed that course requirement for the major. A student who gets a grade lower than C- in a course required for the major must repeat that course unless he or she is granted an exception. The exception request process is described later in this section, after the discussion of pre-requisite enforcement. Due to the COVID-19 pandemic, from spring quarter 2020 through spring quarter 2021, students were allowed to take any course Pass/No Pass. The Pass level was set at D+ by the University. If a student elected to take a class Pass/No Pass due to the pandemic, a course successfully completed shows up as an EP (Exceptional circumstances Pass) on the student's transcript. EP grades were accepted as meeting program requirements for graduation.

Monitoring of student progress is done at all levels of a student's education, but is done differently for pre-majors than it is for majors. Pre-majors' progress is monitored by the Department Program Coordinator & Pre-major Advisor. All students are contacted and encouraged to get advising each quarter before registration, but advising is not mandatory. However, if a student is struggling academically, an extra effort is made to get the student to come for advising. WWU has multiple advising tools, including Navigate, which provides an academic tracking tool that will flag a student who is having academic problems so that the Program Coordinator is aware of them quickly and can reach out to the student, and Degree Works, which maintains a record of students' progress towards their declared majors.

Once a student has been accepted to the MFGE major academic advising is conducted by MFGE faculty members. All newly accepted students are assigned a program faculty member that will advise them throughout their time in the program. Students have a minimum of two meetings with their advisors, the first at the time of acceptance to the major, and the second to review and approve students' plans to complete program requirements and graduate. The latter meeting is conducted two quarters before students are due to graduate, so it usually occurs during the fall quarter of students' senior year. Students are encouraged to seek advising quarterly to ensure their progress toward the degree, and many do, but since all students take classes from all program faculty members over the course of their seven quarters in the major, much advising is informal and takes place on an ad hoc rather than planned schedule.

The MFGE program has a strong prerequisite structure. If a student does not pass a prerequisite course with a C- or better, the registration system will not allow that student to register for the next course. However, if the student is taking a pre-requisite course at the time of registration, that student will be allowed to register for the next course, and then the Engineering & Design (ENGD) Department office staff must confirm that the student received an appropriate grade of C- or better in the pre-requisite class. Every quarter after grades have been submitted, the ENGD office staff runs grade reports and identifies any and all students who did not attain a grade of C- or better in a pre-requisite course. The ENGD Program Coordinator then sends notices to those students who have not met prerequisites, notifying them that they must drop the course that requires the pre-requisite that was not successfully met and seek advisement. If the student does not drop the class voluntarily the Program Coordinator contacts the faculty member teaching the course so that she or he knows to make the student drop on the first day the class meets. The only reason that a student would be allowed to stay in a class without the appropriate pre-requisites being completed with a grade of C- or better is if he or she has an exception request approved to take the courses out of order or concurrently.

Students who believe that they have a legitimate reason for being allowed to stay in a class without having passed the pre-requisite course(s) with a C- or better must file an exception request. The student must submit the request for the exception and the reason for the exception in writing using the ENGD Department exception request form, which is available on the Department's Policies, Procedures, and Student Forms web page. For a MFGE major or MFGE pre-major, the MFGE program faculty review the student's request and submit a recommendation for or against the exception in writing to the ENGD Curriculum Committee. The Curriculum Committee then discusses the merits and drawbacks of the student's request and makes a decision for or against the exception. The ENGD Department Chair then informs the student of the decision. Records of all exception requests are maintained in the ENGD Department office and entered into students' University records in Degree Works.

The progress of students in the major is discussed during program meetings. If a student is identified as potentially failing a course or courses, then someone, usually the student's advisor, will reach out to talk with the student about the situation and possibly develop a new plan for the student to graduate in a timely manner. If a student does fall into academic difficulties, the University has an Insufficient Progress Policy. If a student fails one or more courses, withdraws from multiple courses during the same academic term, or gets a term GPA below 2.0, that student is notified that they are in potential violation of the Insufficient Progress Policy. If a student violates the Insufficient Progress Policy again, such as by failing a course for a second time, the program faculty will discuss the student's academic progress and any circumstances that may have led to the student's academic difficulties. If there is not an assignable cause, such as illness or injury, then the student will be removed from the major.

C. Transfer Students and Transfer Courses

Transfer students are accepted to WWU according to WWU admission policies. If a student has been admitted to WWU and is interested in the MFGE program, that student applies for the program following the procedure described above. A transfer student may only be accepted into the MFGE major by successfully completing, with a grade of C- or better, the same or equivalent courses to all of the courses a native student must complete before applying to the MFGE program.

The process for the validation and acceptance of credits from other institutions is handled in one of two ways. Institutions in the state of Washington have developed a thorough list of standard course transfers, including universal course numbers for certain classes, while courses that are not on that list and course transfers from out-of-state universities and community colleges are all reviewed on a case by case before being accepted.

If a class at another Washington university or community college uses a common course number, then that course gets entered into the WWU system as a course that can be transferred to WWU, but may or may not count for a specific course in the MFGE program. Such a course will be listed on a student's transfer report as a 1TT or 2TT equivalent, meaning that the course is at the 100 or 200 level (as indicated by the first number) and the credits count at WWU, but not towards the major without Department approval. In this case students must provide a course syllabus and possibly additional course material for MFGE program review. Once a transfer course from a specific Washington university or community college has been reviewed, generally through direct communication with the faculty at that Washington university or community college, the course is entered into the WWU system as an exact transfer, and that course will show up on a student's transfer report as an equivalent of the WWU class without further action on the part of the MFGE program. Once a course is in the WWU system as an equivalent transfer course, the course will transfer smoothly for all students who have that course from that institution.

WWU Admissions will only change a course from another Washington university or community college to being equivalent to a WWU course at the direction of the department that owns that area, so only the Engineering and Design Department can designate transfer of engineering courses as true equivalents. A department may, however, elect to accept a course from another area as an equivalent transfer as well as courses in its own area. This is often done for Math classes, primarily differential equations classes, that are deemed insufficient for Math majors, but can be verified as being sufficient for engineering majors. Students and faculty members from any institution can review course equivalencies on the WWU Admissions website.

Courses from out-of-state universities and community colleges must be evaluated on a case-by-case basis by the MFGE program, which is generally done by the MFGE Program Director for major courses or the Department Chair for pre-major courses, unless they need the input of other members of the ENGD or MFGE faculty. Review of a course from an out-of-state university or community college starts with review of the course syllabus. If the syllabus is sufficiently detailed, no other information is required, but if it is not then the student is required to provide more information from the course, which might include assignments and labs. Once a course has been accepted as a transfer course for a student, it is indicated in the student's file in Degree Works.

In addition to accepting transfer courses, WWU grants credit for certain AP, IB, and Cambridge International Examinations. WWU generally grants credit for College Board Advanced Placement (AP) exams completed with a score of three (3) or higher, according to the posted equivalency chart. Credits are granted upon receipt of official scores (AP Transcript) from the

College Board. WWU will grant up to 15 credits for each approved standard level and higher-level International Baccalaureate (IB) subject examination passed. WWU will generally grant 15 credits for approved A-level Cambridge International examinations and 7.5 credits for approved AS-level examinations with passing grades of A-E, subject to the 45 credit maximum. Approved exams will be given a Satisfactory, "S", grade. Credit will not be granted for both an A-level and an AS-level exam in the same subject area. Some exams may also apply to GURs. Students may receive credit for Math, Computer Science, and Science classes in these manners, but there are no approved equivalencies for required engineering courses.

D. Advising and Career Guidance

As mentioned in Section 1.B, students are advised by the MFGE program faculty, the Department's Program Coordinator & Pre-major Advisor, and possibly the University's Academic Advising Center at different stages of their academic career, and students get career guidance from the MFGE program faculty and through the University's Career Services Center.

Students who have an interest in the MFGE major can get advising from the Department's Program Coordinator & Pre-major Advisor and the University's Academic Advising Center. Once students declare their pre-major the Department's Program Coordinator & Pre-major Advisor serves as the students' advisor until they are accepted into the MFGE program. As mentioned in Section 1.B, advising is not mandatory, but the Department's Program Coordinator contacts all pre-majors each quarter to encourage them to get advising and also tracks their progress toward the major using the Navigate software. If a student is struggling in required classes, an extra effort is made to get that student to come in for advising. Once students have been accepted into the MFGE major, they are assigned an MFGE faculty member as their primary academic advisor. Students who are struggling in their classes are advised more frequently and provided additional advising guidance. Students are encouraged to seek advising each quarter prior to registration but advising is not mandatory.

The primary advising tool is the MFGE Program Planning Guide as shown in Appendix F
All of the fundamental advising information is also available on the MFGE Advising web page.

Career Guidance starts in the ENGR 101 – Engineering, Design, & Society course and continues throughout the program. Career guidance is accomplished through program faculty, student club organized company tours and guest speakers, and the University's Career Services Center. The MFGE Program posts announcements for guest speakers and job openings on the Engineering & Design Canvas page in addition to in-class announcements. More targeted resume and career guidance is given in the first course in the capstone series, MFGE 491.

Career advising through Western's Career Services Center includes career counseling, job search guidance, workshops to help prepare students and alumni, on-campus recruiting opportunities, and special events such as career, internship, and graduate school fairs. They also maintain an on-line job database called Viking Career Link.

E. Work in Lieu of Courses

The MFGE program does not allow majors to substitute work experiences, acquired either before being admitted, or while completing their program, for academic credit. The process for awarding AP, IB, and Cambridge International Examination credit is outlined in Section 1.C.

F. Graduation Requirements

The degree awarded is a Bachelor of Science in Manufacturing Engineering.

The graduation requirements for the MFGE program are documented in the Western Catalog. The program Degree Works is used to both document the requirements and track students' progress towards meeting those requirements. Students can access their own files on Degree Works and department advisors can access any students' file on Degree Works. In addition, the program advisors maintain a degree planning sheet for each advisee. An example of the 2021-2022 degree planning sheet for the MFGE program is shown in Appendix F.

The degree evaluation is completed in four steps: 1) students fill out a graduation application at least two quarters prior to graduation and set up a meeting with their faculty advisor to complete a graduation assessment. Students' plans indicate the courses they plan on taking during their remaining quarters. 2) A faculty advisor completes the degree evaluation using Degree Works. The program advisor confirms that all transfer classes and any exceptions that were granted are properly entered into Degree Works. The faculty advisor then adds a note that lists the students' remaining courses, including the plan to complete any outstanding technical elective requirements, and verifies that with the completion of these courses, students meet all graduation requirements. 3) The Department Chair verifies that the student and advisor's plan satisfy the program requirements and adds a note to Degree Works verifying that the student will have met graduation requirements with the completion of the listed courses. 4) The Registrar's office credit evaluators verify that the students have met all University requirements for graduation.

A student cannot graduate without meeting the program requirements unless they appeal to the departmental exceptions committee as was outlined in Section 1.B.

G. Transcripts of Recent Graduates

The MFGE program will provide transcripts from some of the most recent graduates to the visiting team along with copies of the same students' files from Degree Works, along with any needed explanation of how the transcripts and Degree Works files are to be interpreted.

The program is designated on the transcript as: MFGE-Manufacturing Engineering: WB34

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

Western Washington University Mission and Values:

Western Washington University is a public comprehensive institution dedicated to serving the people of the state of Washington. Together our students, staff, and faculty are committed to making a positive impact in the state and the world with a shared focus on academic excellence and inclusive achievement.

As a community, we uphold certain basic values. These include:
- Commitment to student success, critical thought, creativity, and sustainability
- Commitment to equity and justice, and respect for the rights and dignity of others
- Pursuit of excellence, in an environment characterized by principles of shared governance, academic freedom and effective engagement
- Integrity, responsibility and accountability in all our work

Engineering & Design Department Mission:

The Engineering & Design department at Western Washington University serves current students, industry, the University, and the citizens of Washington State by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience that we provide emphasizes critical thinking and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context. We value and foster teamwork, communication, and a commitment to equity, justice, and the respect for the rights and dignity of others.

B. Program Educational Objectives

The objective of the Manufacturing Engineering Program is to prepare graduates who will be successful in their chosen career paths. Specifically, within five years of graduation, graduates of this program will be capable of achieving:

Success in their chosen profession as evidenced by:
- career satisfaction
- career advancement (e.g., promotion/raises, new jobs/positions, leadership roles, professional license)
- life-long learning (e.g., continued education, technical training, professional development)
- professional visibility (e.g., publications, presentations, patents, inventions, awards, involvement in professional societies and standards bodies)
- entrepreneurial activities.

Or

Success in continued studies as evidenced by:

- satisfaction with the decision to further their education
- graduate and professional degrees earned
- teaching and/or research experiences, and/or
- grant activities and academic publications

The Manufacturing Engineering Program PEOs are available to the public on the Engineering & Design Department website.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

All of the Manufacturing Engineering Program Educational Objectives (PEOs) are "student-centered" and about developing the potential of the students in the program so that they will be strong contributors in their careers and communities after graduation. These are consistent with the "serves the people of the State of Washington" and "making a positive impact in the state and the world" portions of the University mission. Furthermore, a focus on "academic excellence and inclusive achievement" is a key component of preparing students for long-term success.

D. Program Constituencies

Program constituencies are:

1. *Students* – Who rely on the program to prepare them to become successful learners and to have success in their chosen career and/or continued studies.
2. *Employers* – Who depend on the value of our graduates as employees to achieve company goals.
3. *Alumni* – Who are forever tied to the program and its reputation through the success of its graduates.
4. *Faculty* – Who are committed to developing the appropriate outcomes and curriculum that leads to students achieving the educational objectives and who, themselves, rely on the success of the program to achieve their career goals.

E. Process for Review of the Program Educational Objectives

The Program Educational Objectives are reviewed, at least, every three years. Responsibility for the review and documentation is with the MFGE program director and final approval is with the MFGE program faculty. Figure 2.E.1. is a flowchart illustrating the continuous improvement process used by the program. Highlighted are the activities related to the review and continuous improvement of the Program Educational Objectives.

Review of PEOs is handled through surveys and meetings with the constituents.

Students – Students will meet to discuss the program objectives at least every three years as part of the senior project course. Survey forms will be used to provide feedback from the student's perspective.

Employers – The MFGE program's Industrial Advisory Committee, IAC, is shown in Table 2.E.1. It is made up of the primary employers of the program's graduates. They will review the PEOs at least every three years during an IAC meeting. Meeting minutes include feedback from the IAC.

Alumni – The IAC consists primarily of alumni (see Table 2.E.1) so feedback from the IAC also doubles as input from the Alumni. In addition, when the program decides it useful, a survey may be sent to all Alumni to assess the attainment of the PEOs. PEOs are worded in such a way that the evidence of attainment is easily obtained.

Faculty – Faculty will review the PEOs at least every three years during the program evaluation meeting in the spring. Additional discussion may occur any time an issue with the PEOs is raised, which could trigger an improvement with the PEOs and subsequent review by the IAC. In addition, in order to promote consistency across the three engineering programs, the departmental chair convenes a review of the PEOs at a departmental meeting. This allows all faculty to have an opportunity to contribute to the development of the PEOs, and the three engineering programs to coordinate on changes. Any changes to the PEOs will potentially result in a modification of the student learning outcomes to PEO mapping (see Table 3.B.1 in Criteria 3 section).

The current version of the Program Education Objectives (PEOs) was developed and approved by the MFGE program and ENGD department in 2013 as part of the transition to Engineering. Discussion of these by the program's IAC first occurred at the Fall 2013 meeting. For this review period, the PEOs have been regularly discussed each academic year at the MFGE Program and the IAC meetings, the latest is in Spring 2021. These discussions are recorded in the program and IAC meeting minutes for this period.

Member	**Company**	**Position**	**Alumni**
AJ Schuehle	Hexcel	Engineering Manager	Yes
Andrew Gall	Paccar	Manufacturing Manager	No
Anna Novack	Boeing	Tooling Manufacturing Engineer	Yes
Arjay Quedado	Boeing	Manufacturing Electrical Engineer	Yes
Daniel Cuenca	Boeing	Production Engineer Manager	Yes
David Carlson	Hexcel	Engineering Manager	Yes
Fredrick Rudnick III	Boeing	Product Engineer	Yes
Joe Gary	Korry	VP of Engineering & Quality	Yes
Josh Little	Boeing	Manufacturing Engineer	No
Julie Bennett	Boeing	Manager	No
Max Meaker	Janicki	Machine Operations Engineer	Yes

Michael Hinckley	Archer	Director of Engineering	Yes
Randall Weaver	Boeing	Engineering Manager	No
Tim Bond	Boeing	Project Manager	No
Tyler Mohr	Fluck Corp.	Director of Operations	Yes

Table 2.E.1 MFGE Industrial Advisor Committee Membership

Overview of Process

To improve effectiveness and efficiency, the MFGE Program's Continuous Improvement Process is similar in process and timing to that of the Electrical Engineering and Plastics and Composites Engineering Programs.

Figure 2.E.1 highlights those activities in the program's continuous improvement process that focus on the revision of the Program Educational Objectives. The figure outlines the steps taken for revisions to the program objectives, student outcomes, and changes to this continuous improvement process itself. In the flow diagram, squares are objects/information and ovals are processes. This process is executed annually.

The first step in the process is *Program Level Evaluation* (end of Spring/start of Fall). The primary information that is used during this evaluation includes (1) the existing Program Objectives, (2) Student Outcomes, (3) the Outcome to Objective Mapping, (3) the Continuous Improvement Plan, and (4) Assessment Data and Evaluations from the previous year. Other relevant information considered includes data from supporting programs (Math, Physics, Chemistry etc.), changes to ABET-EAC requirements, General University Requirements (GUR) changes, budgetary restrictions, alumni/employer surveys and course evaluations.

If changes are identified by the program, feedback is sought as early as possible on these from the Industrial Advisory Committee (second step, *IAC Review*). IAC meetings occur at the end of the Spring and start of the Fall terms. As mentioned previously, these meetings double as a mechanism to solicit alumni feedback.

For the third step, when changes are recommended, the program faculty proposes these to the Engineering & Design Department's Curriculum Committee as part of a *Departmental Level Review*. This step is designed to as much as possible harmonize PEOs across the department's three engineering programs. If proposed changes are rejected, depending on the recommendations made, the process may return to the first step for further study, and possible amendments for future consideration. If the proposed changes are approved by the Curriculum Committee, these changes are presented to the department faculty as a whole for final approval. Once the changes are approved by the department, depending on any amendments made, further consultation with the IAC may be sought. Approved changes are reflected in a new version of the Program Objectives, Program Outcomes, and/or Continuous Improvement Plan that will be used for the next academic year.

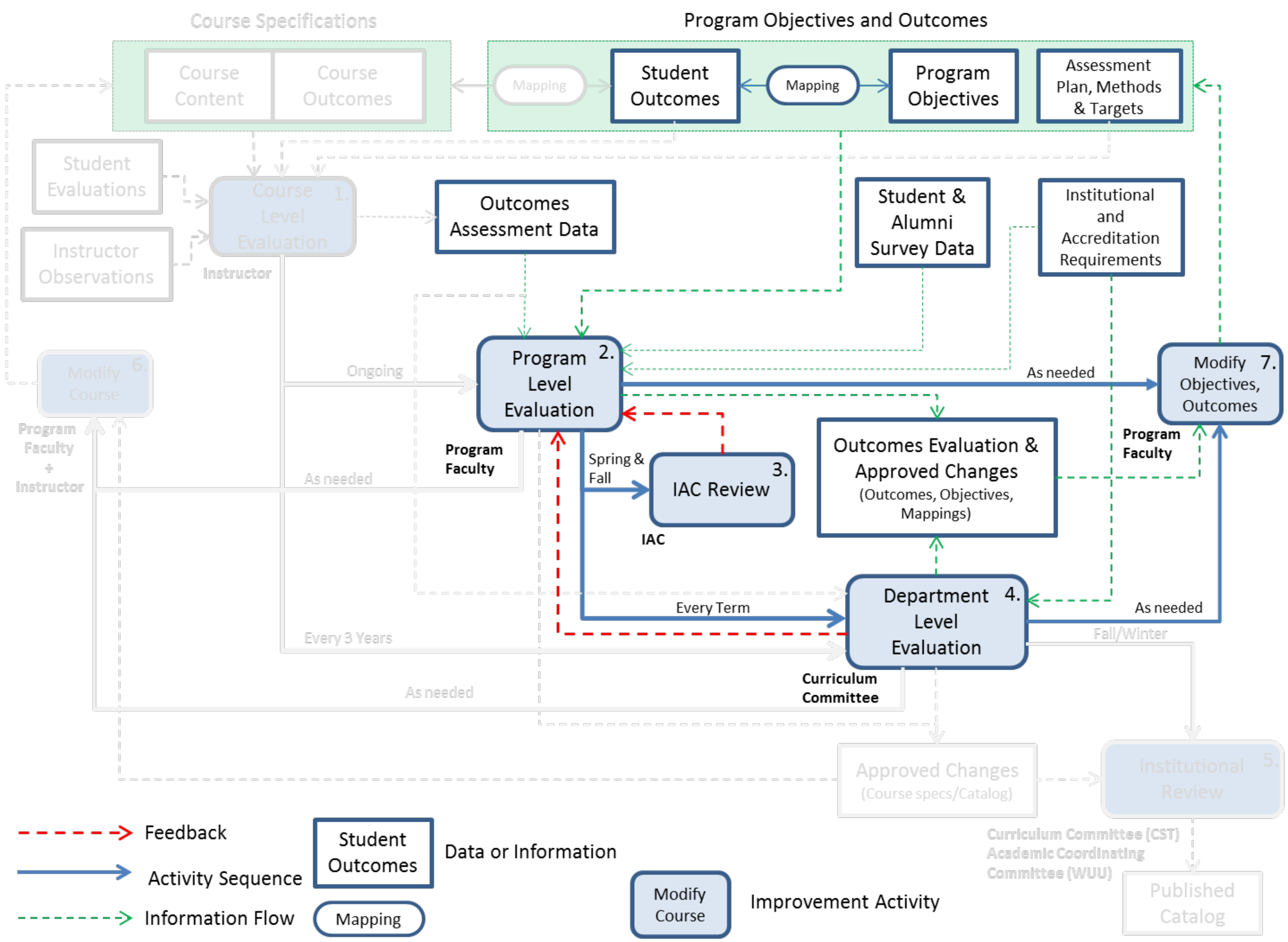


Figure 2.E.1 Continuous Improvement Process (Focus on PEOs)

CRITERION 3. STUDENT OUTCOMES

Student Outcomes

The current Student Outcomes for the MFGE Engineering Program are:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

These outcomes were adopted in spring 2018 and took effect in fall 2018. Up through spring 2018, the Student Outcomes were:

a. an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design and conduct experiments, as well as to analyze and interpret data;
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
d. an ability to function on multidisciplinary teams;
e. an ability to identify, formulate, and solve engineering problems;
f. an understanding of professional and ethical responsibility;
g. an ability to communicate effectively;
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
i. a recognition of the need for, and an ability to engage in life-long learning;
j. a knowledge of contemporary issues; and
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Relationship of Student Outcomes to Program Educational Objectives

Career success requires all student outcomes as they require technical, business, communication, professionalism, and individual outcome categories. The success in continued studies focuses on technical, communication, and individual outcome categories.

Objective and Evidence	Student Outcomes
Success in their chosen profession as evidenced by:	
career satisfaction	1-7 (a-k)
career advancement	1-7 (a-k)
life-long learning	6, 7 (e, h-k)
professional visibility	1-6 (b, c, g-j)
entrepreneurial activities	2-5, 7 (d, f-i)
Success in continued studies as evidenced by:	
satisfaction with the decision to further their education	1, 2, 4, 6, 7 (a-c, e, g, i)
graduate and professional degrees earned,	1-7 (a-c, e, g, i)
teaching and/or research experiences, and/or	1-7 (a-k)
grant activities and academic publications.	1-3, 4, 6, 7 (a,b,f,g,h,i,j)

Table 3.B.1 Outcomes Support of PEOs

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

A.1 Listing and Description of Assessment Processes

Since the last ABET accreditation visit in 2016, we continued to assess a-k Students' Learning Outcomes (SLOs) as previously scheduled (Refer to Appendix E.1 for the a-k rubrics). When ABET approved the transition to 1-7 SLOs, the Faculty mapped the two outcomes and created a new set of rubrics for assessment (see Appendix E.2 for the mapping process, and Appendix E.3 for the 1-7 rubrics). For each SLO rubric, four to six performance indicators (*PIs*) are used to rate students at one of four levels of proficiency: *Exemplary*, *Satisfactory*, *Developing* and *Unsatisfactory*. Below is a **description of the assessment and evaluation process for the SLOs**:

- *Assessment Methodology:* For each *PI* in any of the rubrics, the type of data collected e.g., exam questions, student project work, laboratory work, homework assignments, in-class activities etc., should be described.
- *Assessment Target:* In most cases, 80% of students receiving a *Satisfactory* or *Exemplary* rating on a performance indicator is the target.
- *Continuous Improvement Actions:* For each *PI* in any of the rubrics, the evaluator records any actions proposed to address developing or unsatisfactory performance for any of the *PIs*. These actions are then discussed and determined at program and curriculum committee meetings for which minutes are available.
- *Re-evaluation Plan:* This identifies when the results of the improvement action(s) will be re-evaluated. In most cases actions would be executed so that a re-evaluation can be performed at the time of the next scheduled review.

Formal assessment of SLOs is planned to occur over **a three-year cycle**, please refer to Appendix E.3 for the full review schedule. When we were required to move from outgoing ABET a-k outcomes to incoming ABET 1-7 outcomes effective AY2019-20, the program had already completed a full set of assessment and evaluation of a-k rubrics in AY2017-18 meanwhile creating new rubrics for the incoming 1-7 SLOs. We started the three-year assessment in AY2018-19 (one year before they are officially required) to be able to complete a full three-year cycle and provide sufficient time for evaluation and analysis of the data.

Section 4.A below provides summaries of evaluation and analysis of attainment of the a-k and 1-7 SLOs during this review period. It should be noted that the information captured in these tables show student performance at **summative levels** of assessment and evaluation obtained towards the end of the program (senior year courses). Whenever possible, assessment and evaluation consider data from **more than one course** for comprehensive evaluation. Moreover, *PIs* for one rubric can be assessed in different classes, for example SLO4 has four PIs, SLO4.1 is assessed in MFGE 493, while SLO4.2,3, and 4 are assessed in MFGE 491.

Although SLOs are evaluated on the **summative level** of upper-level courses (MFGE 4xx), lower-level courses "prerequisite structure" are essential blocks that ensures that the foundations of these SLOs are built during the second- and third-year courses (2xx & 3xx). This process is examined through a cyclic review of each course in the **course review cycle schedule,** please refer to appendix E.5 for the full course review schedule. All the courses in the curriculum will be reviewed by the program faculty (and the curriculum committee for ENGRxxx courses) once **every three years**. During these course reviews the faculty responsible will give a detailed presentation answering the following questions:

1. Did students entering the class meet the pre-requisite outcomes, and what is the evidence?
2. Are students meeting the course learning outcomes, and what is(are) the evidence?
3. If not, what changes would you recommend improving students' learning?
4. Are there other changes that you would recommend be made to the course and/or its learning outcomes, and if so, why?
5. What changes have been made to address recommendations made at the last review and what has been their effect? (Added *in AY2018-19 to strengthen the efforts of closing the loop & continuous improvement*)

This helps the program **modify/improve** any unmet SLOs through providing the appropriate support structure in that class or the prerequisites.

A.2 Frequency of Assessment Processes

Formal assessment of **SLOs** and **course reviews** occur over a **three-year cycle**, please refer to appendix E.4 and E.5 for the schedules.

A.3 Expected Level of Attainment for Student Outcomes

The rubrics used for assessment score students at **one of four levels** of proficiency for each performance indicator: *Exemplary*, *Satisfactory*, *Developing* and *Unsatisfactory*. The program has set a common level of attainment for all indicators, with the expectation that **80%** of students achieve an *Exemplary* or *Satisfactory* rating. Since multiple indicators are used to assess an outcome, and attainment may be achieved in some and not in others, a blanket statement that an outcome has been met is not possible in all cases.

A.4 Summaries of Evaluation and Analysis of Attainment of Outcomes

The following are brief summaries of the tabulated assessment and evaluation information for both a-k outcomes and 1-7.

Outcome	Assessment Methodology	Assessment Quarter	Assessment Results
(a) an ability to apply knowledge of mathematics, science, and engineering to solving problems in manufacturing engineering;	MFGE 465 – Selected Homework/Exam Questions MFGE 493 – Performance on Implementation of Senior Project	Fall 2016 Spring 2016	This outcome was successfully achieved. All 5 items on the rubric had 84-100% of students doing satisfactory or exemplary work.
(b) an ability to design and Conduct experiments and to analyze and interpret data within a manufacturing context;	MFGE 453 or 434 – Selected Lab-Work using DOE	Winter 2016	This outcome was mostly achieved. Students did a good job of designing, conducting, and analyzing the experiment, with 84-100% of students doing satisfactory or exemplary work in these areas. However, students did not sufficiently close the loop and tie findings back to relevant literature consistently; only 50% of students did satisfactory or exemplary work in this part, so we will need to address this.
(c) an ability to design products, and to design or select the processes, equipment, tooling, and systems necessary for their manufacture to desired specifications;	MFGE 492 – Design Work in Capstone Project MFGE 493 – Realization of Design in Capstone Project	Winter 2016 Spring 2017	This outcome was mostly achieved. Students followed a design process in both MFGE 492 (project proposal) and MFGE 493 (project implementation), considered and ranked alternatives, proposed and implemented viable solutions, and justified design decisions with analyses with 84-94% producing satisfactory or exemplary work in these areas in MFGE 493 (there was more variation in MFGE 492). The one area where students struggled was in producing appropriate design documentation; only 37% produced satisfactory or exemplary design documentation in MFGE 492, and only 74% did so in MFGE 493. Since this was not an issue last year, we will need to keep an eye on this to see if it is a trend that needs to be addressed or an anomaly.
(d) an ability to function on multidisciplinary teams;	MFGE 493 – Teamwork in Capstone Design Project	Spring 2017	This outcome was successfully achieved. All 4 items on the rubric had 94-100% of students doing satisfactory or exemplary work.
(e) an ability to identify, formulate, and solve engineering problems;	MFGE 493 – Problem Solving in Realization of Project	Spring 2017	This outcome was successfully achieved. All 4 items on the rubric had 100% of students doing satisfactory or exemplary work.
(f) an understanding of professional and ethical responsibility;	MFGE 491 – Ethics Assignment MFGE 493 – Ethics Discussion in Project Self-Assessment	Fall 2016 Spring 2017	This outcome was partially met. 84% of students met or exceeded expectations for identifying ethical issues, but only 79% of them sufficiently contributed to discussions regarding engineering ethics. Since this is just below the target threshold, we will watch this again next year to see if this is an anomaly or a trend, for it was not an issue last year.
(g) an ability to communicate effectively;	MFGE 463 – Engineering Drawings MFGE 492 – Written and Oral Assignments MFGE 493 – Final Report on Senior Project	Fall 2016 Fall 2016 Spring 2017	This outcome was successfully achieved. In MFGE 463 89-100% of students met or exceeded expectation in the various items, and in both MFGE 492 and MFGE 493 95-100% of students met or exceeded expectation in the various items.
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic,	MFGE 491 – Assignments and In-Class Discussions	Fall 2016	This outcome was partially met. 84% of students met or exceeded expectations in their contemporary issues assignments, but only 53% did so in their contributions to class discussions. This is a reversal of last year, though more extreme, so we will need to keep an eye on it next year. The final item on the rubric was met. 92% of students

environmental, and societal context;			met or exceeded expectations in their performance in GUR courses as measured by their GPA in those classes.
(i) a recognition of the need for, and an ability to engage in life-long learning;	MFGE 492 – Research for Capstone Design Project	Winter 2017	This outcome was successfully achieved. All 3 items on the rubric had 84-95% of students doing satisfactory or exemplary work.
(j) a knowledge of contemporary issues;	MFGE 491 – Contemporary Issues Assignments	Fall 2016	This outcome was successfully achieved. All 4 items on the rubric had 84-95% of students doing satisfactory or exemplary work.
(k) an ability to use and practical experience with the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice.	MFGE 493 – Use of technologies in Capstone Project	Spring 2017	This outcome was successfully achieved. All 4 items on the rubric had 95% of students doing satisfactory or exemplary work.

Table A.4.1 Outcome Assessment Methodologies, schedules, and Results for a-k rubrics

Outcome	***Assessment Methodology***	***Assessment Quarter***	**Assessment Results**
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	MFGE 465 – Various Homework Assignments, MATLAB Activities	Fall 2020	A satisfactory (80%) or better rating was attained in the student's ability to satisfy the five PIs of SLO1. To provide more reinforcement of analytical problem-solving skills, MFGE 465 class was moved to third year (now 365) and MFGE 453 became a required class which will be used to assess this outcome on the summative level for the next data collection cycle. All MFGE majors starting with the class admitted in 2022 will have MFGE 453 completed as part of their graduation requirement not a technical elective class.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	MFGE 491/492/493 – Evidence Documented in Capstone Project Report MFGE 463 – Several Assignments and Midterm Questions	AY 2020-21 Fall 2020	A satisfactory (80%) or better rating was attained in the student's ability to satisfy the six PIs of SLO2 in the Capstone project courses. And all PIs but SLO2.3 were satisfactory or better rating in MFGE 463. SLO2.3 is not evaluated in that class.
3. an ability to communicate effectively with a range of audiences	MFGE 492 – Proposal & Presentation in Capstone Project MFGE 493 – Poster Design in Capstone Project MFGE 463 – Work Instructions Assignment	Winter 2019 Spring 2019 Fall 2018	SLO3.2 on 'organized & concise communication' and & SLO3.4 on 'style appropriate to the audience' were not met for the MFGE 492 proposal or the MFGE 463 work instructions, but all *PIs* were met for all other assessments, so students who struggled in fall and winter did well in spring, and there were no issues with presentations or posters for non-technical audiences. May need to relook at work instructions in junior courses.
4. an ability to recognize ethical and professional	MFGE 491 –	Fall 2018 Spring 2019	Students did well in all areas except for the SLO 1.1"recognize and articulate ethical

responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	Ethic Presentation and Analysis MFGE 493 – Self Reflection Assignment, Capstone Report		and professional responsibilities in engineering situations". Performance on that *PI* was just below the 80% threshold in the fall and just above the 80% threshold in the spring, so barely meeting expectations and in need of tracking.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	MFGE 492 – Weekly Teamwork Evaluation MFGE 493 – End of Quarter Peer Evaluation	Winter 2020 Spring 2020	A satisfactory (80%) or better rating was attained in the student's ability to satisfy the five PIs of SLO5. Despite COVID, students were able to satisfy all *PIs* while working virtually with their teams and sponsors.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	MFGE 463 – Lab Experimentation and Reporting	Fall 2021	A satisfactory (80%) or better rating was attained in the student's ability to satisfy the five PIs of SLO6. Performance on SLO6.3 "interpret experimental data and results with respect to the driving question" was just above the 80% threshold because the students had to redo their data collection twice based on the instructor's feedback, but their grade was weighted more on the first submission. The final submission was satisfactory.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	MFGE 493 – Final Report in Capstone Project Background Research Section	Spring 2020	A satisfactory (80%) or better rating was attained in the student's ability to satisfy the five PIs of SLO7.

Table A.4.2 Outcome Assessment Methodologies, Schedule, and Results for 1-7 rubrics

A.5 Documentation and Maintenance of Results

The following mechanisms are used for documenting and maintaining the results of the outcomes assessment and evaluation process:

(a) *SLOs Assessment Worksheets* (see sample in Appendix E.6)
This is the primary mechanism used for recording the results from assessment. An Excel worksheet is maintained for each outcome for every course selected for collecting data. Worksheets are designed around the rubrics and performance indicators that have been developed. These are available for use by the instructors teaching a course for which assessment is being conducted. Instructors are required to document the assessment method used and to indicate the number of students attaining each level of achievement. A new worksheet is created for each assessment cycle.

(b) *Program Annual Assessment Report* (Appendix E.7)
These reports summarize SLOs that were assessed for that year and the program continuous improvement documentation for "closing the loop" on actionable assessment and evaluation results.

(c) *MFGE Program Meeting Minutes* (sample in Appendix E.9)

Deliberations on the evaluation of assessment data and continuous improvement actions are currently recorded primarily in the MFGE program's meeting minutes. These are then transcribed into other documentation as needed.

(d) *Course Outcomes 3-Year Reviews* (sample in Appendix E.8)
These record attainment of course level outcomes performed by the instructor every three years. Though not directly worded as the 1-7 program outcomes, all these course outcomes are mapped to the SLOs and the specific performance indicators that they measure. The instructor is required to report to the program (or the ENGD curriculum committee for courses shared with other programs) on the following questions:

1. Did students entering the class meet the pre-requisite outcomes, and what is the evidence?
2. Are students meeting the course learning outcomes, and what is(are) the evidence?
3. If not, what changes would you recommend improving students' learning?
4. Are there other changes that you would recommend be made to the course and/or its learning outcomes, and if so, why?
5. What changes have been made to address recommendations made at the last review and what has been their effect? (*Added in AY2018-19 to strengthen the efforts of closing the loop & continuous improvement*)

It is the responsibility of the Program Director to maintain the documentation and data generated by the assessment process. A shared network drive has been created for instructors to deposit assessment data when it is collected. The director organizes this data and extracts and summarizes what is needed to create the required summaries. Collection and maintenance of meeting minutes is also their responsibility.

B. Continuous Improvement

B.1 The Continuous Improvement Process

The continuous improvement process used to regularly assess student outcomes is shown in Figure 4.1. The inputs to the process (top of figure) are the published student outcomes, program educational objectives and course specifications (defining the course content and course learning outcomes).

1. *Course Level Evaluation:*
Instructors are responsible for ensuring that course outcomes as defined in the course specification are being met. They are able to improve the course as they see fit in a manner that is consistent with the published course specification using their own observations, student evaluations and program feedback. All courses have a lead faculty assigned (or group of faculty) who has responsibility for curriculum development.

   For courses used to assess the SLOs on the summative level, the instructor identifies suitable assessment methods and assignments for collecting the required data. These target the performance indicators used in the rubrics developed for each outcome (see Appendix E.1 and E.3). The instructor collects the assessment data according to the schedule (see Appendix E.4) and passes this on to the program director for evaluation by the program.

Instructors provide informal course updates to the program faculty at end-of-term meetings on an ongoing basis. Changes to courses taken only by majors of the MFGE program may be approved at this time. Changes for courses that are required by other programs are passed forward to the ENGD Curriculum Committee for further deliberation.

In addition to these informal course updates, each course is on a three-year formal review cycle (see Appendix E.5). The instructor at the time of this review must give a presentation to the program or ENGD Curriculum Committee describing how the course is meeting the published outcomes and providing recommendations for improvement.

Supporting Documentation:

- Course specification sheets — Appendix A
- SLOs Rubrics — Appendix E.1, E.3
- Outcome Assessment Data Collection Worksheet (Sample) — Appendix E.6
- Course Outcomes 3-Year Reviews Schedule — Appendix E.5
- Program Meeting Minutes (Sample) — Appendix E.9

2. *Program Level Evaluation:*

Assessment and evaluation will occur on a three-year cycle for each outcome. This schedule is shown in Appendix E.4. If targets set by the program are not achieved, improvements will be proposed, approved and executed to address the deficiency. These are overseen by the lead faculty assigned to the course in question (See Appendix E.4). Evaluation data and recommended changes to courses that are also required by non-MFGE majors are passed on for consideration to the relevant program or the ENGD Curriculum Committee (Department Level Evaluation) before final approval.

As mentioned previously, instructors also give course reviews to the program on a three-year cycle, where attainment of course outcomes is evaluated. More informal updates of the student learning in courses they teach are given by faculty at the end-of-term program meetings. This provides a mechanism to address a problem that might arise within the formal three-year cycle. This is particularly useful in guiding the development of new courses where the content and outcomes are evolving.

The program is also responsible for defining and modifying as needed the student outcomes, program educational objectives, mappings and assessment methods and targets.

Supporting Documentation:

a. Course to Outcome Mapping — Appendix E.4
b. Outcome Rubrics — Appendix E.1, E.3
c. Outcome Assessment Data Worksheets (Sample) — Appendix E.6
d. Program Meeting Minutes (Sample) — Appendix E.9

3. *IAC Review*:

The program uses its Industrial Advisory Committee to provide feedback on all major curriculum changes. In cases where assessment driven changes require significant modifications to a course's content and outcomes, the guidance of the IAC is sought to maximize harmonization with regional industrial practice. The IAC also provides guidance on the introduction of new material to the curriculum and in helping the program set its educational objectives. The IAC meets twice yearly (the end of the Fall term and the end of the Spring term).

Supporting Documentation:

a. IAC Meeting Minutes (Sample)	Appendix. E.10

4. *Department Level Review*:
The ENGD Curriculum Committee is responsible for curriculum oversight at the department level. Evaluation of assessment data for all courses with the ENGR designation (mostly pre-major classes) is the responsibility of this committee with input from the programs.

Evaluation results and recommended changes for MFGE courses, particularly those that are required by other programs, are also reviewed by this committee. This is done on a three-year cycle, though the program is free to bring forward an issue that arises from evaluation at any time for consideration. Any curriculum changes that result in modifications to the published program and course descriptions in the WWU Catalog, must be reviewed and approved by the curriculum committee. Examples of these include changes to course prerequisites, credit hours, descriptions and course requirements for the major. Web forms have been developed by the university for this purpose.

Supporting Documentation:

a. Course 3-Year Reviews (Sample)	Appendix E.8
b. ENGD Curriculum Committee Meeting Minutes (Sample)	Appendix E.11
c. WWU Program and Course Change Forms (Sample)	Appendix E.12

5. *Institutional Review*:
This occurs at two levels. The first is by the Curriculum Committee of the College of Science and Engineering. All program and course changes that impact information published in the university catalog must be reviewed and approved by this committee. A similar review is conducted at the university level by the Academic Coordinating Committee (ACC). As a case in point, the distribution of the credit hours of the MFGE 491/2/3 were re-evaluated and changed in AY2019. This change was first approved by the program, the department, and then the institution's approval.

Documentation:

a. WWU Program and Course Change Forms (Sample)	Appendix E.12
b. Program annual assessment report	Appendix E.7

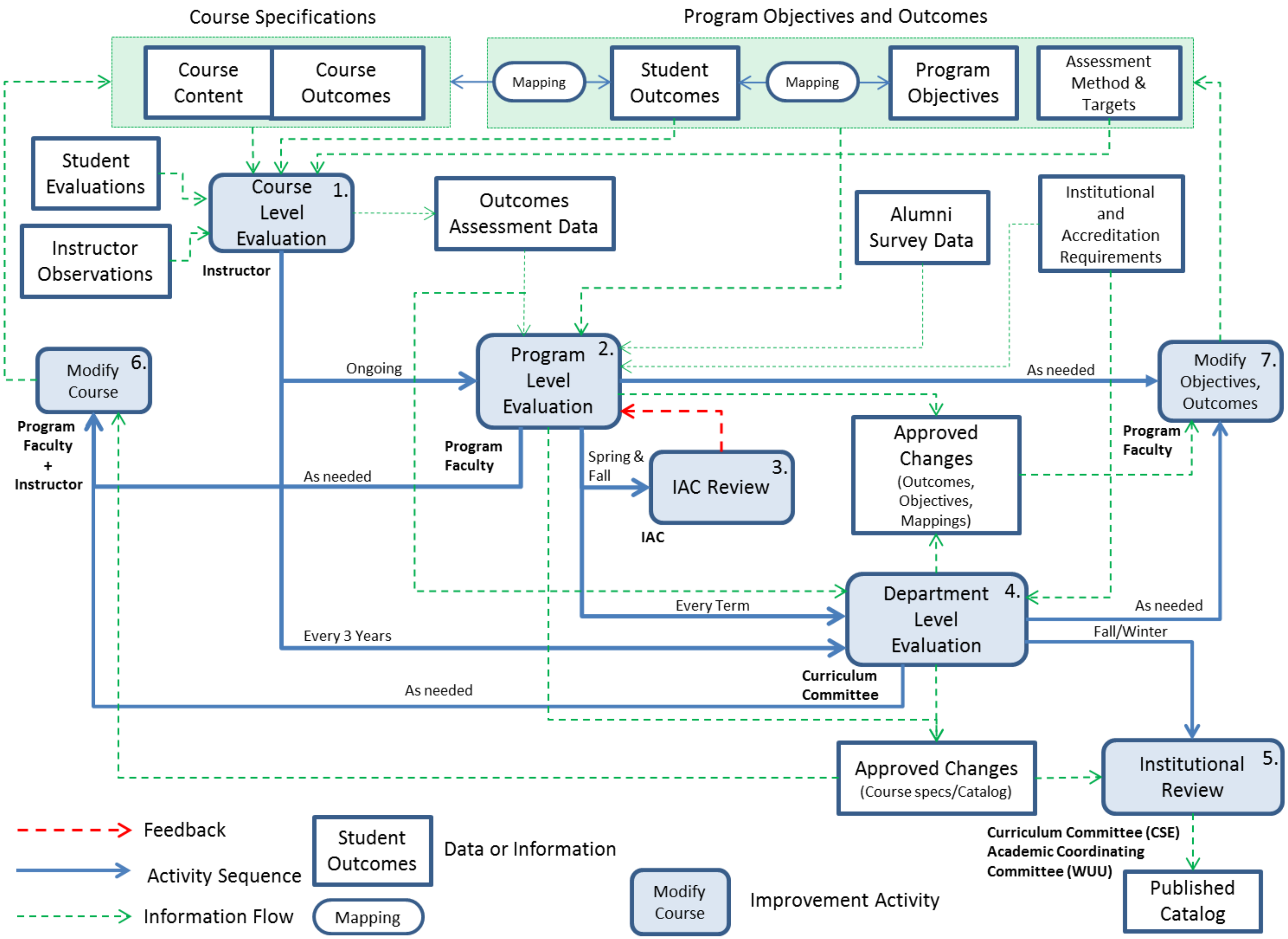


Figure 4.1 Continuous Improvement Flowchart

B.2 Continuous Improvement Actions

B.2.1 Actions Derived Directly from Summative Assessment Data Evaluation

Table B.2.1 provides a summary of the improvement actions currently proposed based on summative assessment data evaluation of SLOs 1-7 during the review periods 2019-19, 2019-20, & 2020-21, summative evaluation was carried out during AY 2021-22. A complete list of actions for a-k SLOs can be found in Appendix E.13.

A. Improvement Actions Identified Directly from Evaluation of Collected 1-7 Assessment Data						
SLO	**Year Assessed**	**Description of proposed improvement recommended by evaluation**	**Rationale that improvement can assist in achieving the outcome, or its assessment**	**Evidence of improved learning or its assessment**	**Responsible Faculty and Deadline**	**Status of Improvement Action/Conclusions from Evidence Collected in 2021-22**
1	2020-21	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A
2	2020-21	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A
3	2018-19	Continue working to improve student's abilities to write work instructions to effectively communicate information with a broad range of audience	Practice will help in preparing students to better communicate technical data in work instructions	Scores for SLO 3.4 will rise above the 80% threshold.	David Gill (F2021)	Student achievement met the 80% target. More emphasis on writing on work instructions in the mastery level class (assessment class) and the reinforcement class (pre-requisite) helped the students achieve the target in SLO3.4.
4	2018-19	Continue working to improve student's abilities to identify and articulate ethical dilemmas with more structured assignments.	Practice will help in preparing students for their presentation and exam.	Scores for SLO 4.1 will rise above the 80% threshold.	Derek Yip-Hoi (F2021)	Student achievement met the 80% target. As expected, Shifting the Project Planning content from 491 to 492 created space during the term for more focus on developing this ability.
5	2019-20	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A
6	2020-21	The rubric as introduced did not provide an informative assessment tool	PIs should be worded differently to assess all types of	- Instructors will find it appropriate to use the rubric as an	David Gill (F2021)	The instructor proposed adding "when relevant" to PI 6.4 when the description used "research literature" so broader analysis can be evaluated. Student

		for the outcome. A revised rubric was proposed and evaluated in 2021-22.	experimentation not only the specific statistical DOE method	assessment tool for analyzing experimentation in various settings - Scores for SLO 4.1 will rise above the 80% threshold.		achievement met the 80% target. As expected, Shifting the Project Planning content from 491 to 492 created space during the term for more focus on developing this ability.
7	2019-20	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A

Table B.2.1 Proposed Improvements Based on Summative Assessment Data Evaluation

B.2.2 Improvement Actions Derived from Other Evidence Gathered

In addition to the continuous improvement actions derived directly for the summative assessment of SLOs, the program is also paying particular attention to potential improvements that are not directly driven by 1-7 outcomes assessment and evaluation, but important, nonetheless. These improvements have been identified from observations and discussion amongst the faculty and other constituents such as students, alumni and members of the program's IAC. Table B.2.2 below provides a summary of the improvement actions currently proposed based on other evidence gathered during 2020-21. A full list of improvements for all the academic years in this review period for 1-7 SLOs is included in Appendix E.13

B. Improvement Actions Identified from Other Evidence Gathered					
Description of Proposed Improvement 2020-21	**Area(s) of Impact***	**Rationale that improvement will have Impact in the Area(s) Indicated**	**Evidence to demonstrate that Impact has been Realized**	**Responsible Faculty and Deadline**	**Status of Improvement Action/Conclusions from Evidence Collected**
Perform assessment of SLOs 1, 2 and 6 to determine effectiveness.	A	Change to new 1-7 outcomes have been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is	S. Alqudah (F2021)	S2021: Second round of assessment data using SLOs 1, 2 were completed. Assessment revised SLO6 was completed and the revised rubric was approved.

			complete and effective.		
Improve exposure to automation by making Robotics (MFGE 453) a required course for all MFGE majors.	C	Currently majors have a choice between robotics and advanced CNC (MFGE 434). This will help to expand the exposure of all MFGE majors to robotics. Given the increase in use of automation in local industry, this direction was decided upon in consultation with the program's IAC.	All MFGE majors starting with the class admitted in 2022 will have MFGE 453 completed as part of their graduation requirement.	S. Alqudah (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to make robotics required by all MFGE majors. This change will be in effect for the class admitted in winter 2022.
Provide more timely reinforcement of analytical problem-solving skills by moving MFGE 465 Machine Design from the senior to the junior year as MFGE 365.	C	Currently most students have at least a one-year gap between completing ENGR 225 Strength of Materials and applying this material in MFGE 465. There is concern that students are forgetting this foundational material. Moving MFGE 465 to the junior year will reduce the gap to reinforcement and provide more opportunities to engage juniors in analytical work.	Faculty teaching MFGE 365 will observe the preparation of students based on the MFGE 225 prerequisite and report on preparation of students at next MFGE 365 course review in 2024. This should indicate adequate preparation.	T. Algeddawy (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to replace MFGE 465 with MFGE 365. W2021: Both classes have been scheduled for the 2021-22 academic year to facilitate the move to the junior year.

Formalize expansion of learning opportunities for majors in Robotics, Automation and Systems Integration (RASI) by converting MFGE 497B Systems Integration from an experimental course to MFGE 454. This course will now appear in the university catalog and in program planning guides as an option for majors to take.	C	This is the next in a sequence of steps taken by the program over the past few years to expand learning opportunities in RASI. This completes improvement 3 started in 2018-19. Though this class will remain an option, together with the introduction of MFGE 250 in S20 and the improvement above to make robotics required by all majors, it will greatly impact the amount of exposure majors can receive to RASI	Faculty teaching MFGE 454 will be able to observe the abilities of students having taken all courses in the sequence that supports RASI i.e., MFGE 250, EECE 351, EECE 352, MFGE 453 and MFGE 454. At the next course review the faculty will provide evidence of improvement in the preparation of majors who have taken this full sequence through assessment of the course's outcomes and prerequisite outcomes.	T. Algeddawy (S2021)	F2020: Changes have been made through the formal WWU curriculum approval adding MFGE 454 to the program. W2021: Class has been included in the 2021-22 academic year.
Move courses with a high level of specialization to the senior year to provide room in the junior year for more foundational experiences such as completing outstanding Math/Science requirements, computational methods and machine design, and to participate in research. The courses that will be moved are MFGE 362 (renumbered to MFGE 462) and PCE 372. The	C, SS	The 2020-21 junior course load is 3/4/4. This is an increase from the previous 3/3/4 load. The two openings in fall and winter have been used by some students to complete requirements from the sophomore year. Some students, particularly those working, also benefit from the lighter course load. Returning to a 3/3/4 load will increase the flexibility of students to complete	Fewer students will need to take summer classes between their sophomore and juniors' years because of the additional opportunity to complete a lower-division requirement. Fewer students with external commitments such as work struggle to keep pace with the program.	D. Yip-Hoi (W2021)	F2020: Changes have been made through the formal WWU curriculum approval process to renumber MFGE 362 to MFGE 462. W2021: MFGE 362 and MFGE 462 have been scheduled for 2021-22 and PCE 372 temporarily dropped to return in 2022-23.

course load will return to 3/3/4		requirements without having to take summer classes and help students with heavy work commitments. Moving PCE 372 to the senior year allows MFGE 365 to be scheduled in the junior year.			
Expand technical elective opportunities by giving majors the option to take one required course from MFGE 434, 454 and 462 and to use the other two as potential elective options.	C, SS	Currently majors are guaranteed available one technical elective each year. The introduction of MFGE 454 together with the move of MFGE 362 to a senior level class has made it possible to give majors two options from among MFGE 434, 454, 462.	Fewer students have difficulties finding classes to complete their 6-credit technical elective requirement.	S. Alqudah (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to require students to take one of MFGE 434, 454 and 462. The other two are available as technical elective options. .
Transfer responsibility for the development and assessment of MFGE 342 Design of Experiments to the PCE program.	C, FS	Due to the experimental nature of several of PCE advanced courses DOE techniques are more widely practiced than in the MFGE program. PCE faculty have taken the lead in recent years in developing and instruction of MFGE 342. Shifting the responsibility helps better balance the teaching workload of each program for courses than	The balance in shared courses that each program manages continues to be roughly equitable as their curriculum evolves.	D. Yip-Hoi (W2021)	F2020: Changes have been made through the formal WWU curriculum approval process to require students to rename MFGE 342 to PCE 342 formally transferring ownership. W2021: PCE 342 has been scheduled for 2021-22 replacing MFGE 342. .

		are taken in common.			
Redistribution of content between MFGE 250, ENGR 351, and ENGR 352.	C	Moving PLCs from EECE 352 to MFGE 250 allows for a more manufacturing-applied treatment of this topic. This also ensures that PCE majors who do not take EECE 352 get exposure. Moving microcontrollers from EECE 352 to EECE 351 benefits MFGE majors by creating room in EECE 352 for a more in-depth treatment of feedback control while also benefiting PCE majors taking EECE 351 who current are not exposed to MCs.	Faculty teaching MFGE 250, EECE 351 and 352 will be assessing student learning on PLCs, microcontrollers and feedback control. Their course outcomes assessment on these topics at the next course reviews and their observations will be used as evidence that this change has benefitted student exposure and learning. These should indicate that students are meeting the 80% threshold.	J. Newcomer - MFGE 250 (S2023) EECE faculty - ENGR 351 (F2023) EECE faculty - ENGR 352 (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to approve the new course contents of EECE 351 and 352. .
Changes in modality of teaching for MFGE 250, 491, 492 and 492 have been performed to give instructors more flexibility in how instruction in these courses is delivered.	FS, P	The need to switch to online instruction during the Pandemic has highlighted advantages of judicious use of remote instruction to complement face-2-face experiences to improve efficiency in learning. Initially, instructors of these four	Faculty teaching these courses who decide to use online modalities will gather feedback from students in course evaluations to determine the impact of the approaches. These along with observations of improvement in efficiency	J. Newcomer - MFGE 250 (S2023) EECE faculty - EECE 351 (F2023) EECE faculty - EECE 352 (S2024)	F2020: Changes have been made through the formal WWU curriculum process to change the modalities of instruction for MFGE 250, 491, 492 and 493. .

		courses have decided to formalize the ability to continue using different modalities of instruction. For example, in the capstone senior project sequence 491-493, remote technologies can assist in more efficient collaborative project work that better integrates industry sponsors.	by the instructor will be presented at the next course review to highlight the improvement.		

*Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology

Table B.2.2 Proposed Improvements Based on Other Evidence Gathered

C. Additional Information

Copies of the assessment instruments and materials referenced in 4.A. and 4.B will be available for review at the time of the visit. Samples of some of these are included in Appendix E. Additional samples of other information such as minutes from meetings can be provided upon request.

CRITERION 5. CURRICULUM

A. Program Curriculum

1. Curricular Paths to Degree

The Manufacturing Engineering program has **one curricular path** to degree and is based on a **quarter system.** As required, the details of the current curriculum for the MFGE path to degree can be found in **Table 5.1** at the end of this section using the ABET stipulated format. Since the last ABET review, several **changes to the curriculum** including adding, removing, and modifying courses have been made. The main result of those changes was the addition of two credits to the MFGE program to expand it from 149-153 to 151-155 (GURs not included). The 2 additional credits were created to support the enhancement of the pre-major curriculum by expanding ENGR 104 - Introduction to Engineering & Design (3 credits)- into ENGR 101 - Engineering, Design and Society (2 credits)- and ENGR 115- Innovation and Design (4 credits). Those changes were thoroughly discussed during the MFGE program meetings, the Engineering & Design faculty meetings, the Industrial Advisory Committee (IAC) meetings, the Curriculum Committee (CC) meetings, and finally approved by the College Policy, Planning, and Budget Council (PPBC) Committee. Table 5.A.1 below summarizes those changes in detail.

Year	Adding	Removing	Modifying	Description	Credit Impact
21-22	ENGR 101 ENGR 115	ENGR 104		Enhancements of the pre-major curriculum by expanding ENGR 104 Introduction to Engineering and Design (3 credits) into ENGR 101 Engineering, Design and Society (2 credits), and ENGR 115 Innovation and Design (4 credits).	+3
			ENGR 225	Reduced from 5 to 4 credits with the credit saved used to support the change of ENGR 104 to ENGR 101 and 115.	-1
			MFGE Program	Made MFGE 453 Introduction to Robotics a required class for all majors to ensure exposure to this subject for all graduates.	0
	MFGE 454			Added a new technical elective class on Systems Integration to support students wishing to further specialize in robotics and automation.	0
	MFGE 365	MFGE 465	MFGE Program	Moved MFGE 465 Machine Design from the senior to the junior year renumbered as MFGE 365. This is a more foundational subject, and this change introduces it sooner in the curriculum and closer to its engineering science prerequisite ENGR 225 Mechanics of Materials.	0
	MFGE 462	MFGE 362	MFGE Program	Moved MFGE 362 Advanced CAD Modeling and Analysis from the junior to the senior year renumbered as	0

				MFGE 462 and offer it as a technical elective not a required class. It was felt that this topic is better suited to specialization in the senior year.	
			MFGE Program	Increased technical elective opportunities for majors though some of the changes described above. Majors are now required to take one of MFGE 434 Advanced CAM and CNC, MFGE 462 Advanced CAD Modeling and Analysis, and MFGE 454 Systems Integration. A major may take at least one of the other two classes for their technical elective's requirement (4 – 6 credits), and possibly both.	0
			MFGE Program	Moved PCE 372 introduction to Composites Materials and Processes to the from the junior to the senior year. This helped create the room to move machine design to the junior year as MFGE 365. It was felt that PCE 372 better served senior-year specialization of those majors wishing to focus on composites manufacturing.	0
	PCE 342	MFGE 342	MFGE & PCE Programs	Passed ownership of Design of Experiments to the Plastics and Composites program. The class remained a requirement for MFGE majors, and the content is unchanged.	0
20-21			MFGE 491 & 492	Rebalanced content between the first and second classes in the Capstone Senior Project sequence moving content on Project planning from 491 (4 to 3 credits) to 492 (2 to 3 credits)	0
18-19	MFGE 340	CSCI 140	MFGE Program	Replaced the computer science Introduction to Programming class with a required applied numerical methods class (MFGE 340) that in addition to introducing programming concepts provides exposure to numerical methods and their application in engineering.	0
	MFGE 350		MFGE Program	Added a new class MFGE 350 developed to introduce newly admitted majors to the fundamentals of automation. This was renumbered to MFGE 250 in 2021-22 to reflect placement in the spring of the sophomore year	+4
		OPS 460	MFGE Program	Removed OPS 460 Designing and Improving Lean Operations from the program. Review of this course's content by the faculty and feedback from students showed that this course increasingly duplicated content in MFGE 341 Quality and Continuous Improvement (though with a business focus) as the latter course evolved.	-4

Table 5.A.1: Changes to MFGE curriculum since the last ABET Review

2. Alignment of Curriculum with Program Education Objectives

Over the years, The MFGE curriculum has evolved and improved with significant input from the program's constituencies, especially the Industrial Advisory Committee (IAC). Consideration of the **Program's Educational Objectives** (**PEOs**) has been ongoing during discussions of curricular changes at IAC meetings. This has provided ample opportunity for three of the program's constituents (industry, alumni, and faculty) to dialog on, and guide this alignment.

As an example, all the curriculum changes that were mentioned in section 1 above have been discussed and approved by the IAC in Spring 2021 meeting (please refer to the IAC meeting minutes in Appendix E.11). Most of our IAC members are alumni from the program and having a direct input from those IAC members provides an invaluable insight into our curriculum that aligns perfectly with the PEO's.

The MFGE program is a large program with at least 148 credit hours of Math, Science, and Engineering coursework. This allows for the successful attainment of the program outcomes while emphasizing strong laboratory components in both coursework and projects for design, testing and practice.

One of the PEOs is preparing students to be successful in their chosen profession. The strategy to meet this objective is to prepare the student to be immediately of value to the companies that hire them, and to have an appreciation for life-long learning that makes them contributors throughout their entire careers. Our curriculum will prepare industry-ready graduates who can start work on the shop floor from day one because of the amble hands-on experience they gain in the labs at Western.

Another strategy for student success in their careers is to cover topics important to the employers that hire our students. This includes a strong topic thread in robotics & automation, and in composite materials and manufacturing.

3. Curriculum and Prerequisite Structure Support of the Program's Required Course

Table 5.A.3 shows the mapping of required MFGE courses to the program's 1-7 student learning outcomes (SLOs) assessment quarter and course review term. SLOs are evaluated through data assessment of the performance indicators of the 1-7 SLOs in the upper-level courses (**summative assessment**, MFGE 4xx). However, lower-level courses "prerequisite structure" are essential blocks that ensure the foundation of these SLOs are built during the second- and third-year courses (2xx & 3xx). This process is examined through a **three-year cyclic review** of each course as shown in table 5.A.3. All the courses in the curriculum including the technical elective courses and courses from other programs will be reviewed by the program faculty (and the curriculum committee for ENGRxxx courses) once every three years. During these course reviews the faculty responsible will give a detailed presentation answering the following questions:

1. Did students entering the class meet the pre-requisite outcomes, and what is the evidence?
2. Are students meeting the course learning outcomes, and what is(are) the evidence?
3. If not, what changes would you recommend improving students' learning?

4. Are there other changes that you would recommend be made to the course and/or its learning outcomes, and if so, why?
5. What changes have been made to address recommendations made at the last review and what has been their effect? (Added *in AY2018-19 to strengthen the efforts of closing the loop & continuous improvement*)

This helps the program modify/improve any unmet SLOs through providing the appropriate support structure in that class or the prerequisites.

Prog	Course #	Course Name	SLO 1-7 and Course Review Term									Responsible Faculty	
MFGE	**4xx**	**Used for summative level assessment**	F21	W22	S22	F22	W23	S23	F23	W24	S24	Primary	Secondary
MFGE	493	Manufacturing Project Implementation			D						D+R	Yip-Hoi	Alqudah
MFGE	492	Manufacturing Project Definition		D+R			D					Newcomer	Yip-Hoi
MFGE	491	Project Research, Planning and Ethics	D+R						D			Yip-Hoi	Alqudah
MFGE	463	Design of Tooling	D+R						D			Gill	Newcomer
MFGE	454	Systems Integration				R	D					Algeddawy	Newcomer
MFGE	453	Industrial Robotics		R						D		Algeddawy	Newcomer
MFGE	434	Advanced CAM and CNC					R			D		Gill	Yip-Hoi
MFGE	**3xx**												
MFGE	381	Manufacturing Process Planning						R				Alqudah	Newcomer
PCE	372	Introduction to Composites Materials and Processes					R					Larson	Misasi
PCE	371	Introduction to Plastics Materials and Processes							R			Misasi	Larson
MFGE	462	CAD Modeling and Analysis Using Surface **(elective)**								R		Yip-Hoi	
MFGE	454	Systems Integration **(elective)**				R						Algeddawy	
MFGE	434	Advanced CAM and CNC **(elective)**					R					Gill	Yip-Hoi
MFGE	365	Machine Design							R			Algeddawy	Gill
MFGE	341	Quality Improvement								R		Alqudah	Peyron
MFGE	340	Numerical Methods for Engineers									R	Yip-Hoi	
MFGE	333	Design for Manufacture		R								Alqudah	Yip-Hoi
MFGE	332	Introduction to CAM and CNC								R		Gill	Yip-Hoi
MFGE	**2xx**												
MFGE	261	Introduction to Computer Aided Design			R							Yip-Hoi	Algeddawy
MFGE	250	Introduction to Manufacturing Automation					R					Newcomer	Algeddawy
MFGE	231	Introduction to Manufacturing Processes			R							Gill	Yip-Hoi
MFGE	250	Introduction to Manufacturing Automation					R					Newcomer	Algeddawy
Others													
ENGR	225	Mechanics of Materials				R						Davishal	Algeddawy
ENGR	214	Statics						R				Davishal	Newcomer
ENGR	170	Introduction to Materials Science and Engineering								R		Peyron	Davishal
ENGR	115	Innovation in Design							R			Davishal	Hoekstra
ENGR	101	Engineering Design & Society							R			Davishal	Hoekstra
ENGR	352	Introduction to Automation and Controls									R	Lund	Algeddawy
ENGR	351	Electronics for Engineering				R						Lund	Newcomer
PCE	342	Data Analysis and Design of Experiments			R							Peyron	Alqudah

D: Data collection term for SLOs 1-7 assessment and evaluation, **R**: Course Review term

Table 5.A.3 MFGE Courses SLOs and Review Mapping

4. Flowchart of Program's Prerequisite Structure

Figure 5.A.4, and 5.A.5 show the prerequisite structure of the program. Courses are positioned in a grid that indicates the topical area (e.g., Math, Science, Engineering Science etc.) and the recommended term that the student should take the class. This structure and the scheduling of classes makes this a "lock step" program. Upon acceptance to the major, students take the same required classes each term, in addition to any remaining GURs. There is room in the schedule and flexibility in the prerequisite structure to allow students to complete up to two courses from the first two years of the program at the beginning of their junior year. For example, a student can complete PHYS 163 and MATH 331 during their Fall and Winter terms in the junior year without delaying their progress through the junior year.

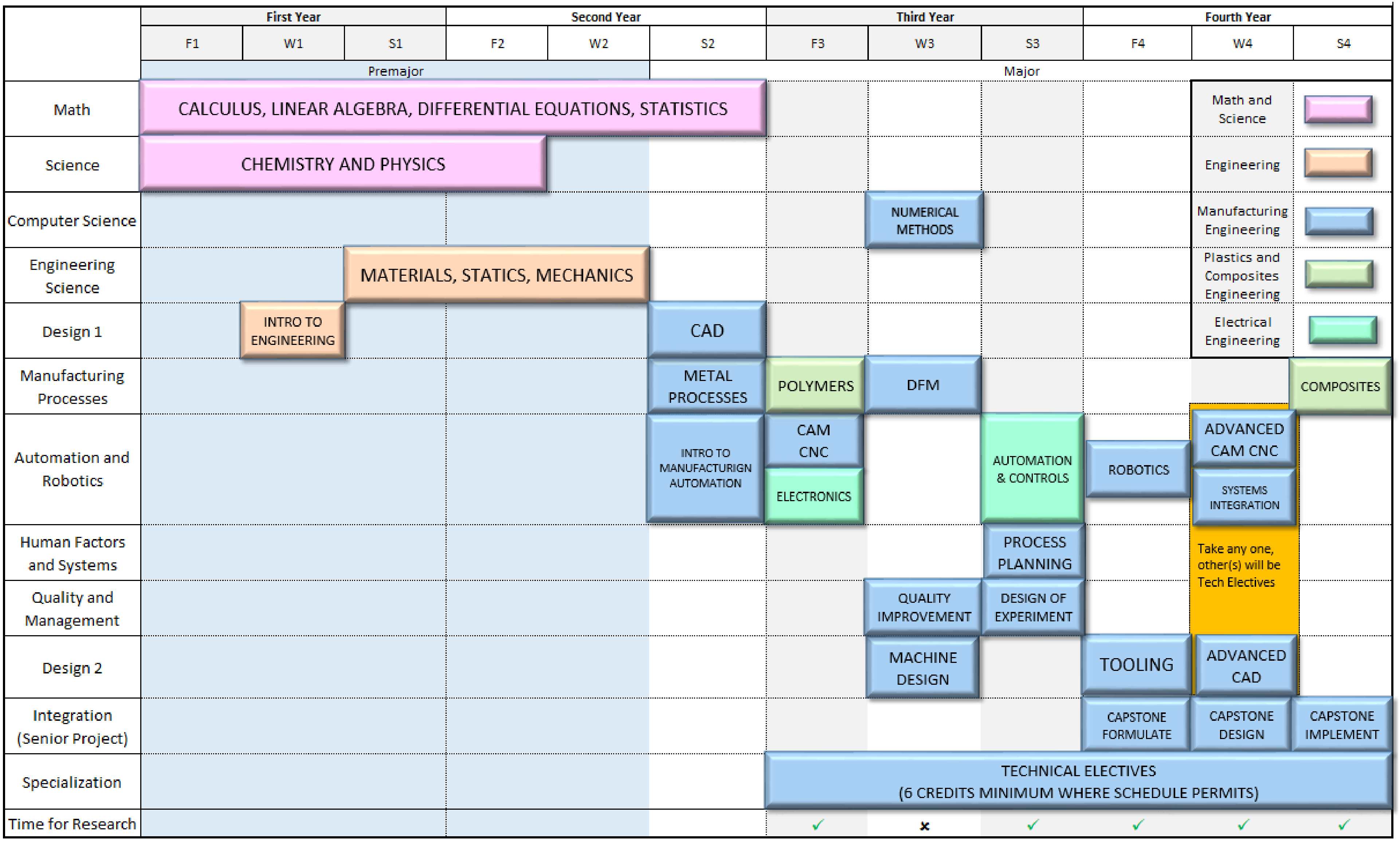


Figure 5.A.4 Program Flowchart of Prerequisite Structure of MFGE Program

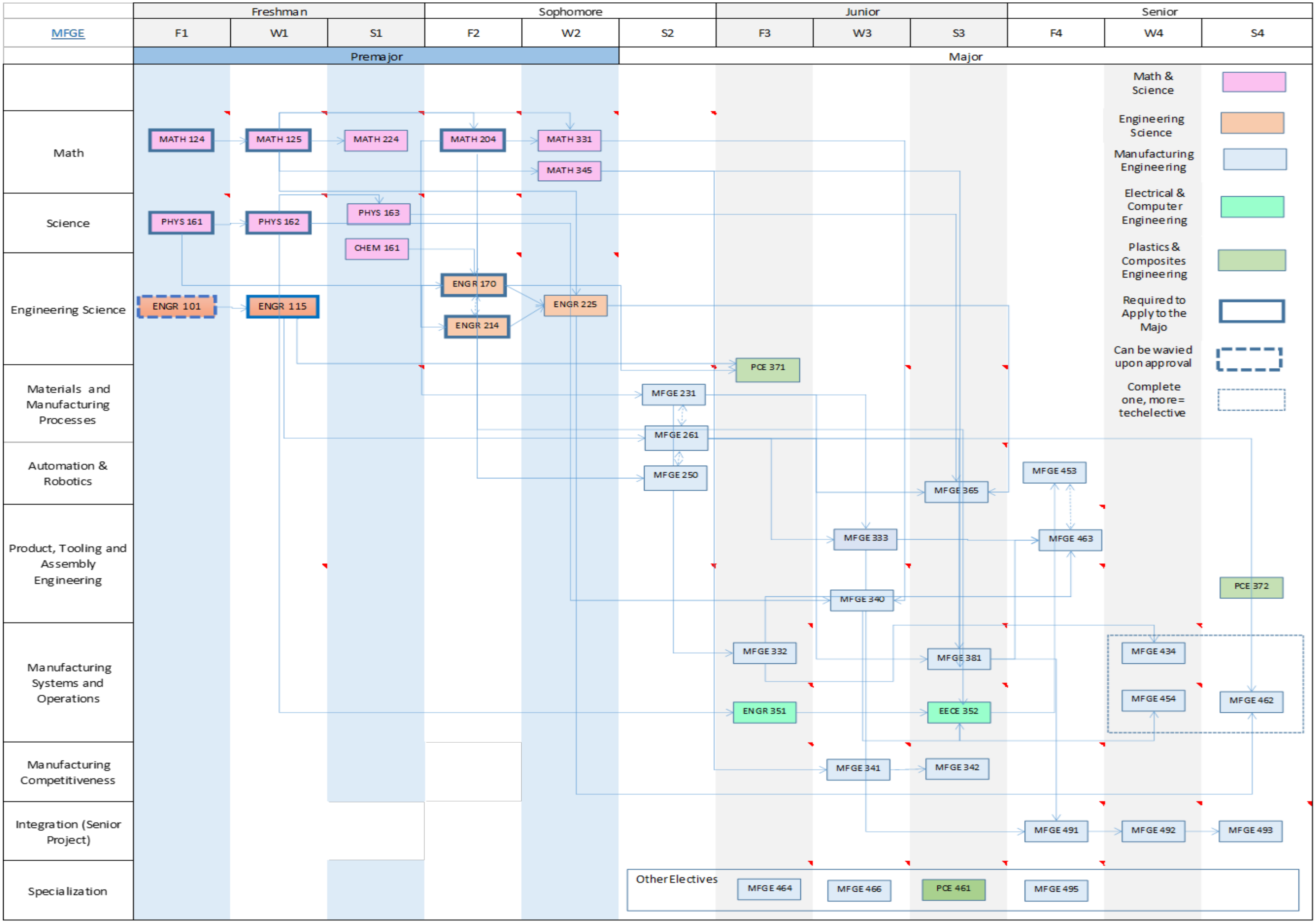


Figure 5.A.5 Detailed Course Flowchart of Prerequisite Structure of MFGE Program

Advising plays a significant role in ensuring that incoming students (WWU pre-majors or transfer students) are ready to apply to the MFGE major. Direct advising by Lisa Ochs in addition to several general advising sessions has been a reliable process to ensure a streamlined admission process.

5. Meeting the ABET Requirements for Each Subject Area

Table 5.1 at the end of this section has been completed according to the requirements for this self-study. In summary:

- Total credit hours to graduate with a MFGE degree (including GURs) = **189 – 193**
  - Range is due to differences in credits for electives
- Math and Basic Science Component Credit Hours= **48** (**24.9% - 25.4%** of total)
  - This satisfies the credit hour (45) requirement for accreditation
- Engineering Content Credit Hours = **103 – 107** (**54.5% - 55.4%** of total)
  - This satisfies the credit hour (67.5) requirement for accreditation
- General Education Credit Hours = **38** (**19.6% - 20.1%** of total)
- Full Load Credit Hours per Quarter (Year) = **16 (48)**
  - Students typically take four 4 credit classes per quarter as a full load.

a. Math and Basic Science Courses (total of 10 courses accounts for 48 credits):

The math courses taken by majors are in calculus (x 3), linear algebra, differential equations, and engineering statistics (MATH 124, 125, 204, 224, 331, 345, total of **27** credits). The fundamental topics covered are used in the appropriate engineering sciences and core manufacturing engineering courses that they feed into (see the prerequisite structure in Figure 5.A.5). For example, the statistics topic covered in MATH 345 is an important tool that students use in Quality Improvement (MFGE 341). One credit (**1**) in math that covers additional topics in linear algebra is covered in-context within the Statics class (ENGR 214).

The basic sciences include the engineering physics series that covers topics such as mechanics, electromagnetism, waves, and geometric optics (PHYS161, 162, 163, total of **15** credits) and the first general chemistry course (CHEM121, **5** credits). All these courses have laboratory experiences, thus satisfying the requirement to "include physical or natural science with laboratory experiences as appropriate to the discipline." These courses also satisfy WWU's GUR requirement for the Natural Sciences. Table 5.5.a below summarizes the math and basic science requirement

Course #	Course Title	Credits
CHEM 161	General Chemistry I	5
MATH 124	Calculus & Analytic Geometry I	5
MATH 125	Calculus & Analytic Geometry II	5
MATH 204	Linear Algebra	4

MATH 224	Multivariable Calc. & Geometry I	5
MATH 331	Differential Equations	4
MATH 345	Engineering Statistics	4
PHYS 161	Physics w/ Calculus I	5
PHYS 162	Physics w/ Calculus II	5
PHYS 163	Physics w/ Calculus III	5
Additional math credit covered in ENGR 214		**47+1 = 48**

Table 5.5.a Math and Basic Science Requirement

b. Engineering and Applied Science Courses (total of 5 courses accounts for 17 credits)

The 100 and 200-level ENGR courses required for the degree are a combination of introduction to engineering and engineering sciences courses. They provide a foundation for the 300 and 400-level courses that follow. These courses are: ENGR 101, ENGR 115, ENGR 170, ENGR 214, and ENGR 225. They cover key topics such as engineering design and graphics, materials, statics and mechanics of materials respectively. Except for ENGR 225, students must take these classes as a pre-major. As discussed under Criterion 1, student performance in those pre-major classes is the determining factor in their admission to the major. Pre-majors for all programs within the department except for Electrical and Computer Engineering students take these classes. As mentioned previously, **one** credit from ENGR 214 is counted towards satisfying the program's Math and Basic Science requirements, which explains the total of 17 credits, not 18). Table 5.5.b below summarizes the engineering and applied science requirements.

Course #	Course Title	Credits
ENGR 101	Eng., Des., & Society	2
ENGR 115	Innovation Design	4
ENGR 170	Intro to Material Science & Engineering	4
ENGR 214	Statics	4
ENGR 225	Mechanics of Materials	4
One ENGR 214 credit covers math requirement		**18-1=17**

Table 5.5.b Engineering and Applied Science Requirements

c. Core Manufacturing Engineering Courses (86-90 credits)

In addition to the 17 credits of Engineering and Applied Science courses, the manufacturing program core requires another 86 to 90 credits, see table 5.5.c.1 below. Those credits are offered as follows:

- 48 credits are **required** subject matter classes that span key areas in manufacturing engineering (MFGEXXX)

- 10 credits are **required** for the capstone senior project (MFGE 491/492/493)
- 14 credits are **required** subject matter classes that span key areas in manufacturing engineering related to design of experiments and special manufacturing processes related to Plastics and Composites (PCEXXX).
- 8 credits are **required** subject matter classes that span key areas in manufacturing engineering in relation to Electronics and Controls (ENGR 351 & ENGR 352). Note: these courses used to be named EECE 351/352, but since they are offered by the Electrical and Computer Engineering (EECE) program as service classes, they have been approved to be changed to MFGE designation during the 21-22 academic year.
- 6 to 10 are **required** technical elective credits, those credits are reviewed and approved by the program faculty and the IAC committee as shown in 5.5.c.2 table below.

Course #	Course Title	Credits
ENGR 351	Electronics for Engineering	4
ENGR 352	Intro to Automation & Control	4
MFGE 231	Intro to Metal Manufacturing Processes	4
MFGE 250	Introduction to MFGE Automation	4
MFGE 261	Intro to CAD	4
MFGE 332	Intro to CAM and CNC	4
MFGE 333	Design for Manufacturing	4
MFGE 340	Numerical Methods for Engineers	4
MFGE 341	Quality & Continuous Improvement	4
PCE 342	Data Analysis and Design of Experiment.	4
MFGE 365	Machine Design	4
MFGE 381	Manufacturing Process Planning	4
MFGE 453	Industrial Robotics	4
MFGE 454	Systems Integration, **or**	
MFGE 434	Advanced CAM & CNC, **or**	4
MFGE 462	Advanced CAD	
MFGE 463	Design of Tooling	4
MFGE 491	Project Research, Planning, and Ethics	3
MFGE 492	Manufacturing Project Proposal	3
MFGE 493	Manufacturing Project Implement.	4
PCE 371	Intro to Polymer Materials and Processing	5
PCE 372	Intro to Composites Materials and Process.	5
See Table 5.5.c.2	Technical electives	6 to 10
Total core engineering		**86-90**

Table 5.5.c.1 Manufacturing Engineering Core Requirements

Course #	Course Title	Credits
MFGE 434	Advanced CAM/CAD	4
MFGE 454	Systems Integration	4
MFGE 462	Advanced CAD	4
MFGE 464	Des. & Anal. if Mechanisms	4
MFGE 466	CAD Automation	4
MFGE 495	Directed-Research in Manufacturing	1-4
PCE 331	Injection Molding	4
PCE 461	Tooling for Plastic Processes	4
PCE 472	Advanced Composites	3
ID 320	Industrial Design CAD skills	4
MGMT 311	Intro to MGMT & ORG Behavior	4
MGMT 313	Teamwork Basics	4
OPS 463	Enterprise Resource Planning systems (ERP)	4
OPS 466	Supply chain Management	4

Table 5.5.c.2: Approved Technical Elective Classes for MFGE Students

These core engineering courses (86-90 credits) are specified in more detail as follows:

- *Materials and Manufacturing Processes (21%*):* In addition to the Engineering and Applied Science Courses (Table 5.5.b) majors get exposure to the selection and processing of materials including emphasis on polymers and composites (PCE 371 and 372) due to regional industry practice. This reflects the historical connection that exists between the MFGE and PCE programs and the regional aerospace industry's increasing preferences for use of these materials. Majors are exposed to aspects of metal processing in MFGE 231, 332 and 333. These classes include extensive laboratory experiences that involve fabrication work on industrial type equipment. They also include project work that is typically team-based.

- *Process, assembly, and product engineering (26%*):* Majors take 8 credits in courses emphasizing CAD modeling and product design analysis (MFGE 261 and 462). This includes the design and analysis of fiber-reinforced polymer composites. Additional aspects of product design are emphasized in Design for Manufacture (MFGE 333). Process design and process planning are covered in MFGE 332, 381 and 333. The design of tooling includes tools for plastic processes, metal processes, fixturing and inspection (PCE 372, MFGE 463). A course in machine design (MFGE 365) also supports the design of manufacturing equipment. Computer and fabrication lab experiences that support team-based projects are also a hallmark of courses in this area.

- *Manufacturing Systems and Operations (26%*):* Topics in this area currently include material on automation covered in ENGR 351 & 352, MFGE 250, 332, 434 and 453. Production system design including topics such as cell layout, systems integration, equipment selection, ergonomics, safety and health are covered in MFGE 381, 434, 453 and 454.

- *Manufacturing Competitiveness (12%*):* Majors complete classes in Quality & Continuous Improvement (MFGE 341), Design of Experiments (PCE 342), and the Lean Manufacturing emphasis in Manufacturing Process Planning (MFGE 381). These classes contain content in Manufacturing Management. MFGE 491 also has content that introduces students to project management. This is done in the context of their capstone senior design experience where they are expected to develop a plan for the execution of their project.

- *Integration and Specialization (14%*):* Majors complete three classes (10 credits) of senior capstone project (MFGE 491/492/493) and 6 to 10 credits from the approved technical electives courses (Table 5.5.c.2). This allows students in their senior year to influence the distribution of their exposure to the four areas above to suit their interests.

** Percentages based on a minimum of 6 credits of technical electives.*

6. Broad Educational Component, Technical Content & PEOs

The general education component in the MFGE program is satisfied by the General University Requirements (**GURs**). The program requires GURs in six areas – 1) Natural Sciences (SCI), 2) Comparative, Gender, and Multicultural Studies (CGM), 3) Social Sciences (SSC), 4) Humanities (HUM), 5) Quantitative and Symbolic Reasoning (QSR), 6) and Communication (COM). **Required MFGE program courses** such as math, physics, and chemistry **satisfy** the SCI and QSR requirements which is one of the ways these broad educational components **complement** the technical content of the MFGE curriculum. Students are required to complete the remaining of the GUR requirements in the other four areas. This requires **an additional 38** credits of GURs. These six areas in the GURs align with the PEOs in that it provides the MFGE students with opportunities to acquire skills, knowledge, and experience across many fields that will enable them to succeed in their chosen caress and will help them develop a strong sense of social responsibility. MFGE PEO states that *"The objective of the Manufacturing Engineering Program is to prepare graduates who will be successful in their chosen career paths.*"

7. Design Experiences in the Program

Table 5-1 uses a check mark to indicate courses where majors are exposed to engineering design. Within the manufacturing discipline, students can have these design experiences within the context of developing products, processes, tooling, equipment and systems. These experiences culminate in the capstone design experience which will be discussed in the next section. A summary of each of these follows.

- *Product Design*:
  Students are introduced to the design process (Figure 5.A.7) in ENGR 115 and apply aspects of it in various team-based design projects. Additional product design is conducted in MFGE 261, 462, and 333. In 261 students use 3D parametric CAD to detail a design for a Lego® car which they prototype with blocks built on a 3D

printer. In 462 students apply surface modeling techniques to design a rear spoiler for a racing car that satisfies aerodynamic requirements, and to design a springboard to be fabricated using fiber reinforced composites to satisfy deflection constraints. In 333 students used a commercial product of their choice to improve upon its DFA and DFM strategies using various design analysis.

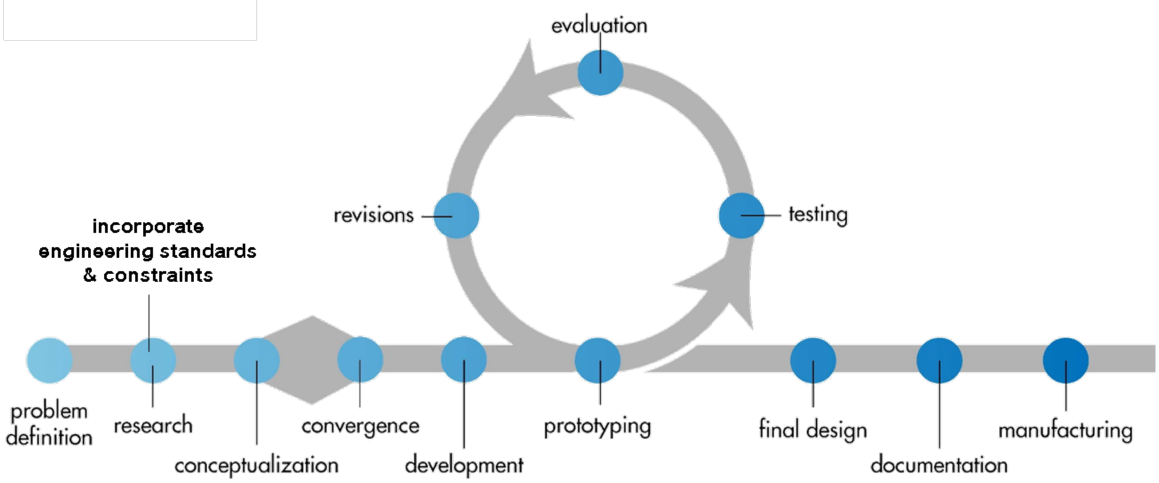


Figure 5.A.7 The Design Process used in the MFGE Program

- *Process Design:*
  MFGE 332 introduces Computer-Numerical Control (CNC) Machining. As part of the assignments and project, students must complete process plans that identify operations, tooling and process parameters for machining a range of parts, including some that are fabricated in the CNC laboratory. Impact of process parameters on cycle time and quality is considered during planning.

- *Tool Design:*
  Students design jigs and fixtures for machining, inspection, assembly, and plastic processes in MFGE 463. They also learn to incorporate competing design constraints of stability, determinism, constraint, part deflection, tool/probe access, human factors, environmental effects, tolerancing, and cost.

- *Machine Design:*
  The machine design course MFGE 365 introduces students to the design of mechanical components.

- *Production Systems Design:*
  In MFGE 381 workstation and work envelop designs are studied using simulation techniques to capture ergonomic requirements and to enhance process efficiency.

Another technical elective course that also focuses on systems design in MFGE 454.

- <u>Capstone Design Experience:</u>

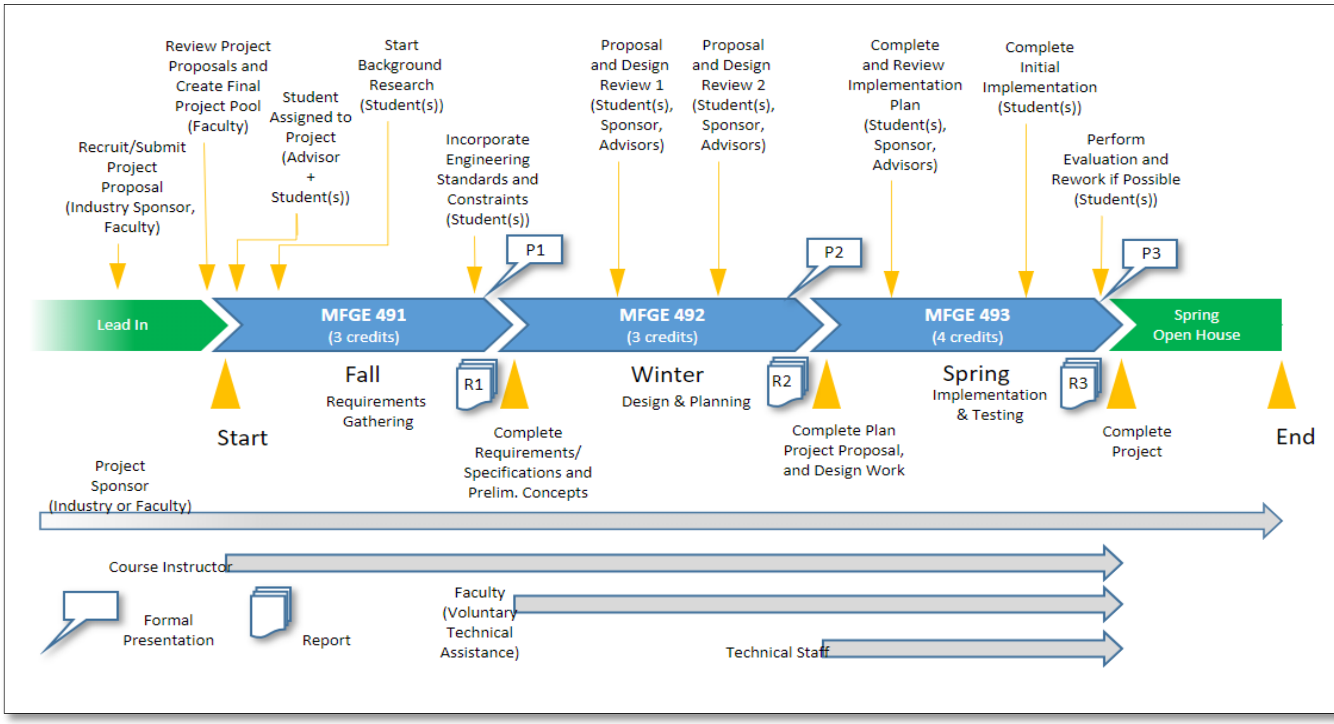


Figure 5.A.8 Capstone Senior Project

Figure 5.A.8 shows an overview of the capstone senior project that all majors are required to take. It is a three course, 10 credit sequence that covers the entire senior year. The administration of this project starts during a lead-in period prior to the beginning of the academic year.

- *Project Lead-In:* During this period, projects from potential industrial sponsors are submitted and solicited. At the start of the fall term, all submitted project proposals in the pool are reviewed by the faculty assigned to MFGE 491 for appropriateness. This involves a number of things. First and foremost is to determine if the project meets a suitable threshold in design content for the manufacturing engineering discipline to provide an appropriate capstone experience for a major. Since project proposals can vary significantly in scope and content, there is also a determination of the scope of the projects and the number of the students in each team, and whether it can benefit from a multidisciplinary team approach. Since the last review, the program has been emphasizing and prioritizing industry-sponsored projects that require a team of students (3 or 4) to work on real-world design problems under the direct supervision of their industrial sponsor. On some occasions when some faculty have research projects that can fit under the Capstone project criteria, those projects can serve as capstone projects, but the programs top priority remains industry sponsored projects.

- *MFGE 491 (3 credits):* The first course in the sequence focuses on problem definition. During normal years, onsite meetings with sponsors at their facilities within the first two weeks of the term kick off requirements gathering. Follow up communications with sponsors throughout the term help teams develop a robust list of sponsor requirements and to convert these into a set of preliminary engineering specifications. Background research into the problem that reviews the technical literature is also initiated early in the term by teams. The expectation is that while this is most intensive at the beginning of the project, it will continue well into the design and even implementation and testing phases as decisions are made that necessitate retrieval and study of new material. Students are expected to demonstrate their ability to learn on their own (life-long learning) through the research component of their project. Towards the end of the term conceptual design is initiated. Findings are formally communicated to sponsor and instructor through a final technical presentation and report. The latter doubles in supporting assessment for technical communication writing proficiency skills that is required by the university.

- *MFGE 492 (3 credits):* During the winter term, teams work on finalizing and ranking concepts. The highest ranked solution is then developed into a final detailed design. This phase includes preliminary testing of facets of the solution either through simulation or using quick prototypes. Teams are encouraged where feasible to develop a digital mockup of their solution for the purposes of analysis and simulation. Multiple design reviews occur during the term involving the sponsor. This helps to keep the work focused on the problem and to clarify any uncertainties before the final design is set. The term concludes with a formal presentation of the final solution along with a plan for implementation. As with 491, a report requirement also serves to develop and assess technical writing proficiency skills.

- *MFGE 493 (4 credits):* The final term of the sequence involves teams implementing their solution. There are several tacks this effort can take depending on the project and sponsor. Some complete fabrication and testing work fully within the department’s lab and workshop spaces. Others are fabricated and tested at the sponsor’s facilities. Teams are required to undergo a final implementation review early in the term that includes confirming scheduled use of departmental resources for fabrication. Teams are expected to complete their implementation with a couple weeks to spare to allow for testing and rework if needed. It is often the case that time does not permit significant changes to the final solution when identified by testing. These are documented and discussed in the final presentation and report for the year. Students may voluntarily continue with a project after receiving a final grade should their sponsor desire final modifications. In some years an Open House for projects is held during exam week. However, the scope of this can be greatly impacted by non-disclosure agreements that some sponsors require.

- *Capstone Project Advising*: The bottom of Figure 5.A.8 shows the advising resources available for each student during their capstone experience. Every student project has a sponsor. Sponsors can be either from industry or a faculty member and are expected to be able to provide the information needed to define the constraints for the problem and possess the appropriate technical expertise to assist the student in design and implementation. They are also expected to pay for the project expenses and provide access to equipment that is needed that is not available on campus.

  The course instructor(s) is responsible for administering the sequence. This includes teaching supporting subject matter in MFGE 491. But more importantly, they are responsible for establishing a timeline for deliverables, ensuring that students are meeting milestones, and primarily responsible for grading and assessment. They also assist students in resolving conflicts that might arise with their sponsor. The program feels that for continuity there is an advantage to having the same instructor teach the entire sequence in a given year. However, challenges in scheduling faculty teaching assignments have made this difficult in the past and will likely continue to do so for the foreseeable future.

  Faculty that are neither sponsors nor the course instructor are also free to provide voluntary consulting assistance to students at any point during the sequence, though this is most likely during MFGE 492 and 493.

- 2021-22 Senior Projects:
  - Team 1: "Composite Mold Cleaning Automation", Sponsor: Sekisui,
  - Team 2: "777X Spar Caul Plate Tape Applicator for Spring Steel Cauls", Sponsor: Boeing
  - Team 3: "Knob Bagging Automation", Sponsor: Korry
  - Team 4: "Removal of Excess Material on Wing Spar", Sponsor: Boeing
  - Team 5: "Fluke IMM Automation", Sponsor: Fluke

8. <u>Cooperative Educational Experiences</u>

While students are strongly encouraged to complete internships and are provided some aid in finding them, the MFGE program does not permit students to count internships toward MFGE program curricular requirements.

9. <u>Materials Available for Review During Visit that Demonstrate Achievement Related to this Criterion</u>

All required materials will be made available during the visit in either hardcopy or digital form. This includes materials such as course materials including course syllabi, textbooks, example assignments and exams, and examples of student work, typically ranging from excellent through poor, evidence that the program educational objectives stated by the program are based on the needs of the stated program constituencies, evidence of a documented, systematically utilized, and effective process, involving constituents, for periodic review of the program educational objectives stated for each program, evidence of the assessment, evaluation, and attainment of student outcomes for each program and evidence of actions taken to improve the program.

B. Course Syllabi

Appendix A includes a course syllabus for every required MFGE program course.

Table 5-1: Curriculum

Manufacturing Engineering (MFGE)

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate whether course is Required, Elective or a Selected Elective by an R, an E or an SE.[1]	*Subject Area (Credit Hours)* Math & Basic Sciences	Engineering Topics; Check if Contains Significant Design (√)	Other	Last Two Terms the Course was Offered: Year and, Semester, or Quarter	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
FIRST YEAR						
MATH 124 – Calculus 1	R	5			Winter 2022 Spring 2022	35 35
PHYS 161 – Physics with Calculus 1	R	5			Fall 2021 Winter 2022	20 20
ENGR 101 – Engineering, Design, and Society	R		2		Fall 2021 Winter 2022	36 36
MATH 125 – Calculus II	R	5			Winter 2022 Spring 2022	35 35
PHYS 162 – Physics with Calculus II	R	5			Winter 2022 Spring 2022	20 20
ENGR 115 – Innovation in Design	R		4 (√)		Winter 2022 Spring 2022	18 18
MATH 224 – Multivariable Calculus & Geometry	R	5			Winter 2022 Spring 2022	35 35
PHYS 163 – Physics with Calculus III	R	5			Fall 2021 Spring 2022	20 20
CHEM 161 – General Chemistry I	R	5			Winter 2022	24

					Spring 2022	24
SECOND YEAR						
MATH 204 – Elementary Linear Algebra	R	4			Winter 2022 Spring 2022	35 35
ENGR 170 – Introduction to Material Science & Engineering	R		4		Fall 2021 Winter 2022	40 40
ENGR 214 - Statics	R	1	3		Fall 2021 Winter 2022	40 45
MATH 331 – Differential Equations	R	4			Winter 2022 Spring 2022	35 35
MATH 345 – Engineering Statistics	R	4			Winter 2022 Spring 2022	35 35
ENGR 225 – Mechanics of Materials	R		4		Winter 2022 Spring 2022	36 36
MFGE 231 – Introduction to Manufacturing Processes	R		4		Fall 2021 Spring 2022	8 12
MFGE 261 – Introduction to CAD	R		4 (✓)		Winter 2022 Spring 2022	45 24
MFGE 250 – Introduction to Automation (Previously MFGE 350)	R		4		Spring 2021 Spring 2022	26 12
THIRD YEAR						
PCE 371 – Introduction to Plastics Materials & Processes	R		4		Fall 2021 Spring 2022	36 36
EECE 351 – Electronics for Engineers	R		4			
MFGE 332 – Introduction to CAM & CNC	R		4		Fall 2021 Winter 2022	8 8
MFGE 341 – Quality & Continuous Improvement	R		4		Fall 2021 Winter 2022	30 30
MFGE 333 – Design for Manufacture	R		4 (✓)		Winter 2021 Winter 2022	24 24
MFGE 340 – Numerical Methods	R		4		Winter 2021 Winter 2022	30 15

PCE 342 – Design of Experiment	R		4		Winter 2022 Spring 2022	30 30
MFGE 381 – Manufacturing Process Planning	R		4 (✓)		Spring 2021 Spring 2022	24 24
EECE 352 – Introduction to Automation & Control	R		4 (✓)			
MFGE 365 – Machine Design	R		4 (✓)		Winter 2022 Spring 2022	24 24
FOURTH YEAR						
MFGE 491 – Project Research	R		3 (✓)		Fall 2020 Fall 2021	30 24
MFGE 463 – Design of Tooling	R		4(✓)		Fall 2020 Fall 2021	15 12
MFGE 453 – Industrial Robotics	R		4		Winter 2021 Fall 2021	28 12
MFGE 492 – Project Proposal	R		3(✓)		Winter 2021 Winter 2022	28 24
MFGE 462 – Advanced CAD (previously MFGE 362)	SE		4(✓)		Winter 2021 Spring 2022	24 24
MFGE 434 – Advanced CAM & CAD	SE		4		Winter 2021 Winter 2022	10 8
MFGE 493 – Project Implementation	R		4 (✓)		Spring 2021 Spring 2022	28 24
PCE 372 – Intro to Composites Materials & Processes	R		4		Winter 2022 Spring 2022	36 36
MFGE 454 – Systems Integration	SE		4(✓)		Winter 2022	12
Technical Electives (distributed over several quarters)	SE		6-10			
General University Requirements (distributed over several quarters)	SE			38		
TOTALS (in terms of semester credit hours)		48	101-105			
	Minimum Quarter Credit Hours	30 Hours	45 Hours			

Total must satisfy minimum credit hours						

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

CRITERION 6. FACULTY

A. Faculty Qualifications

Professor Jeff Newcomer's primary background is in engineering design, machine design, and automation. Prof. Newcomer's formal education is in Mechanical & Aeronautical Engineering with his Ph.D. focusing on dynamic collision avoidance for mobile robots. His professional experience is limited to internships and summer jobs during his college career. Prof. Newcomer has 28 years of experience teaching engineering and engineering technology, including 25 years in manufacturing programs. He has developed expertise in industrial robotics and other areas of automation related to manufacturing, and manufacturing ergonomics. He is a very accomplished teacher of engineering sciences and has taught in a number of other areas relevant to manufacturing.

Professor Derek Yip-Hoi received his Ph.D. from the Department of Mechanical Engineering at the University of Michigan in 1997. His dissertation research focused on developing Computer-Aided Process Planning methods and software tools to support automation of machining on Mill/Turn machining centers. Following his Ph.D., he worked for several years with the NSF Engineering Research Center for Reconfigurable Machining Systems at the University of Michigan. His work involved supervision of sponsored R&D projects that focused on developing software applications to assist manufacturers design and plan operations on advanced machining lines that could be rapidly reconfigured to meet changes to a product's design or production volume. Sponsors of this work included Ford, GM, and Chrysler. In 2003 he joined the faculty of the Mechanical Engineering Department at the University of British Columbia. His appointment included a position as junior chair of the NSERC sponsored research program in Virtual Machining. His work at this time focused on the modeling of cutter/workpiece engagement geometry to support process modeling for aerospace machining applications. The primary industrial sponsor of this work was Pratt and Whitney, Canada. After 3 ½ years at UBC, he moved to the Department of Engineering Technology (now Engineering and Design) at Western Washington University. His teaching and scholarship interests lie in the areas of design, geometric and solid modeling, CAD/CAM, Computer-Aided Process Planning, and machining. Dr. Yip-Hoi has acted as coordinator of the CAD/CAM option in the Manufacturing Engineering Technology program, the entire Manufacturing Engineering Technology Program, prior to their termination. He served as the director of the Manufacturing Engineering Program until the end of the 2020-21 AY.

Associate Professor David Gill's primary background is in additive manufacturing, precision manufacturing, and CAD/CAM/CNC. He is currently pursuing the development of novel manufacturing processes for the composites industry. Dr. Gill's formal education is in Mechanical Engineering with his Ph.D., dissertation focusing on the precision replication of co-molded micro-optics. His master's thesis focused on the development of a computer-aided fixture planning methodology. His professional experience at Sandia National Laboratories consisted of 7 years focused on precision meso-scale manufacturing of optics and mechanisms as well as the continued development of a large-scale laser metal additive manufacturing process, and of 5 years creating novel thermal energy storage methods for the concentrating solar power industry. During his time at Sandia, David received 2 patents and was team member on 2 pending patent applications. His professional experience at Caterpillar, Inc. included manufacturing engineering of a connecting rod production line and field test engineering for the 3500 Long-Stroke engine for power generation. Dr.Gill joined the faculty of the Engineering & Design Department in Fall 2014 as an assistant professor. He was promoted to an associate professor starting Fall 2019.

Associate Professor Tarek Algeddawy primary background is in Systems Integration, Automation and Robotics. Dr. Algeddawy formal education is in Mechanical, Industrial and Manufacturing Engineering with his Ph.D. dissertation focusing on the co-evolution in manufacturing systems inspired by biological analogy. Dr. Algeddawy has been involved in 30+ industrial projects, as a research fellow and a mentor, in the USA, Canada and Egypt, from the state and private sectors and in varying fields such as, process improvement, automation and engineering learning. He published 57 papers in journals, book chapters and conference proceedings. Dr. Algeddawy and his undergraduate research team have built an automated low-cost open access learning factory (LEAF) laboratory to help teach emerging trends in systems integration, and conduct data driven research at the Engineering & Design Department. Dr. Algeddawy joined the faculty of the Engineering & Design Department in Fall 2018 as an assistant professor. He was promoted to an associate professor starting Fall 2021.

Associate Professor Sura Al-Qudah's primary background is in quality assurance and lean systems. Al-Qudah's formal education is in Industrial and Systems Engineering with her Ph.D., dissertation work conducted in the area of applied operations research and optimization in the healthcare industry. Her research focused primarily on systems/process improvement (Lean Six-Sigma) and applied operations research & modeling for various domains/systems including manufacturing, healthcare, and education. This includes the utilization of various tools and methodologies to help streamline the processes involved in these domains/systems. Al-Qudah's teaching philosophy is focused on student-center learning by creating an interactive learning environment in the classroom. This helps engaging the students in real life problems to help them connect theory with practice. Dr.Al-Qudah joined the faculty of the Engineering & Design Department in Fall 2014 as an assistant professor. She was promoted to an associate professor starting Fall 2020. She is serving as the director of the Manufacturing Engineering Program starting Fall 2021.

B. Faculty Workload

Table 6-2 shows the faculty workload summary. The standard load for faculty in the Engineering and Design Department is 5 classes per year. This includes laboratory contact hours. If a course has more than one lab section, an undergraduate TA is assigned to the course for assistance in the lab and, optionally, grading. Any newly hired faculty are assigned to teach 3 classes during their first year. This is to assist them in establishing their scholarship while they are familiarizing themselves with their new course assignments. This increases to a full load of 5 classes in their second year.

C. Faculty Size

The MFGE program has five full-time faculty all of whom are tenured. However, one of these positions must be split with the administrative responsibilities associated with the Chair of the Department, currently Prof. Jeff Newcomer. The current program goal is to have an annual student to faculty ratio of six to one. This assures that the program can maintain its quality of instruction and that students continue to have close interactions with the faculty. The program currently accepts 24 students each year. From this point of view, the program has an adequate number of faculty.

From a curricular perspective, given the requirements of the program, each faculty (except for the chair) has on average three unique MFGE or ENGR courses that they are responsible for over the course of a year. To establish redundancy, most classes can be taught by more than one faculty, though at times this is achieved by sharing courses with faculty from the PCE program (mostly ENGR courses). All faculty are given the opportunity to offer a technical elective in their area of their specialization, though not all in any given academic year.

Given the small major class sizes (24 students) and the intensive laboratory and project experiences integrated into most MFGE courses, there is a high level of interaction between students and faculty. For some courses, experienced and highly capable students are employed as TAs or lab assistants. This provides an opportunity for mentorship of these students by faculty. In addition, faculty work both formally (MFGE 495) and informally (during summer) with students on projects related to their scholarship.

Student advising for majors is a shared responsibility between the MFGE faculty members, with each faculty member being assigned a set of students from the incoming class to their roll of advisees at the time of admission. All faculty are encouraged to contact their advisees at least once every quarter to go over their course plans and major evaluation forms.

Extensive interactions occur between faculty and industry particularly through the program's Industrial Advisory Committee (IAC). Many of these representatives regularly sponsor student capstone design projects, some of which include an opportunity for a student to do an internship or research-related course work.

D. Professional Development

All the MFGE faculty are continually active in their professional development. Examples include research and scholarship, teaching and learning workshops, accreditation symposiums, industry technical and education conferences, workshops, seminars, and webinars (see Table 6-3).

Faculty development funding is available from the Department, the College, as well as from university-wide programs administered by the university's Research and Sponsored Programs (RSP). Department funding for tenure-track untenured faculty is $1500 and for tenured faculty is $1000. College funding up to $1000/year is available for conference registration at which faculty are presenting their work. In addition, if approved, up to $600/year is available from the college for conference related expenses if faculty are not presenting. RSP has several programs to support faculty development and scholarship, including Summer Research and Summer Teaching grants of $6000 each, Faculty

Development grants of up to $1500, as well as research grant programs with maximums ranging from $1000 to $3000.

Sabbaticals are supported by the University to the extent that state law allows. Sabbatical proposals are submitted by faculty to the Department Chair. The Chair then writes a recommendation to the Dean. The proposal is evaluated and prioritized by the College Personnel committee. At this point, a recommendation may be made to change the number of quarters requested for the leave. The personnel committee makes their recommendations to the Dean who then makes recommendations to the Provost, who makes the final decision.

E. Authority and Responsibility of Faculty

The processes for continuous improvement covered in Criterion 4 are all faculty-centered. Faculty members are involved in the assessment, evaluation, action formulation, and implementation of the accepted actions. Program objectives and program outcomes are developed by the program faculty as a whole. Specific course outcomes are normally developed by the lead faculty member for that course, in consultation with their peers in MFGE and any other program that has a stake in it.

Curricular revision is initiated by the faculty. The creation or modification of a course begins with one or more members of the program faculty bringing the idea forward for consideration. After program consideration, the idea will be discussed with the MFGE IAC. If the program faculty and the MFGE IAC agree that a change to a course or the program is appropriate, then the idea is brought to the Department Curriculum Committee and then the whole ENGD Department faculty for consideration and approval. Once the proposal leaves the department it must be approved by the College Curriculum Committee and the Academic Coordinating Council (ACC), a standing committee of the Faculty Senate. The Dean or an appointed representative sits on the College Curriculum Committee, and the Provost or an appointed representative sits on the ACC.

The modification of student outcomes, course, or program, and of program objectives follows the procedures outlined earlier in Criterion 4. The need to make changes to program outcomes and/or objectives may be recognized by the faculty, or it may come out of discussions with the MFGE IAC, however, once there is an understanding that changes are appropriate, the new program outcomes and/or objectives are drafted by the program faculty, discussed with the MFGE IAC, and agreed upon by all before being implemented. Changes to course outcomes are also drafted by the faculty. Whether or not other program faculty and the MFGE IAC are involved in the development of course outcomes depend upon whether the course is shared by multiple programs or only required for students in the MFGE program and the magnitude of the change. For a new course or a significant modification to a course, the course outcomes would be discussed with the MFGE IAC as part of the normal discussion of curricular change, but minor changes might be undertaken by the program faculty alone. The Administration is not involved in the development or revision of outcomes and objectives, although the program always makes sure that the program outcomes and objectives are consistent with and support the Mission of the University.

Table 6-1. Faculty Qualifications
Manufacturing Engineering

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt. / Ind. Practice	Teach -ing	This Institut -ion		Profession -al Organizat -ions	Profession -al Develop -ment	Consult -ing / summer work in industry
Tarek Algeddawy	PhD, Industrial and Manufacturing Systems, 2011	ASC	TT	FT	0	22	3	None	Med	Med	Med
Sura Alqudah	PhD, Industrial and Systems Engineering, 2014	ASC	TT	FT	2	14	7	None	Med	High	Low
David Gill	PhD, Mechanical Engineering, 2002	ASC	TT	FT	14	7	7	PE	Low	Med	Med
Jeff Newcomer	PhD, Mechanical Engineering, 1994	P	T	FT	2	27	24	None	Med	Low	Low
Derek Yip-Hoi	PhD, Mechanical Engineering, 1997	P	T	FT	0	23	14	None	Low	High	Low

Mark Peyron	PhD, Chemical Engineering & Polymer Chemistry, 1994	ASC	TT	FT	4	17	17				
John Misasi	PhD, Polymer Science and Engineering, 2015	ASC	TT	FT	2	6	6				
Jill Davishahl	MS, Mechanical Engineering, 1999	AST	TT	FT	2	19	6				
Kirk Desler	MBA, Business Administration, 2018	I	NTT	PT	20	1	1				
David Rider	PhD, Chemistry	P	T	PT	0	12	12				
Nipun Goel	PhD, Mechanical Engineering	AST	TT	PT	0	1	1				
Eric Leonhardt	MS, Automotive Engineering	ASC	T	PT	5	20	20				
Deborah Glosser	PhD, Civil Engineering, 2020	AST	TT	PT	10	2	2				

Instructions: Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other

2. Code: T = Tenured TT = Tenure Track NTT = Non-Tenure Track
3. FT = Full-Time Faculty or PT = Part-Time Faculty
4. The level of activity (high, medium or low) should reflect an average over the three years prior to the visit.

Table 6-2. Faculty Workload Summary
Manufacturing Engineering

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Tarek Algeddawy	FT	MFGE 453 (4) Fall 2021 MFGE 365 (4) Winter 2022 MFGE 454 (4) Winter 2022 MFGE 250 (4) Spring 2022 MFGE 365 (4) Spring 2022	60	30	10	100
Sura Alqudah	FT	MFGE 341 (4) Fall 2021 MFGE 333 (4) Winter 2022 MFGE 381 (4) Spring 2022	60	20	20	100
David Gill	FT	MFGE 231 (4) Fall 2021, Spring 2022 MFGE 463 (4) Fall 2021 MFGE 332 (4) Winter 2022 MFGE 434 (4) Spring 2022	70	15	15	100
Jeff Newcomer	FT	MFGE 492 (3) Winter 2022 MFGE 250 (4) Spring 2022	30	10	60	100
Derek Yip-Hoi	FT	MFGE 332 (4) Fall 2021 MFGE 491 (4) Fall 2021 MFGE 340 (4) Winter 2022 MFGE 261 (4) Spring 2022 MFGE 493 (4) Spring 2022	50	20	30	100
Mark Peyron	FT	MFGE 341 (4) Winter 2022 PCE 342 (4) Spring 2022				
John Misasi	FT	PCE 371 (4) Fall 2021				

		ENGR 170 (4) Winter 2022				
Jill Davishahl	FT	ENGR 101 (2) Fall 2021, Winter 2022 ENGR 115 (4) Winter 2022, Spring 2022				
Kirk Desler	PT	ENGR 225 (4) Fall 2021, Winter 2022				
Steve Sandelin	FT	EECE 351 (4) Fall 2021 EECE 352 (4) Spring 2022				
David Rider	FT	ENGR 170 (4) Fall 2021				
Nipun Goel	FT	ENGR 214 (4) Fall 2021				
Eric Leonhardt	PT	ENGR 214 (4) Winter 2022				
Deborah Glosser	FT	ENGR 225 (4) Spring 2022				

1. FT = Full-Time Faculty or PT = Part-Time Faculty, at the institution
1. For the academic year for which the Self-Study Report is being prepared.
1. Program activity distribution should be in percent of effort in the program and should total 100%.
1. Indicate sabbatical leave, etc., under "Other."
1. Out of the total time employed at the institution.

Table 6-3. Professional Development Summary

Manufacturing Engineering

Faculty	Professional Development Activities
Sura Al-Qudah	• Sustaining Inclusive, Student-centered Instruction in WWU Departments Workshop, Sep 15, 2021 • 2021 ABET Symposium (virtual), April 2021 • Engaging Students in Online Environments, Aug 10-14, 2020 • Teaching a Synchronous Course, Aug 3-7, 2020 • Integrated Enterprise Excellence: Going Beyond Lean Six Sigma and the Balanced Scorecard, ISERC pre-conference workshop, FL, May18, 2019 • CSE STEM Equity & Inclusion Workshops (ISMs), Cultural Awareness of Self, WWU, April 2019. • The Academic Leadership for Women in Engineering (ALWE) Workshops, During SWE Conferences in 2017 & 2018 • Scholarship of Teaching & Learning Residency (SoTL), North Cascades Institute, WA, Sep 6-8, 2016.
Tarek Algeddawy	• Joint Center for Aerospace Technology Innovation (JCATI) project SU2021-SP2022, PI: solving the resin buildup cleaning problem in composite part tools in aerospace industry, with a team of 5 undergrads and a Co-PI from PCE. • Automation, Robotics and Learning Factories (2018-present): advancing the automation and robotics area in MFGE by introducing industry standard software, hardware and systems integration, developing an industrial grade learning factory (LEAF) from the ground up, while involving undergrads in the design, fabrication and installation processes. • Equity, Diversity and Inclusion: participation in the STEM Concept workshop by ISM (2019), focused on cultural awareness of self and experiences of others.
David Gill	• "Synchronous Couse Help Session", Aug. 6, 2020 • "Engaging Group & Collaborative Work", July 23, 2020 • "Screencast-O-Matic Power User", July 22, 2020 • "Blended/Online Course Development Boot Camp", July 21-Aug. 4, 2020

	• "Interfolio Training", June 23, 2020 (1hr) • "VERICUT Verification Web Training", June 16-18, 2020 (24 hrs) • "VERICUT Force Optimization Web Training", June 3-4, 2020 (8 hrs) • "OMAX Waterjet Training", Bellingham, WA, September 10-12, 2018 • "The Tenure Process", New Faculty Spring Event, April 12, 2017, WWU • "Composites 101" workshop, AeroDef 2017 Conference, March 7, 2017, Ft. Worth, TX • "Teaching 3D Spatial Skills Workshop", Western Washington University, April 28-29, 2016
Jeffrey Newcomer	• Learned new PLC hardware and software since we adopted new systems for MFGE 250 labs. • Learned new FANUC robot software since we have new LR Mate 200iD models, though the changes are relatively minor. • Learned new FANUC iRVision software as well. Unlike the main robot software, some of the changes to iRVision are significant.
Derek Yip-Hoi	• Engineers Without Borders Officer Training – Self-paced training required using resources at Volunteer Village, Dec 2021 – May 2022. • HSMWorks SolidWorks CAM self-paced, online training, April 2022. • Altair HyperWorks self-paced, online training, August 2021. • CATIA 3DExperience, self-paced, on-line skills transitioning. On-line courses were taken in the following areas: Part Design, Assembly Design, Composites Design, Generative Shape Design, Digital Shape Preparation, Equipment Design, Machining, Structural Finite Element Modeling, Computational Fluid Dynamics (new), Cloud-based PDM infrastructure (new), June 2017 – Mar 2020 • CAM Functional Tolerancing and Annotation Training 2-day training course conducted at Dassault Systemes training center, Pontiac Michigan, Jun 2017 • CAM Automation using CATIA: Professional leave development exposure through a project to automate CAM program conversions for new 5-Axis CNC machines. Conducted at Zodiac Aircraft Cabin Interiors, Jan – April 2017 • Product Data Management Training: Professional leave exposure in the use of Smarteam in managing composite panel and bonding tool data and documentation. Conducted at Zodiac Aircraft Cabin Interiors, Jan – April 2017 • "Teaching 3D Spatial Skills Workshop", Western Washington University, April 28-29, 2016

CRITERION 7. FACILITIES[1]

A. Offices, Classrooms and Laboratories

General: The Engineering and Design department is housed in the Ross Engineering Technology (ET) building, built in 1987. This building contains seven classrooms, with the largest accommodating 60 students, a small seminar room, two computer labs, a lab suite for each of the engineering programs, and a lab suite to support long-term projects. The largest engineering classes have enrollments under 50, so most years all engineering classes are taught in the Ross ET building, and all engineering labs are held in the Ross ET building as well. None of the facilities in the Ross ET building are used in support of basic science instruction. Those programs are located in different buildings on campus and have sufficient laboratory space of their own.

1. **Offices**

   All tenured and tenure-track faculty members have individual offices with a computer and the necessary software to support the courses they teach and their scholarship. Non-tenure track (NTT) faculty members have offices, but most share their office with at least one other NTT faculty member. NTT faculty members also have computers and the necessary software to support their teaching. The main administrative office, ET204, houses the Department's administrative staff and the offices of the Chair, and two senior faculty members. The technical staff also have offices that are located in or close to the laboratory facilities that they oversee.

2. **Classrooms**

   MFGE classes are generally taught in the Ross ET Building in ET 106, ET 107, ET 262 (computer lab), ET 304, ET 308 (computer lab), ET 321, or ET 322. All classrooms have an instructor station with a networked computer with all of the program software, connections for a laptop, and a document camera. The computer labs also have an instructor station, but without the document camera. The ENGD department maintains cameras that faculty can check out to be able to simulcast a class when there is the need to do so. On some occasions a scheduling conflict results in a program class being taught in a General University Classroom (GUC) in another building. GUCs all have the same equipment Ross ET classrooms, but they have integrated simulcasting systems. Depending upon the class, it may also be necessary to make arrangements for program software to be available in a GUC, though that has not been an issue during this review period.

3. **Laboratory facilities**

   The ENGD department maintains a large computer lab, ET 308, with 50 computers and a small computer lab, ET 262, with 22 computers. ET 308 is open 24/7, while ET 262 is available to students during weekdays. Computing resources and software are described in more detail in section 7.B below.

Figure 7.A.1 shows the MFGE lab suite, which includes: ET 134, ET 136, ET 138, ET 139, and ET 304, which is both a lab and a classroom. ET 135, which is a hot metals lab, and ET 308, the large computer lab, are also shown, as are the ET 321 and ET 322 classrooms.

Figure 7.A.1: MFGE Laboratory Facilities and Surrounding Rooms

Machining Processes and CNC Laboratory (ET 136)
This lab space contains state-of-the-art CNC machines spanning 3-axis, 4-axis, 5-axis, turning, mill-turn, and chucker mills and lathes. These capabilities are enhanced with waterjet, manual support machines, and automated metrology and parts handling equipment. Production tooling is available for students to work with. The primary classes that utilize this lab are MFGE 332 Introduction to CAM and CNC (MFGE and PCE), MFGE 434 Advanced CAM and CNC (MFG, PCE elective), and PCE 461 Tooling for Plastics Processes (PCE, MFGE elective). In addition to this required course work, the CNC machines are used to support senior project implementation work for both MFGE and PCE majors (MFGE/PCE 493).

The space also contains traditional manual machining equipment (lathes, mills, drill presses) and some minimal sheet metal and welding capabilities. Its primary curricular use is for machining lab work in MFGE 231 Introduction to Metal Manufacturing Processes, a class taken by all MFGE, PCE, and ID majors. It also serves as a general-purpose machine shop for students in the department. Under appropriate faculty and staff supervision, students who have taken MFGE 231 are permitted to run these machines to fabricate parts for other classes, senior projects, research projects, and for student competition teams purposes. Because of COVID-19 and to comply with the social distancing requirement, the machines were rearranged, and isolation curtains were temporarily installed between each workstation.

Learning Factory (LEAF) Lab (ET 138)
The space has modular stations for material handling and pallet circulation, robotic assembly, vision inspection, and automated material storage. The system can be reconfigured to have two

state-of -the-art UR5e collaborative robots; a 6-DOF and 4-DOF SCARA Epson industrial robot and four Cognex vision systems. All stations are controlled via Allen-Bradley and BRX PLCs, and Red-Lion HMI screens. The system has an open concept to allow senior students in MFGE454 Systems Integration to interact and continuously modify system modules to have a deeper understanding of system level automation control and industrial communication protocols. Sophomore students in MFGE250 have component level interaction with robots, PLCs and cameras rather than system level. In addition, all system components, modules and supporting software are available to senior project implementation work in MFGE 493

Metrology (ET 139)
The space contains a wide range of manual measurement instruments, two Brown and Sharpe Coordinate Measuring Machines (CMMs), and a FARO Scan Arm. Students are introduced to the principles behind and use of measurement instruments as part of their MFGE 231 laboratory experience. The CMMs are utilized in MFGE 341 Quality & Continuous Improvement, a class taken by the MFGE and PCE majors. The Metrology lab is also used to support senior project implementation work for both MFGE and PCE majors (MFGE/PCE 493).

Erich Sarapuu Robotics Lab (ET 304)
The space primarily supports laboratories in MFGE 250 Intro. To Manufacturing Automation (MFGE & PCE), MFGE 453 Industrial Robotics (MFGEs only), and MFGE 454 Systems Integrations (MFGE Elective). It contains a mix of SCARA and articulated arm robots from Denso and Fanuc, and a parallel kinematic, pick-and-place robot, with an integrated vision system, also from Fanuc. This space is located on the 3rd floor of the ET building.

Boeing Computer-Aided Engineering and CAD (ET 308)
And Computer-Aided Engineering and CAD (ET 262)
These spaces are the main departmental computing labs for the MFGE, PCE, and ID students. Various teaching and instructional format are used in this space e.g., straight tutorial or laboratory sessions, activity-based instruction, flipped-classroom blended learning, and collaborative team-based learning. These labs contain, in total, 72 Dell Precision T1700 Workstations with dual flat-screen monitors. These are replaced on a 5-year cycle so as to keep performance on par with advances in the operating system and the CAD/CAM/CAE software they run. Figure 7.A.2 summarizes the key pieces of software currently installed.

A broad range of classes utilize these spaces for instruction. Included amongst these are ENGR 115 (2-3 classes), MFGE 261 (all classes), MFGE 332 (all classes), MFGE 341 & 342 (6-8 lab sections), MFGE 333 (8-10 lab sections), MFGE 365 (all classes), MFGE 381 (4-5 classes), MFGE 434 (all classes), MFGE 453 (all classes), MFGE 463 (4-6 classes), and MFGE 462 (all classes). In addition, many other classes may require students to complete assignments requiring the use of a piece of software installed in these labs.

Rapid Prototyping (ET 307) and the 3D-Printing Lounge (ET 140)
Two Stratasys Dimension FDM machines are available for students to use to build prototypes. These are used in MFGE 261 Introduction to CAD where this technology is introduced. Other lower-end 3D printers are available for the students in ET 140 for students' overflow from the

MFGE 261 class and other classes which may require designing 3D prototypes such as directed-research classes and the senior project series.

• CATIA 2021 • 3DExperience 2022 • Solidworks 2021 • Vericut 9.2.2 • Altair Suite 2021 • Fusion 360 • Moldflow 2019 • Sketchbook Pro 2021 • Blender • Catalyst EX. • ChemDraw 20 • Cura Lulzbot Edition 3.6.23 • DFMA 2019c • Keyshot 10 • Matlab 2021a • Do More Designer 2.9 • Adobe Creative Cloud 2022 (ET 262 only)	• MestReNova 14.2 • Microsoft Office 2019 • Microsoft Project 2019 • Microsoft Visio 2019 • Microsoft Visual Studio 2017 • Minitab 21 • OmniSec 5.12 • OriginLab 2021b • Rhino 7.1 • Robo DK 5.2 • SecondWave Research Studio 5 • Sintratec Central 1.2 • HSMWorks (to be installed) 2022 • Universal Analysis 5.5.24 • Trios 4.5.1 • VitalSource Bookshelf • INRA

Figure 7.A.2: Key Software Available in CAD Labs

B. Computing Resources

The ENGD department has 72 computers for the MFGE, PCE and ID programs located in ET 262 and ET 308. There are an additional 61 computers for the EECE program located in ET 331, ET 338, and ET 340. The 22 computers in ET 262 also contain the software for EECE. These computers are available for local use during building hours of 7am-9pm Monday through Thursday and 7am-6pm Friday through Sunday, except for ET 262 which is closed on weekends. Except for ET 262, students are not kicked out of the building or computer labs when the building is locked, so they can continue to work in the computer labs after the building is closed. In addition, all of these computers are available for remote access through Microsoft Remote Desktop 24/7.

The following software is used by the programs in the ENGD department and available on the lab computers: Altair Simulation Suite, Adobe Creative Cloud, AutoDesk (Fusion360, MoldFlow, SketchBook), CATIA, CGTech Vericut, ChemDraw, Cura, Dassault 3DExperience, DFMA, Keyshot, Matlab, MestReNova, Minitab, Origin, RoboDK, RoboGuide, Solidworks, Microsoft Project, Altium Designer, Anaconda, Click PLC, Eagle Layout Editor, Energia, Git, TourtiseGit, MCUXpresso, MultiSim, PLECS, PowerWorld Simulator, Microsoft Visio. Some of this software is professional versions, while others are more restrictive student editions through our license agreements with vendors.

In addition to the ENGD computer labs there are approximately 400 general university lab computers available for student use. These labs are in various buildings around campus and having varying building hours with some being open 24/7. The University also has some laptops available for checkout by students. Students in the dorms also have access to the lab computers provided by university residences.

File storage is primarily through Microsoft 365 (OneDrive, SharePoint, Teams), however some legacy content is hosted on the ENGD department's file server. The server is a 16 core Windows server with 256 GB ram and 11 TB of storage. It hosts faculty and staff home directories, GT-Suite and CATIA license servers, some departmental files, research data, and the Formula SAE student club files.

The computing facilities are adequate to support the scholarly and professional activities of the students and faculty for the following reasons:

- Remote access is available to students and faculty to access these computing facilities from off-campus or through campus VPN which was a great support during COVID-19 pandemic.
- Many software licenses allow faculty and students to install a copy on their own devices, to use anywhere outside of the lab setting.

C. Guidance

Pre-major students are only allowed to use the equipment in the ENGD Makerspace, 3D printers, sewing machines, vinyl cutters, and a laser cutter, all of which are considered to be safe for novices to use. Nevertheless, students are given demonstrations and supervised when they first use one of the machines in the ENGD Makerspace. Students earn badges on the machines, which allow them to use the machines independently.

Instruction for software is provided in classes that require the use of that software, starting with the introduction of CATIA in the MFGE 261 Introduction to CAD class during students' first quarter in the major. The University's Student Technology Center (STC) also provides training and tutoring on software and the equipment that the STC has, which is very similar to the equipment in the ENGD Makerspace.

Before students are able to use lab suites in the Ross ET building, students who are newly accepted into the major must first complete an online Chemical Safety course and quiz that was created by the University's Environmental Health and Safety (EHS) department. Once students have passed the EHS course, they must attend a Laboratory Safety Orientation. At the end of the Laboratory Safety Orientation students receive a lab badge that is color-coded by major. Students' first badge is valid for spring of their sophomore year and all of their junior year. At the beginning of their senior year, students repeat the EHS course and attend a second Laboratory Safety Orientation, at which they receive a new lab badge that is valid for their senior year. Students who return for a fifth year repeat the senior Laboratory Safety Orientation and receive a new badge for that year.

Once students have a valid lab badge, they are able to enter lab suites. Before students are allowed to use any of the equipment in a lab suite, they participate in an orientation to learn the basic safety procedures and requirements for that lab suite. Each lab suite has an Instructional Technician to maintain the lab suite and its equipment and to enforce the lab rules. For basic equipment, such as drills and hand tools, faculty and staff do not give formal instruction but instead perform training on a case-by-case basis. For more advanced machinery, tooling, and processes each student must attend a laboratory demonstration performed either by the lab technician or course instructor before attempting to operate the equipment or perform the process. Students are only allowed to use the lab suites when they are supervised by a lab technician or a faculty member. The MFGE lab suite is open during the day on weekdays. The PCE lab suite is open during the day on weekdays, and in the evening Monday through Thursday for a limited set of activities. The Project Lab suite is open in the afternoon and evening Monday through Thursday, and during the day on Fridays.

Due to the COVID-19 pandemic, the Laboratory Safety Orientations were temporarily suspended, and students received their lab orientation and safety briefings directly in the lab suites that they were using for classes. During this period students were not able to use lab suites that they did not need for a class in which they were currently enrolled.

D. Maintenance and Upgrading of Facilities

Although the University is aware of the problem, at this point there is not a campus plan for regular replacement of lab equipment. At this time, equipment is supported through student lab fees, one-time financial support, and in-kind donations. This applies to both the replacement of existing equipment and the acquisition of new pieces with updated technology.

The primary funding source for equipment in the MFGE program is currently the equipment replacement fee charged in every MFGE and PCE course. This fee supports an equipment replacement plan that is intended to replace each piece of laboratory equipment on a 20-year cycle and computers on a 5-year cycle. The computer portion of the fee also supports annual software costs, the maintenance of 3D printers that are available for all students in the programs to use, and the replacement of teaching computers and projectors in department classrooms. The fees are adjusted every year to take into account in-kind donations, steep discounts, or matching funds for equipment purchases and equipment maintenance. The fees may also be adjusted to shorten or lengthen the replacement cycle for specific pieces of equipment. The fee generally funds one large piece of equipment (> $50k) for the MFGE or PCE program each year and many smaller purchases as well. A portion of the fund is always set aside to address safety issues, if there are any safety issues to address. The average annual spending from the equipment fund for the last six years has been almost $120k.
The ENGD department is in the process of building an equipment endowment that can be used to supplement funding from lab fees. Large monetary donations made to the department in recent years have been added to this endowment, and the interest that it earns is being rolled back into the principle. It is the plan of the department to grow this endowment to be a sustainable source of funding that amounts to a third of the cost of equipment replacement, with the other two thirds coming from student lab fees, donations, and internal and external grants.

MFGE equipment replaced during this review period via the methods outlined about includes four robots and a waterjet cutter.

The recent hire of new faculty members has also provided an opportunity to introduce new resources. Though primarily to support faculty scholarship, in many cases this has the potential to double for instructional purposes. An example of such an acquisition during this review period is the equipment in the Learning Factory (LeaF) lab that is used for both research and the MFGE 454 Systems Integration class

Maintenance of existing equipment is primarily performed by the faculty and technical staff, and supported by the department's operating budget and lab fees. A portion of the department's operating budget is reserved for equipment repair each year, and it is generally sufficient to cover equipment repair costs. In specific cases when the Department budget has not been adequate to cover equipment repair, the Dean's office has supplied additional funds.

E. Library Services

Engineering and Design is supported by the library with journals, books, standards, and a reference collection. A subscription to IEEE Xplore is available to students and faculty and is deemed an important resource to support research within the IEEE standards. The book collection is adequate and can be used as a traditional book loan or through the "course reserves" for courses that request this service. Access to journal articles is good. Journals are available online, many e-books are online, and several reference items are online also. The library "interlibrary loans (ILL)" is another reliable and adequate resource to submit and track requests for articles, book chapters, and loanable items such as books and DVDs. The library purchases materials on demand. An online form is used by faculty to submit purchase requests. Journal subscriptions are considered when requested and ordered when usage merits the purchase.

Databases purchased by the library to support Engineering include:

- IEEE Xplore
- ASTM Standards
- SAE Standards
- EBSCO Academic Search Complete
- ACM Digital Library
- Computer Abstracts International
- SPIE Digital Library
- Engineering Index and INSPEC are available by appointment

Overall, the library is an important and adequate resource for the MFGE program for both students and faculty.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

The primary program leadership is shared between the Program Director and Department Chair. The Program Director reports to the Department Chair, who reports to the Dean of the College of Science and Engineering, who reports to the Provost and Vice President for Academic Affairs, who reports to the University President.

The Program Director shares responsibility for the program curriculum and resources with the Department Chair. For the PCE program, the Program Director is Dr. Sura Al-Qudah and the Department Chair is Dr. Jeff Newcomer. Dr. Al-Qudah has been a faculty member in the MFGE program since 2014, has been the MFGE Program Director since 2021. As Program Director, Dr. Al-Qudah is responsible for the curriculum, the MFGE program's four other tenured faculty, limited-term faculty, the instructional technician, approximately 45 MFGE majors, and the program laboratory suite. Appointment of the Program Director is based on a joint recommendation of the Chair and the program faculty.

The Engineering and Design (ENGD) Department Chair, Dr. Jeff Newcomer, who has been the Chair since fall 2012, shares responsibilities with Program Directors for curriculum and facilities for five programs – Electrical and Computer Engineering, Manufacturing Engineering, Plastics and Composites Engineering, First-Year Programs, and Industrial Design. These programs comprise a total of over 400 majors and pre-majors. The Chair, with appropriate consultation with Department faculty and staff, is responsible to the Department, the College, and the University for leadership in matters effecting the Department including, but not limited to:

- Faculty teaching assignments and workloads;
- Course scheduling;
- Curricular planning;
- Recommending appointment of new faculty and staff, including opportunity hires;
- Administering the space and equipment allocated to the Department;
- Budget management and authority;
- Addressing student and faculty concerns by using the relevant university procedures;
- Administering faculty and staff development and performance reviews;
- Reviewing and evaluating faculty tenure and promotion cases;
- Managing the Department's resources;
- Management of assessment and accreditation efforts;
- Management of lab safety programs, including maintaining compliance and training;
- Working with the Foundation to obtain donations for the Department; and
- Other duties assigned by the Dean.

The Chair is also responsible for the development and maintenance of departmental records, for facilitating the harmonious functioning of the Department, for management of the Department's resources, and for providing information to the Dean in a timely manner for use in personnel and departmental resource decisions.

The Dean, Dr. Brad Johnson, is responsible for the leadership of all departments and centers in the College of Science and Engineering (CSE), including the:

- Biology Department,
- Chemistry Department,
- Computer Science Department,
- Engineering & Design Department,
- Geology Department,
- Mathematics Department,
- Physics & Astronomy Department,
- Science, Mathematics and Technology Education (SMATE) program,
- Internet Studies Center, and
- Advanced Materials Science and Engineering Center (AMSEC).

The Dean also has an Associate Dean, Dr. Jackie Caplan-Auerbach, who primarily handles curriculum, assessment, and student considerations such as academic honesty violations and grievances. Dean Johnson started as Dean fall 2017 and Dr. Caplan-Auerbach started as Associate Dean during fall 2017 as well. College-wide decisions are made by the Dean in consultation with several advisory committees including the:

- Policy, Planning, and Budget Council (PPBC),
- Curriculum & Assessment Committee,
- Diversity, Equity, and Inclusion Committee,
- Personnel Committee,
- Technical Operations Committee, and
- Dean's Advisory Committee (DAC).

Each of these committees has a representative from each department. DAC is made up of department Chairs and the SMATE and AMSEC Directors

The Provost, Dr. Brent Carbajal, is responsible for all academic affairs at Western including eight colleges/schools:

- College of Business and Economics,
- College of Fine and Performing Arts,
- College of Humanities and Social Sciences,
- College of Science and Engineering,
- Fairhaven College of Interdisciplinary Studies,
- Graduate School,
- The College of the Environment, and
- Woodring College of Education.

The Dean of each of these colleges reports to the Provost, as does the Dean of the Libraries and five Vice Provosts. The Provost is one of five Vice Presidents that report the President, Dr. Sabah Randhawa, who in turn reports to the Board of Trustees.

Leadership is involved in program decisions in proportion to the impact of the change on the Department and other academic units. Proposals for program changes, ranging from small course changes to program expansion, originate in the program. The Chair ensures that changes that impact multiple programs have input from all of the effected programs, and the curricular change process ensures that programs external to the Department are aware of and approve academic changes that impact them.

All academic course and program changes are reviewed and approved by the ENGD Curriculum Committee, the Department Chair, the CSE Curriculum Committee, and the Academic Coordinating Commission (ACC), which is the university-level curricular body.

All proposals for program expansion are discussed in the ENGD department, by both the PPBC and DAC committees at CSE, at the University Planning and Resources Council (UPRC), and by the Council of Deans run by the Provost, before going to the President and the Vice Presidents for final consideration. Successful proposals are either funded by the Provost or included in the University's operating budget request to the State. The First-Year Programs Director position, four EECE faculty positions and a EECE staff position have been funded through this process during this review period.

Due to the COVID-19 pandemic, the University put in place a hiring freeze from March 2020 to July 2021.

- EECE: Despite the hiring freeze, the Dean and Provost recognized the growing interest in EECE and authorized faculty searches for two positions during the 2020-21 academic year.
- MFGE: Since MFGE did not have any open faculty or staff positions during this period, the MFGE program was unaffected by the hiring freeze.
- PCE: The PCE program was in the middle of a faculty search when the hiring freeze went into effect, and that search was cancelled. The tenure-track line still exists, but because the University's enrollment is down almost 10% compared to pre-pandemic levels, the search for a new PCE faculty member was not authorized for the 2021-22 academic year. The search has been authorized for the 2022-23 academic year.

Leadership has been more than sufficient for maintaining program quality and continuity. The ENGD leadership group, made up of the Chair and the five Program Directors, has a good mix of experienced members and relatively new members with fresh perspectives. The Dean, who was a department chair for nine years and Associate Dean for three years before becoming Dean, is very experienced and has been very supportive of program needs. The Provost and the Associate Vice President for Academic Affairs, Dr. Brian Burton, have been in their positions for nine years and have also been very supportive of the program and its needs. The only concern is that both Provost Carbajal and Associate Vice President Burton are retiring summer 2022, Dean Johnson has been appointed as the new Provost, a position he will begin on August 1, 2022, and

Dr. Janelle Leger, the current Chair of Physics and Astronomy, has been named the Interim Dean of CSE.

B. Program Budget and Financial Support

1. The MFGE program's budget is a subset of the ENGD Department's budget. The Department's annual recurring budget includes funding for twenty-three permanent, full-time faculty positions and eleven permanent, full-time staff positions (salary and benefits), including five faculty positions and one staff position exclusively for the MFGE program. There are also three permanent, full-time faculty positions in the Department that are funded through the Institute for Energy Studies (IES), one of which is fully in the EECE program, and a permanent, full-time faculty position in Chemistry that is 0.333 FTE in the PCE program. Staff positions and their role in support of the MFGE program are briefly discussed in Section 7.C below. During this review period, the Department has added five faculty positions, and both of the staff positions that were part-time at the last review are now full-time positions.

   The Department has a $75,000 operating budget. The Department's operating budget has increased by $2,000 for each new faculty position added to the Department, but otherwise has been steady for many years. The Department's operating budget is divided into a portion for each program, funding for faculty travel ($1,500/yr for tenure-track faculty members and $1,000/yr for tenured faculty members), funding for equipment repair, and a small amount to support the main office. The current breakdown of the Department operating budget is:

   - EECE: $4,000
   - FYP: $1,600
   - ID: $1,600
   - MFGE: $3,200
   - PCE: $3,200
   - Travel: $24,000
   - Technicians: $4,500
   - Repair: $13,000
   - Chair/Office: $19,900

   Because the College supports faculty travel, including registration fees, for up to two trips per year, a portion of the money budgeted for Travel in the Department operating budget is often used for repairs or to support programs. The Department budget allocations are reviewed every few years, most recently during the 2021-22 academic year due to the addition of FYP and the cancellation of the Industrial Technology-Vehicle Design program, and adjustments to allocations are made if they are warranted by changes in programs.

   For the 2022-23AY (FY2023), the Engineering and Design Department is giving more budgetary control to the Program Directors, including control over the travel funding that is allotted to program faculty members. Since most travel costs are actually covered by the College, this will give the programs more flexibility. The new program allotments for the engineering programs are:

- EECE: $19,750
- FYP: $5,350
- MFGE: $11,450
- PCE: $11,450

Beyond its recurring budget, the Department has multiple funding sources, including annually requested recurring funds and numerous self-sustaining funds:

- The College of Science and Engineering provides annual funding for non-tenure track faculty members (NTTs) on an as-needed basis and 1,000 hours of funding per quarter for undergraduate teaching assistants (UTAs). The annual request is prepared by the Chair and submitted to CSE during winter quarter of the previous fiscal year. The request the 2021-22AY (FY2022) was funded at is usually initially funded at ~$183,000 for salary with $50,000 set aside for UTAs and an additional ~$50,000 set aside for benefits, and the Dean's Office approved additions of $25,000-$30,000 to that request as things changed during the academic year (most of which impacted the Industrial Design program, not engineering). This funding has always been sufficient to meet Department needs, and the Dean's Office has always provided full funding for all requested NTT sections. However, requests for UTAs during the 2021-22 academic year exceeded the 1,000 hrs/qtr that had been sufficient in previous years, so the 2022-23 academic year request was increased to ~$187,000 for salaries with $80,000 set aside for UTAs. The reduction in funding for NTT salaries is due to a reduction in need for NTT led sections due to new hires in the EECE program, so all of the requested sections were funded.
- The Department maintains seven lab fee funds for consumables, including three that specifically support the MFGE lab suite. Fees are set based upon expected materials use and other costs, such as specialized software licenses, and attached to each class that uses the lab or lab suite supported by the fund. These funds are supposed to be at or near zero balance at the end of each academic year, and they rarely exceed $5,000 at any given moment.
- The Department maintains three lab fee funds for equipment and computers: 1) a fund to support computers, equipment, and software for EECE, 2) a fund to support computers, annual software costs, and 3D printing for MFGE, PCE, ID, and First-Year Programs (FYP), and 3) a fund to support major equipment purchases in MFGE, PCE, and ID. Computers are replaced on a five-year cycle and major equipment is replaced on a twenty-year cycle. More information is given about the computer and equipment replacement approach in Section 7.D.
- The Department maintains two self-sustaining funds, one related to fees accrued through use of equipment by external users and one general fund. These funds are used for infrastructure improvements and occasionally used for repairs if operating budget funds and funds from the Dean's Office are insufficient. The two funds currently have a combined balance of ~$150,000.

- The PCE program has a fund that is supported by project fees. This fund is used to pay the salary and benefits of the PCE Research Associate and costs associated with projects paying into the fund.
- The Department has a general Foundation fund. This fund is used for program enhancements and to support faculty professional development. The current balance of the Foundation fund is ~$121,000.
- Each engineering program has a Foundation fund. These funds are used for program enhancements at the discretion of the Program Directors for each program. The current balance of the EECE, MFGE, and PCE funds are ~$3,200, ~$36,000 and ~$19,000 respectively. While these funds are not frequently used, the MFGE program spent ~$46,000 on laboratory equipment from its fund in summer 2021.
- The Department is building an equipment endowment. When the principal value reaches $1,000,000, the intent is to spend interest from that fund on major equipment purchases, which should allow for the reduction in what students pay in lab fees for the equipment replacement funds. The current balance of the equipment endowment is ~$630,000.

2. As Western is primarily a teaching University, there are many programs to support teaching. The College funds undergraduate teaching assistant (UTA), the Center for Instructional Innovation and Assessment (CIIA) sponsors events, and provides resources and support for implementation, the Office of Research and Sponsored programs (RSP) supports summer teaching grants, and the Science, Math, and Technology Education (SMATE) program has been offering grant funded curriculum development workshops and teaching orientation workshops for new faculty for the last two years. In addition, the Department will send faculty to workshops or classes to improve teaching and/or content knowledge. This is generally done on an as-needed basis, and it has not been needed recently.

   As mentioned above in Section 8.B.1, the College has been providing funding for 1,000 hours of UTA support each quarter. UTAs are used primarily to support lab activities, and sometimes as graders as well. Priority is given to lab support followed by classroom support and then grading, so as demand for UTA hours has increased, support for grading has been rare, but all requests for lab and classroom support have been accommodated.

   While the College provides support for laboratories and grading, the CIIA provides support for innovation. The mission of the CIIA is:

   > [D]edicated to the enhancement of teaching and learning on the campus of Western Washington University. The Center promotes discussion and debate about teaching and learning, provides support to faculty in instructional innovation and course development, and helps nurture a culture of educational innovation and instructional excellence across disciplines.

   The CIIA realizes its mission through: 1) sponsoring events including workshops, webinars, and summer grant opportunities, 2) serving as a clearinghouse for teaching, learning, and assessment resources, and 3) providing support for implementation of new teaching and assessment methods. The CIIA ran a number of paid workshops to support faculty members switching to online teaching during the pandemic, which was greatly helpful for engineering faculty members, most of whom had never taught an online class before.

Although it is primarily a research support office, RSP overlaps with the CIIA a bit in that it offers grants to support teaching innovation. RSP provides a competitive grant opportunity for Western faculty to get $6,000 of summer salary to "to provide faculty with time to engage in projects that will result in significant enhancement of instruction." An individual faculty member is eligible to receive a summer teaching grant every other summer.

A different sort of grant support is provided by SMATE. While SMATE's primary focus is preparation of K-12 teachers, SMATE's mission is:

> [T]o improve teaching and learning of science, mathematics, engineering, and computer science by all and for all. We accomplish this through teaching, research, professional development, and partnerships with people and communities in the university, the state, the region and throughout the world. Ultimately we expect to see the results of our work in the healthy and socially just communities around us.

In addition to its grant and workshop activities, SMATE sponsors a paid, three-day teaching workshop for new faculty members before the academic year begins, and almost all new faculty members in engineering participate in this workshop.

3. Maintenance and upgrade of infrastructure and facilities and acquisition, maintenance, and upgrade of equipment are different processes at Western. While general maintenance of infrastructure and facilities is completed by Facilities Management (FM), upgrade of infrastructure and facilities is run through the University's capital budget process. In contrast, acquisition, maintenance, and upgrade of equipment is primarily a Department process that uses a combination of lab fees, grants, in-kind donations, working with industry partners, and sometimes includes the College, the Western Foundation, and University's Student Technology Fee (internal) grant process.

   General infrastructure and facilities maintenance is conducted by FM based primarily upon their campus-wide plan, which is regularly updated. Upgrade of infrastructure and facilities is part of the University's capital budget process. Major capital projects, such as building construction, building renovation, and building expansion are part of the University's ten-year capital plan. Classroom and laboratory renovations and improvements, both programmatic and infrastructure, are part of the University's minor capital project process. This process begins with the submission of a proposal, which can be done by any individual or group on campus. The proposals are then separated into programmatic proposals and preservation proposals, the latter of which includes anything that is related to safety as well. Preservation proposals are assessed and prioritized by FM. FM completes projects in that order as funding allows.

   Programmatic proposals all go to the college or division level where they are all prioritized. The Provost's office then prioritizes all projects from the colleges. The project lists from the Provost and the other Vice Presidents are reviewed by UPRC, which may recommend changes, and then ultimately reviewed and approved by the President. The faculty have input at the College through PPBC and DAC, and at the university level through UPRC. Once the proposed projects are all prioritized, they are scheduled and completed as funding allows. Funding for programmatic projects has been limited recently, but the ENGD Makerspace was funded for an upgrade during the 2021-22 academic year, with the work due to take place during summer 2022.

Unlike infrastructure and facilities, the University does not have a general equipment acquisition, maintenance, and upgrade process, so this is managed by the Department. As mentioned above in Section 8.B.1, the primary source of regular funding is student lab fees. To make sure that these funds are used well and expediently, the Department maintains and annually updates an equipment priority list and acquisition plan.

Whenever possible, lab fee funds are supplemented by grant funds, donations, and University funding sources. Another source of equipment funding has been the University's Student Technology Fee (STF) program. This program is funded by the university-wide student technology fee, and a portion of the funds are set aside to fund equipment acquisition through a proposal process. During this review period, the Department received electronics simulation software for the EECE Energy program; a Universal Cobot for MFGE labs suite; a twin-screw extruder, two microscopes, a Selective Laser Sintering 3D printer, a universal test stand, and a sheet press for the PCE lab suite; and equipment for the Makerspace through the STF program.

During this review period, the major equipment acquisitions by the MFGE program are:

- OMAX Waterjet Cutter
- Three Universal UR5e Cobots
- Three articulated FANUC robots, one LR MATE 200iC and two LR MATE 200iD, all with vision systems.
- Two Epson robots, one articulated and one SCARA, both used
- Two Flexlink conveyor belts
- Four Cognex cameras
- SNAP DM200 Video Measurement System
- Haas Mini Mills
- Haas CL-1 Lathe
- Haas ST-10Y Turning Center
- Haas VF-2TR Machining Center

4. Resources have been and remain adequate to attain student outcomes. There are three facets to resources required to attain student outcomes: 1) salaries sufficient to hire and retain appropriately qualified faculty and staff, 2) sufficient operating funds to support annual activities, and 3) consistent funding for the acquisition, maintenance, and upgrade of equipment. While there is room for improvement, especially in the equipment funding situation, there is and has been sufficient support to meet student outcomes.

As is discussed below in Sections 8.C, 8.D, and 8.E, salaries and benefits are competitive enough to have allowed the Department to attract and retain faculty and staff. While faculty searches have been complicated by the pandemic recently, we have had only one top candidate turn down Western for a job at another university during this review period, and no faculty members have left for other faculty positions. The faculty contracts have had consistent salary increases, and the compression and equity adjustments have raised salaries for senior faculty members to appropriate levels when compared to national averages for engineering. Staff positions are a bit more challenging, due to the rigidity of the State classification system, but almost all of ENGD staff positions have been reviewed and reclassified to higher levels during this review period, so staff retention has been consistently good as well, though there has been some turnover among the classified staff.

As was discussed above in Section 8.B.1, the Department operating budget has been sufficient for operation as it is well supplemented by College and one-time funds. The additional funds from the College for faculty and staff travel and professional development essentially expand the Department operating budget by ~30% each year. The one drawback of this funding model, as opposed to the funds being in the Department, is that it makes long-term planning for professional development more difficult because funding must be requested for each specific event. Fortunately the Department has sufficient one-time funds to supplement funding for activities that the College will not or cannot fund. The University was also very good about supporting the additional costs incurred from the switch to online instruction due to the pandemic, so the Department did not have to bear those costs out of its operating budget or one-time funds.

Finally, as was discussed above in Section 8.B.3, funding for acquisition, maintenance, and upgrade of equipment has been sufficient, but there is not as large of a regular funding stream as is desirable. Ideally the student lab fees would be about one third of the funding for equipment rather than the largest share. When the Department's equipment endowment gets large enough, and it is getting close, it will be able to provide some regular funding for equipment acquisition, maintenance, and upgrade. For this reason, the equipment endowment is one of the fundraising priorities at this point and time. It would be ideal if the University were also able to consistently contribute to the planned replacement of equipment, but while there have been discussions about doing so, no plans have ever emerged from those discussions.

C. Staffing

The Department currently has three permanent, full-time office classified staff people, seven permanent, full-time technical classified staff people, and one full-time soft-money technical professional staff person. The office staff support all five programs in the Department. Six of the eight technical staff have primary focus areas for supporting labs and programs, while the last two support all five programs in the Department. Below is a brief description of each staff person's responsibilities:

Administrative Services Manager B (ASM), Amy Lazzell – The ASM serves as both the Department Financial Manager and Office Manager. The ASM maintains and tracks budget information for all Department funds including operating, lab fee, foundation, grant, start-up for new faculty hires, and self-sustaining. The ASM also manages payroll, purchasing, hiring procedures including all personnel forms, and serves on the Department Resources Committee. Finally, the ASM supports academics directly by managing the lab fee change process. The ASM is a 1.0 FTE position.

Program Coordinator (PC), Lisa Ochs – The PC serves as the pre-major advisor for all five programs in the Department, designs and manages the Department website, maintains advising and outreach materials such as program planning guides, and supports assessment activities. The PC also supports academics by managing the entering of the course schedule into the University's system. At any given time the PC has 150-300 pre-major advisees, of whom 75-100 are pre-majors in the MFGE program. The PC is a 1.0 FTE position with a 0.083 FTE temporary reduction.

Office Assistant 3 (OA), Jodie Perman – The OA serves as the first point of contact for the Department and does several jobs that are important to program support. She orders lab badges for all majors, collects and files syllabi for all classes, and manages textbook orders for classes. The OA is a 1.0 FTE position.

Electronics Technician 4 (ET) for EECE, Reza Afshari – The ET for EECE is responsible for maintaining the EECE labs, supporting the lab activities in them, and enforcing lab rules, including all safety rules. In this role, the ET for EECE also orders parts, and designs and fabricates equipment to support labs and other faculty activities. The ET for EECE is assigned to the EECE program, but does support other areas in the Department when electronics work is needed, as long as such work does not interfere with EECE program needs. The ET for EECE is a 1.0 FTE position.

Instructional and Classroom Support Technician 4 (ICST) for MFGE, Ben Kaas – The ICST for MFGE is responsible for maintaining the MFGE labs, supporting the lab activities in them, and enforcing lab rules, including all safety rules. In addition to working with students in the labs on class and senior projects, the ICST for MFGE maintains equipment, orders parts for the lab, and prepares materials for the lab activities. The ICST for MFGE also runs biweekly meetings of the technical staff so that they may are aware of what is going on in all of the labs and are able to support each other. The ICST for MFGE is a 1.0 FTE position. Because this job has gotten more complicated with time, it is currently being reviewed for possible reclassification or conversion to a Professional Staff position.

Instructional and Classroom Support Technician 4 (ICST) for PCE, Currently Open – The ICST for PCE is responsible for maintaining the PCE labs supporting the lab activities in them, and enforcing lab rules, including all safety rules. The ICST for PCE is also the Chemical and Material Safety Officer. In this role the ICST for PCE maintains inventories of materials, makes sure that all new materials and chemicals are properly logged and have Safety Data Sheets on file, and makes sure that all disposals of materials and chemicals are done properly. The ICST for PCE is a 1.0 FTE position. The ICST for PCE position has been open since January 2022, so the work has been covered by a part-time temporary ICST person (0.67 FTE), extra support for the PCE faculty from CSE, and extra UTAs. A new ICST for PCE is expected to start on July 5, 2022. Because this job has gotten more complicated with time, it is currently being reviewed for possible reclassification or conversion to a Professional Staff position.

Instructional and Classroom Support Technician 3 (ICST) for Project Lab and Evenings, Mark Dudzinski – The ICST for Evenings is responsible for the Projects labs and works until 9:00 p.m. Monday through Thursday during the academic year to provide students supervised access to certain labs, including the Projects labs, the ID Model Making Shop, and portions of the PCE labs, but not the MFGE labs. The ICST for evenings is a 1.0 FTE position.

Instructional and Classroom Support Technician 3 (ICST) for Industrial Design, *Lisa Collander* – The ICST for ID primarily supports the ID program and labs, but also supports the Makerspace. The ICST for ID is a 1.0 FTE position.

Research Associate 2 (RA) for PCE, Sean Ryan – The RA for PCE works with students and faculty on funded industry sponsored research projects and senior projects. His responsibilities vary with each project, but always involve acting as a liaison with the sponsoring companies, ordering supplies and equipment, and supervising student work on the projects. The RA for PCE is a 1.0 FTE soft-money position.

Information Technology Customer Support – Journey (ITCS) Colin Hanson – The ITCS provides computer and general IT support for faculty, staff, classrooms, computer labs, and general labs for the Department. The ITCS works with other ITCS people in support of the College, but he is fully assigned to support the Department. The ITCS is a 1.0 FTE position.

Engineering Technician Lead (ETL), Stephen James – As the senior technician in the Department, the ETL oversees overall lab safety and organization for the ET building. The ETL also coordinates major building and lab projects, maintains and updates the Department's Emergency Response plan, and coordinates the lab badge program, including the annual lab safety lectures all majors must attend. The ETL is a 1.0 FTE position.

Staff have access to on-campus training through Academic Technology User Services (ATUS), Human Resources (HR), and University courses, which may be taken on a space-available basis. For off-campus training, the College provides $600/year to each member of the staff for staff travel, and staff may request additional funding from the Department as well. For retention, the state classification system does not allow for salary adjustments outside of the proscribed increases, but as staff get more experience and take on additional responsibilities it is common to request that they be moved to a higher classification.

In addition to staff who work exclusively for the Department, there are a number of administrative offices that support the Department. Along with standard university offices such as Academic Advising, Admissions, the Office of Civil Rights and Title IX Compliance (CRTC), Financial Aid, HR, Public Safety, Purchasing, and the Registrar's Office, the following offices support the Department in the following manners:

- ATUS – Computer support for students and computer/software training for faculty, staff, and students.
- Career Services Center – Posting of job and internship opportunities, and the organization and management of three career fairs each year, one of which has an engineering focus.
- Counseling and Wellness Center – Support for students dealing with life problems and emotional concerns.
- Disability Access Center – Support and accommodations for differently-abled students to ensure that they get equal access to curricular and co-curricular activities.
- Environmental Health and Safety (EHS) – Support for technical staff and faculty to make sure that labs are safe and compliant with regulations, including material storage and disposal. EHS Collects and disposes of waste materials from Department labs. EHS conducts safety related training for faculty, staff, and students. EHS conducts assessments of new procedures to assess risk and make sure that PPE is appropriate. EHS will, on request, audit labs for safety and compliance.
- Equity and Inclusion – The University has a number of offices that support students from diverse backgrounds, including:
    - Ethnic Student Center
    - LGBTQ+ Western
    - Lesbian Gay Bisexual Transgender Advocacy Council
    - Queer Resource Center
    - Womxn Center
- Facilities Management (FM) – In addition to general building maintenance and repair, FM works with technical staff to make modifications and improvements where needed. Recently FM made a number of improvements to electrical connections for equipment to improve safety in Department labs.
- Capital Planning and Development (CPD) – Works with faculty and staff to develop plans for space improvements. These may result in minor, intermediate, or major capital projects. CPD then oversees the implementation of funded plans.
- Foundation of WWU – Each college has a foundation officer. The foundation officer works with the Dean and the departments, usually through the Department Chair, to identify and pursue opportunities for philanthropic support from both individual and corporate donors. The foundation officer identifies potential donors, serves as point person for communication with them, and helps develop proposals for funding.
- Government Relations – Works with State and Federal governments to obtain resources for initiatives such as the Transition to Engineering decision package that resulted in funding for 4.0 FTE of faculty and 3.5 FTE of staff.
- Office of Research and Sponsored Programs (RSP) – Provides support for development and submission of external grants. Provides several different types of small internal grants for faculty and students.
- University Communications – Publicizes accomplishments of faculty and students and helps develop materials for external fundraising. Works closely with Government Relations to support their efforts.
- Veteran Services – Provides comprehensive services to veterans, service members, and their dependents as they pursue their education at WWU.

D. Faculty Hiring and Retention

1. The process for hiring new faculty involves the Program, the Department, the Dean's office, and the Provost's office. First the Program proposes a faculty search. Then the Department determines its hiring priorities and provides them to the Dean. Prior to the COVID-19 pandemic, the Dean, in consultation with the Dean's Advisory Council (DAC) and the Policy, Planning, and Budget Council (PPBC), would determine the hiring priorities for the College and then authorize searches as funding allowed. Since the beginning of the pandemic, the Dean is required to provide hiring priorities to the Provost, who has been authorizing searches based on priority of student access. Due to the reduction in enrollment due to the pandemic, a number of faculty searches have been deferred, but some have been authorized to occur during the 2022-23 academic year, including a PCE faculty search that was cancelled in the 2019-20AY. Once the Dean approves a search, the Department selects a Chair for and members of a Search Committee for the position(s), and the Search Committee creates a position description and recruitment plan. The position description is reviewed, possibly amended, and approved by the Department faculty and the Chair. The position description and plan must then be approved by the Dean, the Provost, Human Resources (HR), and the Office of Civil Rights and Title IX Compliance (CRTC) before the position is posted.

   Once recruitment begins, all applications are reviewed by the members of the Search Committee. Once the Search Committee has reviewed all of the applications, it develops a list of five to twelve candidates for phone interviews. A list of candidates for on-campus interviews, usually three, is developed from the phone interviews. On-campus interviews are two days long, and involve the candidate teaching a sample class, giving a research talk, and meeting individually with faculty and administrators, and in groups with students and staff. Once on-campus interviews are complete, the Search Committee makes a recommendation for hiring priorities to the Department. Once the Department has approved a hiring recommendation, the search process is reviewed by CRTC and then approved by the Dean, the Provost, and HR. Once all of the approvals are in place, the Search Committee Chair notifies the top candidate, and the Department Chair begins negotiation of terms and conditions of employment with that candidate. The Dean and Provost also review and approve the formal offer to the candidate before it is tendered.

   A standard package for a new faculty hire includes at least one summer of funding, start-up funding to support the new hire's research, course release for the new hire's first year or two, and funds for relocation expenses. The Department Chair, with approval of the Dean, has some latitude to offer additional salary based upon the candidate's experience, additional summer support, additional start-up funds, or additional course releases. Before a formal offer can be tendered, the Dean, the Provost, HR, and CRTC must all approve the search process and outcome. During this review period, the Department conducted nine faculty searches to fill eight faculty positions, two replacement and six new, for engineering faculty members. Prior to the pandemic, four of six searches were successful, and the top candidate accepted the Department's offer. During one unsuccessful search no offer was tendered. During the other unsuccessful search, which was for two positions, one person turned us down and one accepted the position, but later had to withdraw due to complications due to the pandemic. Since the beginning of the pandemic, searches have been more difficult. One search was cancelled due to the hiring freeze the University imposed in March 2020; that search has now received authorization to restart, and it will occur during the 2022-23 academic year. One search for two positions was authorized despite the hiring freeze. That search resulted in one hire, one person turning us down to take another job, and one person turning us down due to complications due to the pandemic. The most recent faculty search, once again for two positions, resulted in two new hires who will be joining the EECE program in fall 2022.

2. Strategies used to retain current faculty include: 1) professional development funding for travel and webinars, which is described in Section E below, 2) sections in the faculty contract that provide for merit and equity and compression raises, and 3) a retention fund for competitive counter offers maintained by the Provost. Salary increases are determined through negotiations between the University Administration and the United Faculty of Western Washington (UFWW), the faculty union. In addition to general cost-of-living raises and raises associated with promotions, the contract has provided for merit raises based upon exceeding expectations on post-tenure review (PTR), and for equity and compression raises. PTR is conducted every five years. Faculty are reviewed for performance in teaching, research, and service, and required to meet expectations in all three areas. A faculty member who exceeds expectations in one or more areas receives a raise. Equity and compression raises are based upon comparison to the faculty member's field, so the salaries of engineering faculty members in the Department are compared to national averages, and adjustments to salaries are made accordingly. At this time University Administration and UFWW just negotiated a new contract and have agreed to revisit the equity and compression formula. The result of this revisiting is that there were no equity and compression raises during 2021-22 academic year, but the raises are expected to return during the 2022-23 academic year.

E. Support of Faculty Professional Development

Faculty professional development is supported by the Department, the College, the Office of Research and Sponsored Programs (RSP), and the University. The Department provides travel/professional development funds for all tenured and tenure-track (probationary) faculty members. Tenured faculty members have an annual Department travel/professional development allotment of $1,000, and tenure-track faculty members have an annual allotment of $1,500. In addition to travel for conference, workshops, and training sessions, these funds can be also be used for on-line development activities such as webinars. In addition, the department will contribute additional funds as needed for justified faculty development activities. These funds come from either indirect cost recovery, foundation funds, or other one-time funding sources.

The College provides funding for travel to conferences, symposia, and meetings. If the faculty member is presenting one or more papers, the College will fund registration fees up to $1,000 per event for up to two events, and also provides $700 to $1,400 for domestic travel, depending upon location, and $1,500 to $2,400 for international travel, depending upon location, for up to two events. The College will also provide these funds for travel to conferences where the faculty member is not presenting a paper and for other opportunities, such as training sessions, provided that there are funds available. Faculty members presenting papers have first priority for College travel funding, and support for a second trip is subject to the availability of funds. The College also provides the Department Chair with an additional $1,000 for travel to conferences.

RSP provides several internal funding programs that support faculty. RSP provides up to $5,000 for Pilot Projects to generate data for grant applications, $6,000 in salary for Summer Research grants, $6,000 in salary for Summer Teaching grants, a small grants program that provides up to $1,000, and manuscript preparation support for up to $2,200, and a New Initiatives Fund that will provide up to $25,000 to support preparation of major grant proposals (>$500,000) that involve multiple researchers. Prior to the pandemic, the Center for Instructional Innovation and Assessment (CIIA) provided faculty summer grants of $4,000 to attend a five-day workshop to acquaint faculty with models, open-source resources, and ideas for web-based course enhancements, after which the CIIA provides assistance and support for implementing the enhancements. Since the start of the pandemic, the CIIA has offered numerous paid workshops for faculty on online and hybrid instruction. It is expected that CIIA will return to summer workshops at some point in the near future.

Finally, the University provides sabbaticals (professional leave) for tenured faculty members to the extent that state law allows. Faculty are eligible for sabbatical after six years, and leave eligibility is accrued at the rate of one quarter of leave for every two years of service. Because state law limits the number of faculty who can be on leave at one time, professional leave is competitive. Sabbatical proposals for one, two, or three quarters of leave are submitted by a faculty member to the Department Chair. The Chair then writes a recommendation to the Dean. Sabbatical proposals are evaluated and prioritized by the College Personnel Committee. The Personnel Committee makes a recommendation to the Dean, who makes a recommendation to the Provost. All sabbatical applications are reviewed by the University Professional Leave Committee (UPLC), which makes a recommendation to the Provost. Based upon these recommendations and the amount of leave available under state law, the Provost awards sabbatical leaves. Due to State restrictions, the number of quarters of leave awarded to an individual faculty member may be lower than the number of quarters requested.

PROGRAM CRITERIA

1. Curriculum

The MFGE program prepares graduates to have proficiency in the following areas:

A. Materials and manufacturing processes: ability to design manufacturing processes that result in products that meet specific material and other requirements;
B. Process, assembly and product engineering: ability to design products and the equipment, tooling, and environment necessary for their manufacture;
C. Manufacturing systems and operation: ability to analyze, synthesize, and control manufacturing operations using statistical methods;
D. Manufacturing competitiveness: ability to create competitive advantage through manufacturing planning, strategy, quality, and control;
E. Integration and spatialization with large emphasis on manufacturing laboratory or facility experience: ability to measure manufacturing process variables and develop technical inferences about the process.

The 4-Pillars published by the Society of Manufacturing Engineers (SME) was used in the design of the MFGE criteria. These pillars align with the five proficiencies in the program criteria as listed above. Table 1 below illustrates the breakdown of the core engineering courses (*not including Engineering and applied Science*) and where they contribute to each of the five proficiencies. The program is strongest in proficiency B & C with 26% each, with a strong but slightly less emphasis in proficiency A with 21%. The program has a lower emphasis in proficiencies D&E with 12% & 13% respectively. This distribution has been influenced by the industrial practices in the Pacific Northwest, which have traditionally favored B due to the large aerospace presence. The MFGE program views this distribution to be dynamic especially in proficiency C as the aerospace industry is continuously embracing greater levels of automation.

Manufacturing Engineering Core (86*-90 credits)	Percentage*
1) Materials & Manufacturing Processes	21%
2) Product Tooling and Assembly Engineering	26%
3) Manufacturing Systems and Operations	26%
4) Manufacturing Competitiveness	12%
5) Integration and specialization	13%

Table 1. Core Engineering Courses Contribution to the Program Criteria

A complete MFGE curriculum distribution including basic sciences & GURs is shown in Table 2. Please refer to Criteria 5, section 5 for a detailed description of the courses and credits for each of the MFGE curriculum distributions.

	Total	Percentage*
MFGE Required Credits to Graduate	189*-193	
Math & Basic Science	48	25%
GURs	38	20%
Engineering Content (Manufacturing Core + Engineering & Applied Science)	103*-107	54%

Table 2. MFGE Curriculum Distribution

Proficiency E is developed through a broad range of laboratory experiences that majors are exposed to. Most courses in the core of the program contain these experiences, and many require students to apply these to project-type assignments. Table 3 below summarizes these experiences.

Course	Lab Experience
MFGE 261	Computer-Aided Design and fabrication of prototypes using 3D Printing.
MFGE 231	Fabrication using manual machining processes.
MFGE 250	Intro to Robotics
MFGE 332	Programming, simulation and operation of Computer Numerical Control machine tools for prismatic machining (2 ½ D)
MFGE 333	Design for manufacturing and assembly using B-D software
MFGE 341	Programming and operation of Coordinate Measuring Machines.
MFGE 342	Design of Experiments using MS Excel and Minitab
MFGE 381	Design of work cells and use of simulation to study ergonomics.
MFGE 434	Programming, simulation and operation of Computer Numerical Control machine tools for surface machine (3-axis).
MFGE 453	Programming and operation of Robots.

MFGE 454	Programming and operation manufacturing cell with robots
MFGE 462	Surface modeling, laser scanning, composites modeling and FEA.
PCE 371	Exposure to basic methods and safe techniques for processing plastics.
PCE 372	Design, fabrication and process control in the manufacture of composite materials.
ENGR 351	Exposure to electronics test equipment found in industry.
ENGR 352	Programmable logic controllers and programming tools for developing a control or automation system.

Table 3: Laboratory Experience in the MFGE Engineering content classes

SME CMfgT Exam

One measure that we use to assess the success of the curriculum in helping the students meet the Program Criteria is performance on the SME Certified Manufacturing Technologist (CMfgT) Exam. The exam was used as part of the outcomes assessment process for the MET degree from the 2006-07 academic year until the 2015-16 academic year, which is the last year in which that program existed. Based upon that experience, we decided that the exam **was not the best tool** for outcomes assessment for the MFGE program, **but because of its organization relative to the SME 4-Pillars** that the exam **could be used to help us track the effectiveness** of the curriculum relative to the SME 4-Pillars and the Program Criteria. Since the transition to Engineering in 2014, every senior class has taken the exam since then. Below is a summary of the outcomes for the CMfgT exam over those years (2016-2021). The exam passing grade is 60% and tests in several areas in manufacturing. We usually set the target level for our students' performance to 70% and we never got an average score less than that in any of the years. In addition to the overall score, we also map the relevant areas of the exam and the students' performance in those areas to the Program Criteria above. Table 4 gives the mapping of the exam areas to the Program Criteria and the students' performance in each of those areas.

Program Criteria Mapping →					A		B				C	D			
	Pass	Pass %	Mathematics	Applied and Eng. Sciences	Materials Application	Manuf. Proc. Appl. & Op.	Product Des. & Devel.	Process Des. & Devel.	Prod. Sys. Des. & Devel.	Equip/Tool Des. & Devel.	Automated Sys. & Cntrls	Quality & Cust. Service	Manufacturing Management	Personal Effectiveness	Overall Score
2015-16	13	92.9%	75.0%	58.0%	82.1%	69.2%	75.5%	92.9%	68.9%	70.7%	87.7%	79.1%	74.2%	68.2%	73.5%
2016-17	19	100.0%	82.9%	58.6%	78.9%	79.0%	75.2%	94.7%	65.4%	80.7%	87.1%	73.3%	71.7%	77.1%	75.1%
2017-18	15	100.0%	80.0%	66.7%	78.3%	76.1%	75.7%	90.0%	71.9%	83.7%	81.8%	76.4%	62.5%	64.2%	73.3%
2018-19	21	100.0%	78.6%	65.5%	83.3%	79.4%	75.8%	95.2%	73.5%	78.9%	81.4%	70.3%	66.9%	73.6%	74.6%
2019-20	28	96.6%	81.0%	62.9%	82.8%	78.8%	75.4%	98.3%	74.1%	80.5%	86.8%	77.4%	74.4%	81.2%	77.6%
2020-21	27	96.4%	89.3%	72.3%	75.9%	79.1%	69.9%	100.0%	75.1%	75.8%	82.5%	71.7%	71.6%	75.0%	75.5%
Total	123	97.6%	81.9%	64.7%	80.2%	77.6%	74.3%	96.0%	72.1%	78.5%	84.5%	74.4%	70.7%	74.5%	75.3%

Table 4: CMfgT Exam Scores and Program Criteria Mapping

As one can see in Table 4, the students performed well (i.e. average score above the passing level) on all of the areas of the SME CMfgT Exam, but also have room for improvement in many areas as well. The one area that averages below 70% is the “Applied and Engineering Science”. The issue with this area seems to be that students tend to skip these problems because of the long time they require to complete them. It may be that this topic area is not an appropriate measure for this exam due to this confounding factor. Nevertheless, our program is not concerned about this area due to the appropriate math courses that the students are required to take to fulfill the program requirements and the test confounding factor that was stated above. We intend to continue to track all other areas, and if there are any areas where student performance proves to be consistently below expectations, we will look to make appropriate changes to the curriculum to address those issues.

2. Faculty

As documented in Criterion 6 and in Appendix B, the MFGE faculty have experience that spans academic, and governmental/industrial practice. Faculty are actively encouraged to maintain currency in practice through departmental and college funding that can be used for the purpose of professional development. In addition, the department pays for membership in two professional organizations, though all faculty are members of several and pay for the additional memberships using personal funds. These organizations which have a manufacturing focus are as follows:

- Institute of Industrial and Systems Engineers (IISE) – 1 faculty
- American Society of Mechanical Engineers (ASME) – 2 faculty
- Society of Manufacturing Engineers (SME) – 4 faculty
- American Society of Engineering Education (ASEE) – 3 faculty
- Engineering Without Borders (EWB-USA) –1 Faculty
- Society of Women Engineers (SWE) –1 Faculty
- American Society for Quality (ASQ) –1 Faculty

In addition to membership in organizations that promote manufacturing, the faculty are actively engaged in professional training that keeps them at the forefront of manufacturing developments in their area of specialization. Examples of this type of training over the past three years include:

- Sustaining Inclusive, Student-centered Instruction in WWU Departments Workshop, Sep 15, 2021
- 2021 ABET Symposium (virtual), April 2021
- Engaging Students in Online Environments, Aug 10-14, 2020
- Teaching a Synchronous Course, Aug 3-7, 2020
- Integrated Enterprise Excellence: Going Beyond Lean Six Sigma and the Balanced Scorecard, ISERC pre-conference workshop, FL, May18, 2019
- CSE STEM Equity & Inclusion Workshops (ISMs), Cultural Awareness of Self, WWU, April 2019.
- Joint Center for Aerospace Technology Innovation (JCATI) project SU2021-SP2022.
- Equity, Diversity and Inclusion: participation in the STEM Concept workshop by ISM (2019)
- "Synchronous Couse Help Session", Aug. 6, 2020
- "Engaging Group & Collaborative Work", July 23, 2020
- "Screencast-O-Matic Power User", July 22, 2020
- "Blended/Online Course Development Boot Camp", July 21-Aug. 4, 2020
- "Interfolio Training", June 23, 2020 (1hr)
- "VERICUT Verification Web Training", June 16-18, 2020 (24 hrs)
- "VERICUT Force Optimization Web Training", June 3-4, 2020 (8 hrs)
- New PLC hardware and software training, since the adoption of new systems for MFGE 250 labs.
- New FANUC robot software training since acquiring the new LR Mate 200iD models.

- New FANUC iRVision software training. Unlike the main robot software, some of the changes to iRVision are significant.
- Engineers Without Borders Officer Training – Self-paced training required using resources at Volunteer Village, Dec 2021 – May 2022.
- HSMWorks SolidWorks CAM self-paced, online training, April 2022.
- Altair HyperWorks self-paced, online training, August 2021.
- CATIA 3DExperience, self-paced, on-line skills transitioning. On-line courses were taken in the following areas: Part Design, Assembly Design, Composites Design, Generative Shape Design, Digital Shape Preparation, Equipment Design, Machining, Structural Finite Element Modeling, Computational Fluid Dynamics (new), Cloud-based PDM infrastructure (new), June 2017 – Mar 2020

Another mechanism for maintaining currency by faculty is via connections with local manufacturing companies for research & development or to learn more about current manufacturing trends through IAC meetings, guest lecturers, company tours, and professional connections.

Appendix A
Course Syllabi

1. CHEM 161: General Chemistry

2. Credits, contact hours, and categorization of credits

   5 credits, basic science

3. Instructor: Elizabeth Raymond

4. Chemistry An Atoms-Focused Approach, 3rd ed, by Gilbert, Kirss, Bretz, and Foster

   a. Other supplemental materials: scientific calculator

5. Specific course information

   a. Brief description – catalog description

      Matter, measurement, dimensional analysis, stoichiometry, atomic and molecular structure, periodic trends, and molecular interactions. Lab included.

   b. Prerequisites: MATH 114

   c. Required course

6. Specific goals for the course

   a. Specific outcomes

   - Develop an understanding of the structure of atoms and the development of modern atomic theory.
   - Use the concepts of bonding and the electronic structure of the atom to predict the three-dimensional shapes and electron distributions within molecules.
   - Use the periodic table to predict the chemical properties and electronic structure of elements.
   - Correctly use symbolism and vocabulary to communicate chemical ideas.
   - Understand how the interactions between particles (atoms, ions, and molecules) dictate the physical properties of matter.
   - Correctly use mathematical models and methods to describe a chemical event quantitatively.

1. MATH 124: Calculus and Analytic Geometry I
2. Credits, contact hours, and categorization of credits

   5 credits; math

3. Instructor name: Greg Shwartz
4. Calculus, 7^{th} Edition, Hughes-Hallett, Gleason, McCallum, et al., 2017.
   a. Supplemental materials: graphic calculator
5. Specific course information
   a. Brief description – catalog description

      Average and instantaneous rates of change, interpretation, computation, and application of derivatives to optimization, rates, graphing, and antiderivative problems. Graphing calculator required.

   b. Prerequisites: MATH 115 or 118
   c. Required course
6. Specific goals for the course
   a. Specific outcomes
      - Develop ability in problem solving.
      - Interpret and communicate mathematics
      - Work comfortable with the following types of functions: trigonometric, polynomial, absolute value, exponential, logarithmic, rational and hyperbolic, as well as functions of defined parametrically, or by graph or table.
      - Apply the concepts of transformation, composition, symmetry and inverses to the functions listed above.
      - Understand and apply the concept so limits and continuity.
      - Understand and apply the limit definition of a derivative numerically, algebraically and graphically
      - Understand the relationship between the graph of a function and its derivatives
      - Use the derivative rules to determine the derivative of a function, whether given in equation form, graphic form, or via tables.
      - Strengthen algebraic simplification skills by simplifying derivatives.
      - Understand and apply the concept of implicit differentiation.
      - Evaluate the first and second derivatives of a function and interpret the results.
      - Construct and interpret sign charts.
      - Use the first and second derivative tests to determine the extrema of a function.
      - Create and interpret functions that model real world applications then use calculus to optimize those functions.
      - Use differentiation to reveal and compare related rates.

- Become familiar with L'Hopital's Rule and its application.
- Become familiar with the hyperbolic functions and their derivatives.
- Work with parametric equations and their derivatives.
- Become familiar with antiderivatives and differential equations.

1. MATH 125; Calculus and Analytic Geometry II
2. Credits, contact hours, and categorization of credits

   5 credits; math

3. Instructor name: Andrew Richardson
4. Calculus, 7th Edition, Hughes-Hallett, Gleason, McCallum, et al., 2017.
   a. Supplemental materials: graphic calculator
5. Specific course information
   a. Brief description – catalog description
      The definite integral, techniques of integration, applications including area and volume, growth and decay, introduction of differential equations.
   b. Prerequisites: MATH 124
   c. Required course
6. Specific goals for the course
   a. Specific outcomes
      - understand the definite integral as a limit of Riemann sums
      - estimate definite integrals using Left Hand Sums, Right Hand Sums, Midpoint, Trapezoid, and Simpson Rules
      - understand under what conditions a technique for estimating an integral results in an overestimate or an underestimate
      - find antiderivatives graphically
      - use the FTC to evaluate definite integrals and to represent a particular antiderivative
      - compute antiderivatives and definite integrals using substitution (including change of limits) and integration by parts
      - compute antiderivatives and definite integrals of rational functions which may require a technique of partial fractions or trigonometric substitution
      - determine whether an integral with an infinite limit of integration converges
      - compute improper integrals
      - use integration to compute an areas, volumes, quantities dependent on density, centers of mass, work, force of a fluid, and arc lengths

1. MATH 204: Elementary Linear Algebra
2. Credits, contact hours, and categorization of credits

   4 credits; math

3. Instructor's name: Adam Nyman
4. Textbook: Linear Algebra and its Applications, 5th Edition, Lay, Lay, and McDonald, 2018.
   a. Supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description

      Systems of linear equations; matrices; the vector space Rn; linear independence, bases, subspaces and dimension in Rn; introduction to determinants and the eigenvalue problem applications.

   b. Prerequisites: MATH 125, MATH 224 is recommended
   c. Required course
6. Specific goals for the course
   a. Specific outcomes
      - Ability to translate between systems of linear equations, vector equations, and matrix equations, and perform elementary row operations to reduce the matrix to standard forms.
      - Understanding of linear combination and span.
      - Determination of the existence and uniqueness of a system of linear equations in terms of the columns and rows of its matrix.
      - Ability to represent the solution set of a system of linear equations in parametric vector form and understand the geometry of the solution set.
      - Understanding of linear dependence and independence of sets of vectors.
      - Understanding of linear transformations defined algebraically and geometrically, and ability to find the standard matrix of a linear transformation.
      - Understanding and computation of the inverse and transpose of a matrix.
      - Understanding and computation of the determinant of a matrix and its connection with invertibility.
      - Understanding of the notions of a vector space and its subspaces and knowledge of their defining properties.
      - Knowledge of the definitions of a basis for and the dimension of a vector space, and ability to compute coordinates in terms of a given basis.
      - Ability to find bases for the row, column, and null spaces of a matrix, find their dimensions, and knowledge of the Rank Theorem.

- Ability to find eigenvalues and eigenvectors of a matrix.
- Knowledge of all aspects of the Invertible Matrix Theorem.
- Knowledge of the Diagonalization Theorem and ability to diagonalize a matrix

1. MATH 224: Multivariable Calculus and Geometry I
2. Credits, contact hours, and categorization of credits

   5 credits; math

3. Instructor's name: Edoh Amiran
4. Textbook: Multivariable Calculus, 7th Edition, McCallum, 2017.
   a. Supplemental materials: none listed
5. Specific course information
   a. Brief description – catalog description

      Coordinate systems, curves, and vectors in the plane and in space, partial derivatives, applications including optimization and motion, multiple integrals.

   b. Prerequisites: MATH 125
   c. Required course
6. Specific goals for the course
   a. Specific outcomes
      - appropriate recollection and use of the definitions of vectors, linearization, and derivatives with respect to vectors
      - ability to describe settings geometrically, including graphs and level sets of functions, projections, and the angles between vectors
      - ability to describe and calculate the behavior of functions, including rates of change, critical points and optimal values
      - ability to describe geometric regions analytically for purposes of integration
      - projections, decompositions, and calculations of rates using vectors
      - integrals in rectangular, polar, cylindrical, and spherical coordinates

1. MATH 331: Ordinary Differential Equations
2. Credits, contact hours, and categorization of credits

   4 credits; math

3. Instructor's name: Daphne Scott
4. Textbook: Differential Equations: From Calculus to Dynamical Systems, 2nd Edition, by Noonburg, 2019.
   a. Supplemental materials: graphing calculator
5. Specific course information
   a. Brief description – catalog description

      First order equations, first order systems (primarily linear), applications and modeling, qualitative reasoning

   b. Prerequisites: MATH 204, MATH 224 recommended
   c. Required course
6. Specific goals for the course
   a. Specific outcomes
      - Understand and utilize the essential course content at an appropriate level.
      - Recognize that a problem can have different useful representations (graphical, numerical, or symbolic) and select the most appropriate format and methods.
      - Model real world problems mathematically and interpret the results appropriately.
      - Use appropriate software and technological tools, and judge when such use is helpful.
      - Communicate mathematical results and arguments clearly, both orally and in writing.
      - Appreciate the central role of mathematics in the sciences and the real world
      - Set up an initial value problem for a differential equation or system that models a given dynamical process and, when it is possible to solve the problem, to interpret the solution in the context of the problem.
      - Recognize separable differential equations, find their general solutions, and use the general solution to solve initial value problems.
      - Recognize linear first-order differential equations, solve them using the method of integrating factors, and solve related initial value problems.
      - Sketch and read slope-fields of first-order equations, use slope-fields to qualitatively describe solutions, and understand the relationship between slope-fields and Euler's method.

- Construct the phase line for autonomous first-order equations, and find and classify equilibrium solutions, and use the phase line to qualitatively describe solutions.
- Understand the statement and implications of the existence and uniqueness theorems.
- Find bifurcation values and construct and interpret bifurcation diagrams for autonomous first-order differential equations that depend on a parameter, and understand how a small change in the parameter value can affect the qualitative behavior of solutions.
- Convert a higher-order differential equation into a first-order system.
- Produce and interpret direction fields and phase portraits for systems of autonomous differential equations, and use them to analyze the qualitative behavior of solutions to the system, and understand the relationship between solution curves in the phase plane and solutions of the system and the solution's component curves. Find equilibrium solutions of such systems.
- Find the general solution of any 2x2 linear system with constant coefficients, solve initial value problems for such systems, classify the equilibrium solutions of such a system, and describe the qualitative behavior of solutions by analyzing the phase portrait.
- Understand the trace-determinant plane as a graphical summary of the possible qualitative behaviors for 2x2 linear systems with constant coefficients, and use it to analyze such systems that depend on a parameter.
- Find the general solution of second-order homogenous linear equations with constant coefficients, solve related initial value problems, describe the behavior of the solutions and understand the use of such equations to model oscillatory behavior.

1. MATH 345: Statistics for Engineers
2. Credits, contact hours, and categorization of credits

   4 credits; math

3. Instructor name: Amy Anderson
4. Textbook: Applied Statistics and Probability for Engineers, 5th ed, by Montgomery and Runger, 2011.
   a. Supplemental materials: calculator
5. Specific course information
   a. Brief description – catalog description

      Basic probability, discrete and continuous probability distributions. Descriptive statistics and the use of computer statistical packages. Statistical inference, including 1- and 2-sample hypothesis tests and confidence intervals for means and proportions, paired t test and sample size calculations.

   b. Prerequisites: MATH 125
   c. Required course
6. Specific goals for the course
   a. Specific outcomes

      - Explain the concepts of a population, a sample, and variability.
      - Distinguish between retrospective studies, observational studies, and designed experiments as means of data collection.
      - Understand the concepts of sample space and events, and the interpretation of probability.
      - Use the addition rule, multiplication rule and total probability rule in probability computation.
      - Understand the concepts of conditional probability and independence, and Bayes Theorem, and be able to solve problems involving these concepts.
      - Understand the concept of a random variable, both discrete and continuous.
      - Obtain the probability mass function of a discrete random variable for some random experiments or situations.
      - Understand the probability mass function(p.m.f.), probability density function (p.d.f.), cumulative distribution function (c.d.f.), the relationship between the p.m.f. /p.d.f. and the c.d.f., and be able to obtain one from the other.
      - Calculate the mean and variance of a random variable (both discrete and continuous) and evaluate probabilities involving the distribution of the random variable, using calculus if necessary.

- Understand the characteristics of the binomial, Poisson, continuous uniform and exponential distributions, and solve basic problems involving these distributions.
- Understand the importance of the normal distribution and solve elementary probability problems involving the normal distribution.
- Calculate the basic statistical measures of a data set, i.e., sample mean, sample standard deviation, sample median, range.
- Construct and interpret frequency distributions, histograms, boxplots and probability plots.
- Understand the concept of a sampling distribution and be able to use the central limit theorem.
- Understand the concept of a confidence interval and how it is used for estimation.
- Construct a confidence interval for the population mean, the population proportion, the difference in two population means or the difference in two population proportions.
- Compute the sample size needed to estimate population mean or population proportion.
- Understand the idea behind hypothesis testing, and p-value.
- Conduct a hypothesis test for the population mean, population proportion, difference in two population means and difference in two population proportions and compute the p-value for the test.
- Know when to use and how to conduct a paired t test.
- Use a statistical software package, such as Minitab and/or Excel, to plot graphs, to calculate basic statistical measures such as the mean and the median of a data set, and to compute the probabilities involving well-known distributions

1. PHYS 161: Physics with Calculus I

2. Credits, contact hours, and categorization of credits

   5 credits, basic science

3. Instructor: Takele Seda

4. Physics for Scientists and Engineers, 4^{th} ed, by RD Knight

   a. Other supplemental materials: none listed

5. Specific course information

   a. Brief description – catalog description

      Kinematics and dynamics of particles; work and energy; gravitation; collisions and conservation of momentum. Includes lab.

   b. Prerequisites: MATH 124 or concurrent

   c. Required course

6. Specific goals for the course

   a. Specific outcomes

      - construct and utilize graphs, vector diagrams, and natural language to *qualitatively* describe how objects move and respond to forces.
      - use math to *quantitatively* describe how objects move and respond to forces.
      - use the concepts of conservation of energy and momentum to qualitatively and quantitatively describe how objects move.
      - Implement a structured approach to solving physics problems, particularly those posed in natural language (i.e. the type of problem that students will face outside the classroom)

1. PHYS 162: Physics with Calculus II

2. Credits, contact hours, and categorization of credits

   5 credits, basic science

3. Instructor: Svenja Fleischer

4. Physics for Scientists and Engineers, 4^{th} ed, by RD Knight, 2017

   a. Other supplemental materials: none listed

5. Specific course information

   a. Brief description – catalog description

      Electrostatics, DC circuits, magnetic fields, and electromagnetic induction. Includes lab.

   b. Prerequisites: PHYS 161, MATH 124, and MATH 125 or concurrent

   c. Required course

6. Specific goals for the course

   a. Specific outcomes

      - Apply core concepts of electromagnetism to the motion and interactions of charged particles. These
      - concepts include electric and magnetic forces, electric and magnetic fields, electric potential and potential
      - energy, and the principle of superposition.
      - Apply concepts of current, voltage, resistance, and capacitance to analyze DC circuits.
      - Apply mathematical models to make quantitative predictions in the context of electromagnetic interactions.
      - Collect and analyze data, and build mathematical models by inferring patterns in observations of natural
      - phenomena.
      - Apply concepts and mathematical models to perform multi-step analysis of real-world phenomena.
      - Communicate scientific ideas, explanations, and arguments clearly and concisely.
      - Transfer the mathematical and conceptual foundation developed in this class to future science courses.

1. PHYS 163: Physics with Calculus III

2. Credits, contact hours, and categorization of credits

   5 credits, basic science

3. Instructor: Takele Seda

4. Physics for Scientists and Engineers, 4^{th} ed, by RD Knight, 2017

   a. Other supplemental materials: none listed

5. Specific course information

   a. Brief description – catalog description

      Rigid body kinematics and dynamics; rotation and oscillation; waves in elastic media; light as a wave; interference and diffraction of light; geometric optics. Includes lab.

   b. Prerequisites: PHYS 162, MATH 124, and MATH 125 or concurrent

   c. Required course

6. Specific goals for the course

   a. Specific outcomes

      - Apply core concepts of classical mechanics to the motion of a rigid body in 2 dimensions. These concepts include force and Newton's laws, torque and Newton's 2nd law for rotations, the work-energy principle, and the conservation of linear and angular momentum.
      - Be able to solve equations of motion for oscillatory situations in analytical and graphical ways.
      - Understand wave properties of light and sound including interference, diffraction, and polarization.
      - Be familiar with concepts of geometric optics including reflection, refraction, lenses and optical instruments.
      - Apply concepts and mathematical models to perform multi-step analysis of real-world phenomena involving incompressible fluids.
      - Collect and analyze data to infer patterns in natural phenomena.
      - Communicate scientific ideas, explanations, and arguments clearly and concisely.

1. Engineering 101: Engineering, Design, & Society

2. 2 Credits, and categorization of credits: Engineering Topics

3. Jill Davishahl

4. No textbook required

5. Specific course information
    a. Introduces students to the field of engineering and design and explores the relationship between engineering, design, technology, and society. Provides a structure for students to explore and understand the role of social justice in engineering and design while developing foundational skills necessary for student success. Topics include societal impact of technology, the relevance of social justice in the engineering and design profession, ethical decision making, and social mindfulness in design.
    b. prerequisites or co-requisites: None
    c. Required for majors

6. Specific goals for the course
    a. • Demonstrate knowledge of the engineering and design professions and associated technologies. • Conceptually explain the design process. • Explain the role of social justice in engineering practice. • Effectively communicate knowledge and understanding of professional ethics and responsibility. • Describe how contemporary issues impact engineering design and practice. • Reflect on how your life experience, privilege, and culture affect the way you may practice engineering and/or design.

7. Brief list of topics to be covered
    a. Engineering and social justice
    b. Social mindfulness in design
    c. Exploring alternative mindsets
    d. Identify and belonging
    e. Creativity and visual communication
    f. Ethical decision making
    g. Engineering design and society

1. Engineering 115: Innovation in Design

2. 4 Credits, Engineering Topic

3. Jill Davishahl

4. Textbook: No textbook required for this course

5. Specific course information
    a. This project-based course introduces students to the engineering design process and explores the role of creativity, teamwork, and communication in innovative design. Topics include design thinking, creativity in design, team dynamics, engineering graphics, role of failure in design, importance of diverse perspectives, and the global impact of design.
    b. prerequisites or co-requisites: ENGR 101
    c. Required for majors

6. Specific goals for the course
    a. 1. Solve a design problem using the engineering design process. 2. Apply ethical analysis and creative problem-solving techniques to develop and design solutions for diverse user groups. 3. Use and select appropriate tools and technical skills necessary to build, test, and evaluate design concepts. 4. Participate in developing a functional project team. 5. Collaborate with team members in situations requiring creative problem solving. 6. Provide and accept feedback, resolve conflicts in a professional manner, and promote diversity of thought. 7. Communicate engineering concepts, ideas, and decisions effectively and professionally in a variety of ways such as written, visual, and oral. 8. Demonstrate the ability to mentally manipulate 2-dimensional and 3-dimensional figures. 9. Evaluate relationships between physical quantities by applying dimensional analysis.

7. Brief list of topics to be covered

    a. 1. Social Responsibility, Creativity, and Diversity 2. Teamwork & Collaboration 3. Communication of Design Ideas 4. Technology & Skill Development

1. Engineering 170: Introduction to Materials Science and Engineering

2. 4 Credits, and categorization of credits: Engineering Topics

3. David Rider

4. 1) Required Textbook: Introduction to Materials Science for Engineers, 8e, Shackelford, James.
    a. Student Companion Site: Mastering Engineering (accessible through Canvas)
    b. Recommended Textbook: Fundamentals of Materials Science and Engineering, W.D. Callister & D.G. Rethwisch, John Wiley & Sons, 4th Ed., 2012.
    c. Scientific calculator.

5. Specific course information
    a. The course examines the relationship between structure, properties, processing and performance of materials. Students are introduced to physical and mechanical properties of materials (including metals, polymers, ceramics and composites) and materials selection, based on engineering design criteria. Processing topics include strengthening, deformation, phase equilibria, microstructure and thermal treatments.
    b. prerequisites or co-requisites: N/A
    c. Required for majors

6. Specific goals for the course
    a. Conceptually explain the classification schemes that are used to categorize engineering materials. 2. Explain the differences in the mechanical behavior of engineering materials based upon bond type, structure, composition, and processing. 3. Describe the basic structures and repeat units for common thermoplastics and relate the distribution of molecular weights, degree of polymerization, percent crystallinity, and glass transition temperature to properties in service. 4. Describe how and why defects (point, line and interfacial) in materials greatly affect engineering properties and limit their use in service. 5. Calculate engineering stress, strain and the elastic modulus from data and for basic engineering applications. 6. Describe why each of the fundamental mechanical engineering properties of materials covered in the course (stress, strain, elastic constant, creep, fatigue, wear, hardness, Poisson’s ratio, toughness, ductility, flexural strength, impact strength, elongation) are important in engineering design. 7. Select the appropriate engineering materials and size basic parts, including the use of appropriate safety factors and cost, for specific engineering applications using mechanical properties such as: yield strength, tensile strength, ductility or elongation, impact strength, toughness, Poisson’s ratio, flexural strength, hardness, fatigue life, and creep. 8. Work in teams to research and then orally communicate current properties and applications of engineering materials and how to measure such characteristics using modern equipment and instrumentation. 9. Apply ethical principles and professional responsibilities in the selection of materials in engineering design. 10. Use binary phase diagrams to predict microstructures and also to

understand precipitation hardening. Understand how thermal treatments affect the microstructure and, thus, properties of materials. explicitly indicate which of the student outcomes listed in Criterion 3 or any otheroutcomes are addressed by the course.

7. Brief list of topics to be covered
    a. Atomic structure and bonding characteristics; crystal structure & unit cells
    Polymers; imperfections, deformation & strengthening in solids
    Mechanical properties of materials; phase diagrams and microstructure;
    Composites, ceramics, ferrous and selected non-ferrous metals

1. Engineering 214: Statics
2. 4 Credits, and categorization of credits: Engineering Topic
3. Nipun Goel
4. Recommended Text: Hibbeler, R. C., Engineering Mechanics: Statics, 14th Ed., Pearson, 2016
5. Specific course information
    a. Statics is the study of forces on bodies at rest.
    b. prerequisites or co-requisites: MATH 124; MATH 125 or concurrent; MATH 204 recommended; and PHYS 161
    c. Required for majors
6. Specific goals for the course
    a. 1. Draw complete and correct free body diagrams for rigid body systems. 2. Write an appropriate set of equilibrium equations from a free body diagram. 3. Solve equilibrium equations using appropriate tools to find unknown loads on a static system. 4. Apply linear algebra techniques to solve systems of equations.
7. Brief list of topics to be covered
    a. Drawing complete and correct free body diagrams for rigid body systems. Writing an appropriate set of equilibrium equations from a free body diagram. Solving equilibrium equations using appropriate tools to find unknown loads on a static system. Applying linear algebra techniques to solve systems of equations.

1. Engineering 225: Mechanics of Materials

2. 4 Credits, and categorization of credits: Engineering Topic

3. Kirk Desler

4. Recommended Text: Hibbeler, R. C., Mechanics of Materials, 10th Ed., Pearson

5. Specific course information
    a. Principles and basic concepts of structural analysis including: internal forces, stress, strain, axial loading, torsion, bending, combined loads, and buckling. Introduction to stress transformation and failure analysis.
    b. prerequisites or co-requisites: ENGR 170; ENGR 214; MATH 125
    c. Required for majors

6. Specific goals for the course
    a. 1. Determine internal force at any point in a structure 2. Determine stress at any point in a structure 3. Determine deflection at any point in a structure 4. Develop a safe solution to an open-ended problem 5. Select appropriate materials to meet structural needs

7. Brief list of topics to be covered
    a. Statics Review (shear and moment diagrams), Stress & Strain, Materials & Axial Loading, Torsion, Centroids & 2nd Area Moment of Inertia, Bending, Transverse Shear, Combined Loading & Stress Transformation, Beam Design & Deflection, Buckling, Intro to Failure Theories.

1. Electrical and Computer Engineering 351: Electronics for Engineering

2. 4 Credits, and categorization of credits: Engineering Topic

3. Stephen Sandelin

4. Electronic Course Pack (via Canvas)

5. Specific course information
    a. Analysis of basic electric circuits. Design of simple circuits using passive elements and electronics to modify input signals and produce desired output signals. Analog-to-digital conversion and introductory microcontroller development. Laboratory reinforces the circuit concepts presented in the classroom and promotes competent use of basic electronic instruments.
    b. prerequisites or co-requisites: Math 125, PHYS 162
    c. Required

6. Specific goals for the course
    a. Students will have a working knowledge of the analysis of basic electric circuits, the design of simple circuits using passive elements and electronics to modify input signals and produce desired output signals. How analog-to-digital conversion and introductory microcontroller development works.

7. Brief list of topics to be covered
    - Circuits Review: Voltage, Current, KVL, KCL, Voltage and Current Dividers
    - DC Analysis: Node/Mesh analysis, Superposition, Source Transforms and Thevanin/Norton
    - AC Circuits: Capacitors, Inductors, Impedance
    - Semiconductors: Diodes, Bipolar Junction Transistors, Field Effect Transistors
    - Power Circuits: Buck and Boost converters
    - Amplifiers: Operational Amplifiers, Instrumentation Amplifiers
    - Digital Basics: Number Bases, Analog to Digital Conversion
    - Microcontrollers: Basic Architecture, Programming Techniques, Port Control

1. Electrical and Computer Engineering 352: Introduction to Automation and Control

2. 4 Credits, and categorization of credits: Engineering Topic

3. Stephen Sandelin

4. Textbook: "Introduction to Robotics: Analysis, Control, Applications," 2nd Edition, Saeed B. Niku, Wiley, 2010.
   a. Electronic Course Pack (via Canvas)

5. Specific course information
   a. Design and analysis of electronic automation and control systems. Emphasis on fundamentals of digital design and the integration of digital and analog systems in the development of control systems. Laboratory design implementation.
   b. prerequisites or co-requisites: EECE 351, MATH 341
   c. Required

6. Specific goals for the course
   a. Design and analyze simple analog and digital automation circuits with time-varying inputs.; Use a microcontroller to engineer a basic control or automation solution.; Use a programmable logic controller and programming tools to develop a control or automation system.; Determine the appropriateness of microcontrollers or PLCs based on realistic design constraints.; Design and analyze simple control systems including PID control.; Understand the operation and application of brushed DC and stepper motors.; Design motor feedback and control systems using rotary encoders.; Be able to test and troubleshoot circuits using the appropriate instrumentation.

7. Brief list of topics to be covered
   a. Motors: Brushed DC, Stepper, Brushless, H-bridge / PWM control; Regulators: Linear, Buck/Boost/Buck-boost; Microcontrollers; PLCs; Controls: System definition, Open loop control, Closed loop control, Feedback, PID control

1. Manufacturing Engineering 231: Introduction to the Manufacturing Process

2. 4 Credits and categorization of credits: Engineering Topic.

3. David Gill (Instructor) and Ben Kaas (Lab Instructor)

4. No textbook required.
    a. other supplemental materials: Dial Calipers, Safety Glasses

5. Specific course information
    a. An introduction to the manufacturing processes used to cast, form, cut, and join metal when creating parts per an engineering drawing. Students will be required to complete a fabrication project using machining processes. Includes an introduction to metrology and CNC.
    b. prerequisites or co-requisites: ENGR 170 or ID 380; MFGE 261 or concurrent
    c. required for program

6. Specific goals for the course
    a. 1. Will know how to utilize the entire manufacturing cycle from creating of basic form (casting, forming) through the addition of precise features (machining) to a full assembly (joining). You will understand processes and the terminology used to identify and describe the equipment, tooling and expendables used in these processes.
    2. Will understand how a process can be modeled from first principles, have the ability to calculate key process parameters, and understand the limitations of your calculations.
    3. Will be able to utilize basic metrology principles and to choose different measuring instruments for the purpose of verifying dimensions and tolerances on fabricated parts.
    4. Will have video experience in the operation of manual lathes, mills, drills, sheet metal bending and welding equipment. This knowledge will help you know the capabilities and limitations of each tool along with important related safety, health and environmental concerns.
    5. Will have discussed the fabrication of a part using information from an engineering drawing in order to achieve the desired part performance.

7. Brief list of topics to be covered
    a. Big Idea 1 –Creating parts by RESHAPING material (Casting, Forming). Big Idea 2 – CHIP FORMING (subtractive) processes remove material, but greatly increase a part’s value. Big Idea 3 – Creating features by ADDITION or NON-CHIP FORMING processes. Big Idea 4 – Creating products by JOINING and ASSEMBLING parts. Big Idea 5 – MEASUREMENT is the only way to know if the part is correct.

1. Manufacturing Engineering 250: Introduction to Manufacturing Automation

2. 4 Credits, and categorization of credits: engineering topic

3. Jeff Newcomer

4. Textbook: no required textbook for this course
    a. Suggested Textbook: Industrial Automation and Robotics, Gupta, A.K., Arora, S. K., and Westcott, J. R., 2017.

5. Specific course information
    a. An introduction to the fundamentals of manufacturing automation including pneumatics, sensors, programmable logic controllers, robotics, locating principles and machine vision for inspection.
    b. Prerequisites: PHYS 162; MFGE 261 or concurrent
    c. Required

6. Specific goals for the course
    a. 1. Assess and improve or redesign a pneumatic system. 2. Program robots to complete fundamental manufacturing tasks. 3. Describe the role of peripheral devices for basic robotic systems and when they are appropriate. 4. Integrate fundamental automation tools to implement an automation system to work with a structured, repetitive manufacturing task.

7. Brief list of topics to be covered
    a. 1. Pneumatic Cylinders & Flow Control Valves 2. Directional Control Valves 3. Robotics & Optical Encoders 4. SCARA Robot Programming 5. Machine Vision

1. Manufacturing Engineering 261: Introduction to Computer-Aided Design

2. 4 Credits, and categorization of credits engineering topic

3. Derek Yip-Hoi

4. Textbook: MFGE 261 – Introduction to CATIA, Derek Yip-Hoi (e-Text through www.StudyCAD.com)

5. Specific course information
    a. Introduction to parametric, Computer-Aided Design. Covers sketching and feature-based modeling in the creation of 3D parts for engineered products, assembly modeling and drafting. Emphasizes modeling of machined and plastic components and generation of drawings with proper dimensioning and GDT. Introduction to fabrication using rapid prototyping.
    b. Prerequisites: ENGR 104 or ENGR 115
    c. Required

6. Specific goals for the course
    a. 1. Model parts and assemblies that capture design intent using parametric, feature-based CAD modeling techniques. 2. Demonstrate knowledge of CAD modeling techniques that capture the structure and manufacturability of molded and machined parts. 3. Read and create engineering drawings of parts and assemblies with appropriate views, dimensions, annotations, tolerances, and GD&T. 4. Apply the design process in developing and ranking design alternatives. 5. Work as part of a team in managing a project to meet intermediate milestones and design goals.

1. Manufacturing Engineering 332: Introduction to CAM and CNC

2. 4 Credits and categorization of credits: Engineering Topic.

3. Derek Yip-Hoi (Instructor) and Ben Kaas (Lab Instructor)

4. Text: Haas Automation, Inc., Mill Series, Programming Workbook, 2015
    a. other supplemental materials: Calipers, Safety Glasses, USB Drive, Plastic 3-Ring Binder

5. Specific course information
    a. Introduces the application of Computer-Aided Manufacturing and Computer Numerical Control for fabricating parts using machining processes. Includes manual part programming principals, process planning, cutting tool selection, fixturing, part program generation using CAM, verification of NC programs, set-up and operation of CNC equipment.
    b. prerequisites or co-requisites: MFGE 231 and MFGE 261
    c. Required for program

6. Specific goals for the course
    a. 1. Generate programs for CNC machining using manual part programming techniques. 2. Generate and verify programs for CNC machining using CAD/CAM and simulation software. 3. Demonstrate knowledge of machining process planning, including cutting tool and parameter selection for operations performed on a CNC machine. 4. Demonstrate knowledge of the procedures to set-up, program, and operate CNC equipment to produce machined parts in accordance with the specifications on a drawing.5. Apply knowledge of safety, health and environmental concerns in operating manufacturing

7. Brief list of topics to be covered
    a. Process Planning; Tooling, Holders, Offsets, Parameters, Part Programming, Rapid Motion and Linear Interpolation, Work and Tool Offsets, Circular Interpolation, Canned Cycles, Cutter Compensation, Sub-Programs, and CATIA Prismatic Machining.

1. Manufacturing Engineering 333: Design for Manufacture

2. 4 Credits; engineering topic

3. No required text

4. Specific course information
    a. Introduces the consideration of the capabilities of manufacturing processes during product design. Includes impact on geometry, material properties, surface finish and dimensional accuracy. Foundry, forming, joining and machining processes will be explored. Project work will compare parts designed for different process scenarios and require generating appropriate fabrication documentation using CAD.
    b. prerequisites or co-requisites: MFGE 231 or ETEC 246; MFGE 261 or ETEC 113
    c. Required

5. Specific goals for the course
    a. Knowledge of how different types of manufacturing processes constrain the size, shape, location, tolerancing and finish off part features specified during the design of a product. Knowledge of how the choice of a manufacturing process influences, or is constrained by, the material used in a design, and the impact of processing on the final condition of the material. The ability to incorporate into the design of a product, specifications, and guidelines that facilitate its manufacturability (DFM). The ability to incorporate into the design of a product, specifications, and guidelines that facilitate its assembly (DFA). The ability to effectively communicate fabrication requirements including GD&T annotations on an engineering drawing.

6. Brief list of topics to be covered
    a. Overview and Introduction to Design for Manufacture, Design for Assembly & DFA Lab, Tolerance & Fits, Surface Finish, Material Selection, DFM

1. Manufacturing Engineering 340: Applied Numerical Methods for Engineers

2. 4 Credits and categorization of credits: engineering topic.

3. Derek Yip-Hoi

4. Chapra, S.C., Applied Numerical Methods with MATLAB for Engineers and Scientists, 4th Edition. McGraw Hill 2018.
    a. Software: MATLAB R2021a

5. Specific course information
    a. Numerical solutions to problems in engineering using modern scientific computing methods and tools. Application of mathematical knowledge in selecting computational algorithms and communicating results. Introduction to MATLAB programming for numerical computation.
    b. Prerequisites: MATH 204, PHYS 162; Concurrent: MATH 331
    c. Required for program.

6. Specific goals for the course
    a. 1.write and document effective MATLAB scripts involving logical and iterative flow control and file input and output.2.generate plots of numerical data using MATLAB's data visualization functions.3.demonstrate knowledge of finite precision and the inherent limits of numerical computations.4.select the appropriate numerical methods to apply to engineering problem solving with consideration to the mathematical operations involved, accuracy requirements, and available computational resources.5.demonstrate knowledge of and implement numerical solutions to problems that involve root finding, linear systems, curve fitting, integration and differentiation and ordinary differential equations.

7. Brief list of topics to be covered
    a. Root Finding and Optimization, Linear Systems, Curve Fitting, Integration and Differentiation Ordinary Differential Equations

1. Manufacturing Engineering 341: Quality and Continuous Improvement

2. 4 Credits and categorization of credits: engineering topic.

3. Sura Al-Qudah

4. Recommended textbooks:
    a. Setter, Craig Joseph, Six Sigma: A Complete Step-by-Step Guide: A Complete Training & Reference Guide for White Belts, Yellow Belts, Green Belts, and Black Belts, The Council for Six Sigma Certification, 2018
    b. Summers, Donna C. S., Six Sigma: Basic Tools and Techniques, Pearson, 2007
    c. Dennis, Pascal, Lean Production Simplified, Boca Raton: CRC Press, Third Edition, 2015

5. Specific course information
    a. A practical application of quality and continuous improvement tools including Lean and Six Sigma as applied to manufacturing operations. Principles and applications of Measurement System Analysis (MSA) for variable and attribute data. Proper use and interpretation of inspection equipment.
    b. prerequisites or co-requisites: MATH 345 or MATH 341
    c. Required for program.

6. Specific goals for the course
    a. Demonstrate knowledge of the key concepts of quality assurance and Lean Six Sigma - Apply quality tools to continuously improve manufacturing processes and products - Apply and analyze creative problem-solving tools in the improvement of processes and products - Apply statistical process control tools in a practical way - Use inspection equipment such as micrometers, dial calipers, and coordinate measuring machines.

7. Brief list of topics to be covered
    a. Quality concepts, Lean Enterprise, VSM, QFD, FMEA, DMAIC (I), DMAIC (II), Measures and metrics, SPC for variables, Process capabilities, SPC for attributes

1. Manufacturing Engineering 365: Machine Design

2. 4 Credits, contact hours, and categorization of credits in Table 5-1 (math and basic science, engineering topic, and/or other).

3. Tarek Algeddawy

4. Optional text: Shigley's Mechanical Engineering Design. Budynas, R. and Nisbett, K., 10th edition, Mc-Graw Hill.

5. Specific course information
    a. Introduces the sizing and selection of machine components to satisfy design requirements. Includes a study of mechanical components such as stepped shafts, keys, bearings, springs, gears, and power screws. Design activities implement computer-based numerical methods to streamline the design procedure.
    b. prerequisites or co-requisites: MFGE 261; ENGR 225; PHYS 163.
    c. indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program

6. Specific goals for the course
    a. Apply the mechanical design process. Apply design methods of different mechanical components. Apply previous knowledge of mechanics of materials. Design mechanical components appropriate for a given loading condition and function. Design mechanical systems comprised of multiple mechanical components.

7. Brief list of topics to be covered
    a. Shaft components, Shaft external reactions, Shaft internal reactions, Shaft stresses, Shaft fatigue, Failure theories under fatigue, Shaft design process, Shaft deflection, Keys, rings and set screws, Bearing selection, Bearing with axial loads, Intro to gears, Gear loads, Spur & helical gears stresses and design, Power screws, Belt selection, Spring design.

1. Manufacturing Engineering 381: Manufacturing Process Planning

2. 4 Credits, engineering topic

3. Sura Al-Qudah

4. Textbook: No Required Text
   a. Suggested References: 1. Automation, Production Systems and Computer-Integrated Manufacturing, Groover, M., 2005. 2. Lean Assembly: The Nuts and Bolts of Making Assembly Operations Flow, Baudin, M., 2002. 3. Kaizen Assembly: Design, Constructing, and Managing a Lean Assembly Line, Ortiz, C., 2006. 4. Body Space, Anthropometry, Ergonomics, and the Design of Work, Pheasant S. & Haslegrave, C., 2006. 5. The Rules of Work, A Practical Engineering Guide to Ergonomics, MacLeod, D., 2013.

5. Specific course information
   a. Organization of people, equipment, and workstations to create manufacturing systems that are safe and efficient. Basic principles of lean manufacturing. Fundamentals of material needs estimation. Design for assembly principles. Ergonomic design of workstations to fit the human body. Fundamentals of industrial safety, including OSHA compliance, proper materials handling and storage procedures, and safety program management.
   b. Prerequisites: MFGE 231; MFGE 261; MATH 345 or concurrent.
   c. Required

6. Specific goals for the course
   a. 1. Organize people, equipment, and workstations to create manufacturing systems that are safe and efficient. 2. Apply basic principles of lean manufacturing and modern ergonomic principles and methods to design workstations that fit the human body. 3. Understand the fundamentals of industrial safety, including OSHA compliance, proper materials handling and storage procedures, and safety program management. 4. Estimate manufacturing quantitative metrics and production performance measures such as takt time, production rate, cycle time, economic order quantity (EOQ), total Inventory cost (TIC), and total cost (TC) to plan for manufacturing operations and economics.

7. Brief list of topics to be covered

a. 1. Group technology & cellular manufacturing 2. Manufacturing time and cost calculations 3. Introduction to safety and health – OSHA/WISHA /Introduction to ergonomics 4. Anthropometry 5. Ergonomic workstation design/CATIA Lab

1. Manufacturing Engineering 434: Advanced Computer-Aided Manufacturing & Computer Numerical Control

2. 4 Credits, engineering topic

3. Dr. David Gill

4. Textbook: no required textbook for this course

5. Specific course information
    a. The study of tool path generation using CAM for the machining of freeform surfaces. Includes exposure to techniques for both 3-axis and 5-axis machining. Introduction to the kinematics of 5-axis machines and their simulation for the purposes of NC verification. Overview of post-processor design. Lab experience includes the programming, setup and operation of CNC machine tools.
    b. Prerequisites: MFGE 332
    c. One from MFGE 434, MFGE 454, or MFGE 462 required for program.

6. Specific goals for the course
    a. 1. Demonstrate knowledge of the techniques for generating tool paths for machining free-form surfaces, including those used in 5-axis machining. 2. Use CAM software to generate G&M code for machining parts with freeform surfaces. 3. Select tools, setup, program, and operate CNC equipment for 3-axis surface machining. 4. Verify NC programs for surface machining using simulation techniques. 5. Demonstrate knowledge of the structure and kinematics of 5-axis CNC machine tools, acquired by using simulation techniques.

7. Brief list of topics to be covered
    a. 1. CNC practice, Tool Loading, Prismatic Machining 2. Softjaw Preparation, Prismatic Practice 3. Parallel Part with Ball and Bull Stepover Analysis 4. Chevron 5. Low Friction Ring Challenge (Lathe vs Mill) 6. Bearing Carriers and Top Caps (5th Axis & 3 Axis)

1. Manufacturing Engineering 453: Industrial Robotics

2. 4 Credits and categorization of credits: Engineering Topic.

3. Tarek AlGeddawy

4. Optional Text: Introduction to Robotics, Saeed B. Niku, 2nd Edition, Wiley, 2011.

5. Specific course information
    a. An introduction to the fundamentals of robotics, including kinematics and inverse kinematics, path and trajectory planning, robot programming for industrial applications, design and development of robot cells, robot safety, and machine vision systems.
    b. Prerequisites or co-requisites: EECE 352; MFGE 463 or concurrent.
    c. Required for program.

6. Specific goals for the course
    a. 1. Establish robot workspace, singularities, frames and Kinematics. 2. Program robots to complete tasks. 3. Use Offline programming (OLP) and simulation software. 4. Design fixtures and fingers for robotic applications. 5. Select appropriate industrial robot for the application. 6. Control sensors and actuators from robot controller. 7. Design or select an appropriate automation process for a given product. 8. Economically justify automated manufacturing equipment acquisitions.

7. Brief list of topics to be covered
    a. Robot characteristics, Trajectory planning, Path planning, Frame transformations, Hand coordinates, Robot representation, Inverse Kinematics, Differential transformations, Differential motion.

1. Manufacturing Engineering 454: Systems Integration

2. 4 Credits and categorization of credits: Engineering Topic.

3. Tarek AlGeddawy

4. Optional Text: 1.) A Guide to the automation Body of Knowledge, Sands and Verhappen, 3rd Edition, ISA, 2018. 2.) Industrial Automation Hands-on, Frank Lamb, McGraw-Hill, 2013.

5. Specific course information
    a. This course aims to give an insight and hands-on experience to the vast world of automation and systems integration. The course will cover a collection of topics such as how to read and develop electrical and pneumatic installation drawings, the five standard programming languages of automation and control, controllers and interfacing systems such as PLC, HMI and SCADA, industrial communication, networking and protocols such as Modbus and Ethernet/IP, automation equipment and components such as robots, actuators, sensors, motors, vision systems, etc. Also, the course will give a glance at safety devices and standards in automation and a brief introduction to Industry 4.0. The hands-on experience during classes will be through using the different control and programming software of simulated PLC, HMI and SCADA systems. Labs use the different Learning Factory (LEAF) automated cells separately for the weekly labs, and the whole system for the term integration project.
    b. prerequisites or co-requisites: EECE 352
    c. One from MFGE 434, MFGE 454, or MFGE 462 required for program.

6. Specific goals for the course
    a. 1. Read automation documentation and follow standards. 2. Program and control different types of automation components. 3. Establish communication between different automation components. 4. Select and control appropriate actuators and sensors for automation. 5. Select and control proper safety devices according to standards. 6. Design and control automated cells of different components. 7. Design and control integrated automated systems of multiple cells.

7. Brief list of topics to be covered
    a. Standards, Documentation and Safety, Automation Controllers, HMI & SCADA, Ethernet Communication, Fieldbus Communication, OPC and MQTT, Robotics and Vision

1. Manufacturing Engineering 462: CAD Modeling and Analysis Using Surfaces

2. 4 Credits, engineering topic

3. Kirk Desler

4. Textbook: (E-book) CATIA V5R20: Surface Design for WWU MFGE 362
    a. Supplementary Reference: CATIA parametric modeling information with student subscription to StudyCAD

5. Specific course information
    a. Introduces advanced CAD modeling techniques using surface-based features and operations. Demonstrates use of surfaces to model both homogenous solid and composite products. Introduces the use of a CAD model of a composite part for structural analysis using FEA.
    b. Prerequisites: ENGR 225 and MFGE 261
    c. One from MFGE 434, MFGE 454, or MFGE 462 required for program.

6. Specific goals for the course
    a. 1. Model and analyze different types of wireframe and surface geometries using a parametric CAD system. 2. Use different types of input data to guide modeling, and to efficiently organize CAD data. 3. Create a CAD model of a laminate composite product. 4. Perform and validate a simple structural analysis on a laminate composite model using Finite Element Analysis. 5. Work individually and as part of a team to design, model and analyze a product comprised primarily of free-form surfaces.

7. Brief list of topics to be covered
    a. 1. Introduction to Surfacing 2. Geometrical Element Management 3. Surface Fillets Digitized Shape Editor Tutorial 4. Curve Analysis and Repair 5. Composite Design and Analysis (Stages 1-5)

1. Manufacturing Engineering 463: Design of Tooling

2. 4 Credits and categorization of credits: Engineering Topics.

3. David Gill

4. Text Book (optional): Fundamentals of Tool Design, Dr. John Nee (Managing Editor), SME, 5th or 6th ed.
    a. Required Classroom Equipment: Calculator and Text Book (every class), Calipers and Safety Glasses (occasionally)

5. Specific course information
    a. Design of tooling used in manufacturing processes to include, but not limited to, inspection gages, fixtures, jigs, assembly fixtures, and tooling for forming processes.
    b. prerequisites or co-requisites: MFGE 332; MFGE 333; MFGE 381
    c. Required for program.

6. Specific goals for the course
    a. 1. Design tooling for different applications that may include jigs, inspection fixtures, workholding, presswork dies, fixtures for joining, and thermoplastic molds. 2. Communicate tooling design and utilization through drawings, appropriate dimensioning and tolerancing, work instructions, and written concept comparison, evaluation, and justification. 3. Utilize design databases and standard parts during the design of tooling process. 4. Design tooling considering cost estimation, degrees of freedom, constraint, deformation, SMED principles and applied loading sources.

7. Brief list of topics to be covered
    a. Project 1 – Inspection Gage, GD&T, Gage Master
    b. Project 2 – Workholding
    c. Project 3 – Joining Fixture
    d. Project 4 – TBD

1. Manufacturing Engineering 491: Project Research, Planning, and Ethics

2. 3 Credits and categorization of credits: Engineering Topic.

3. Derek Yip-Hoi

4. Required textbooks:
    a. Martin and Schinzinger, Ethics in Engineering, McGraw Hill, 4th edition.
    b. Kinsley, Engineering Communication, ISBN 9781133114703

5. Specific course information
    a. First in the series of three capstone project courses. Includes problem definition, background research, requirements gathering and generation of technical specifications for a design problem. Explores professional and ethical responsibilities and the impact of engineering solutions in a global, societal, economic and environmental context. Teamwork, technical proposal writing, project journaling and research skills are also discussed and practiced.
    b. prerequisites or co-requisites: ENG 101; MFGE 333; MFGE 381
    c. indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program

6. Specific goals for the course
    a. 1. define, scope and generate requirements and technical specifications for an engineering design problem. 2. recognize and articulate ethical and professional responsibilities in engineering situations. 3. communicate with professionalism including, proper usage of grammar, correct spelling, and adherence to relevant standards. 4. make informed judgments supported by analysis of the societal, global impact of engineering solutions. 5. make informed judgments supported by analysis of the economic and environmental impact of engineering solutions. 6. identify relevant sources of new knowledge that support engineering problem solving. 7. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

7. Brief list of topics to be covered
    a. Ethics: Ethics and Professionalism, Design: Sponsor Requirements and Specifications, Searching, Recording and Documenting Research Findings, Ethics: Moral Frameworks, Communication: Reading and Analyzing Technical Writing, Ethics: Engineering as Social Experimentation Methodology, Technical Writing

1. Manufacturing Engineering 492: Manufacturing Project Implementation

2. 3 Credits and categorization of credits: Engineering Topic.

3. Sura Al-Qudah

4. No required textbook

5. Specific course information
    a. The second course in the capstone project sequence. Takes project specifications defined in the first course and furthers the planning and design work necessary to support project implementation in the final course. Experience culminates in the writing of a formal project proposal that clearly defines expected project results, resource requirements and project milestones. Includes an introduction to project planning.
    b. prerequisites or co-requisites: MFGE 491
    c. Required

6. Specific goals for the course
    a. 1. The ability to synthesize and extrapolate experiences from courses in the curriculum to design, analyze and/or build a solution to a problem in manufacturing. 2.Effective application of the design process to complete the development of a product, tool, process, piece of equipment and/or an enhancement to a manufacturing system. 3.The ability to follow and update a project plan created for completing an open-ended project. 4.Technical writing skills through the writing of a journal and final project report. 5.Oral communication skills through interactions with project participants and a final presentation.

7. Brief list of topics to be covered
    a. Presentation and formal report (including: problem description and background, literature review, tutorials, solution, implementation, and testing plans)

1. Manufacturing Engineering 493: Manufacturing Project Implementation

2. 4 Credits, engineering topic

3. Advisors: Derek Yip-Hoi

4. Textbook: no required textbook for this course

5. Specific course information
    a. The third and final course in the capstone project sequence. Implements a plan to design, analyze and/or fabricate a process, product, tool, piece of equipment or enhancement to a manufacturing system. The results of the project will be fully documented and communicated through journaling, a final report, a poster and an oral presentation.
    b. Prerequisites: MFGE 492
    c. Required

6. Specific goals for the course
    a. 1. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. 2. An ability to communicate effectively with a range of audiences. 3. An ability to recognize ethical and professional responsibilities in engineering situations. 4. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives. 5. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. 6. An ability to apply the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice

1. Plastics and Composites Engineering 342: Data Analysis and Design of Experiments

2. 4 Credits and categorization of credits: engineering topics.

3. Mark Peyron

4. Textbook: NIST Process Statistics Website

5. Specific course information
    a. A practical approach to Design of Experiments and the analysis of data, including analysis of variance, linear, multiple linear, and nonlinear regression. Emphasis on the proper use and interpretation of the techniques in solving engineering problems rather than on theoretical development. Application of these tools using statistical software.
    b. prerequisites or co-requisites: MFGE 341
    c. required

6. Specific goals for the course
    a. Perform basic uncertainty analysis for sample data and models, including error propagation analysis, as appropriate. Apply the concept of correlation and interpret linear regression and multiple linear regression analyses. Create a calibration curve with confidence bands and perform numerical data interpolation. Assess the validity of a regression model for curve fitting or ANOVA applications and apply to simple non-linear models. Properly apply regression techniques, including when "linearized" analysis vs non-linear analysis is best. Design an effective experiment to model non-linear effects and interactions between experimental variables. Correctly apply analysis of variance and regression techniques to identify significant factors in a complex engineering systems. Design and interpret an effective screening experiment. Design multi-factorial and partial factorial experiments to test for all main effects and interaction effects. Produce professional-quality graphs, tables and technical reports.

7. Brief list of topics to be covered
    a. Statistical fundamentals, uncertainty analysis, error propagation, applications of regression analysis, calibration curves, interpolation, non-linear models & numerical integration (textbook and outside resources). Analysis of variance (ANOVA) & applied multiple regression analysis (textbook & outside resources) Fundamentals of factorial experimental designs & factorial screening designs (text & outside resources). Response surface designs (text & outside resources) and special topics (time permitting).

1. Plastics and Composites 371: Plastics Materials & Processes

2. 5 Credits and categorization of credits: engineering topic.

3. John Misasi

4. Required Text
   a. Baur, Erwin; Osswald, Tim A.; Rudolph, Natalie. Plastics Handbook: The Resource for Plastics Engineers. Hanser Publications. 3rd-5th Edition.
5. Specific course information
   a. Polymer science and analysis of basic plastics materials; experience in product design, tooling, and processing of thermoplastic.
   b. prerequisites or co-requisites: ENGR 115; ENGR 170
   c. Required for majors

6. Specific goals for the course
   a. Create an awareness of the growth and impact of plastics on industry and society, Develop an understanding of the unique properties and characteristics of plastics materials, Acquaint the student with common manufacturing processes and recent technological advancements that are used in creating products from plastics, Realize the design potential of plastics and encourage creative expression with these materials, Develop the student's proficiency in basic methods and safe techniques of processing plastics materials, Advance technical communication skills through formal laboratory reports and other writing exercises, Create an awareness of the growth and impact of plastics on industry and society

7. Brief list of topics to be covered
   - Polymer Properties and Identification
   - Single Screw Extrusion
   - Thermoforming
   - Rotational Molding
   - 3D Printing
   - Compression Molding
   - Injection Molding and Plastics Recycling

1. Plastics and Composites Engineering 372: Introduction to Composites

2. 5 Credits and categorization of credits: engineering topic.

3. Nicole Larson.

4. Required Text: Fundamentals of Composites Manufacturing, Materials, Methods, and Applications, Second Edition, by A. Brent Strong, ISBN: 0-87263-854-5.

5. Specific course information
    a. Polymer and reinforcement systems; material testing; mold design and development; laboratory involvement in reinforced plastics production processes.
    b. prerequisites or co-requisites: PCE 371
    c. indicate whether a required, elective, or selected elective (as per Table 5-1) coursein the program

6. Specific goals for the course
    a. To increase the student's knowledge of the unique properties and characteristics of reinforced plastics. To acquaint the student with common manufacturing techniques and procedures used in the production of reinforced plastic products and composite structures. To strengthen the student's ability to deal with design, tooling, materials selection, and process control in the manufacture of composite materials. To promote an awareness of new applications for composites and emerging trends in processing and manufacturing with these materials

7. Brief list of topics to be covered
    a. Students can choose from 9 tooling methods. Each project will have a series of gates. At each gate you will be required to meet with the professor and lab technician to discuss your progress and receive a grade for that portion BEFORE moving onto the next. Each failure to meet a deadline will cause you to lose all of the points for that section of the project. A separate sheet will be given on the day that the project is assigned to explain the grading and project in more detail. I reserve the right to deny any project that I feel is not appropriate for this course.

Appendix B
Faculty Vitae

1. Name: Sura Al-Qudah

2. Education:
   - Ph.D., Industrial and Systems Engineering, State University of New York at Binghamton, (2014)
   - M.S., Industrial and Systems Engineering, State University of New York at Binghamton, (2010)
   - B.S., Electronics Engineering, Yarmouk University, Jordan, (2004)

3. Academic Experience:
   - Associate Professor, Western Washington University (WWU) 9/2020 – present, FT
   - Assistant Professor, Western Washington University (WWU) 9/2014 – 8/2020, FT
   - Teaching Assistant, Binghamton University, 12/2012-7/2014,
   - Research Assistant, Binghamton University, 1/2011-5/2012,
   - Teaching Assistant, Binghamton University, 9/2010-1/2011,
   - Research Assistant, Binghamton University, 8/2008-5/2010
   - Teaching Assistant, Yarmouk University, 2/2005-6/2007

4. Non-Academic Experience:
   - Electronics Engineer, Biomedical Center of Excellence, Yarmouk University, Jordan, 9/2005-6/2007, PT
   - Medical electronics intern, Royal Medical Services, Prince Rashed Military Hospital, Irbid, Jordan. 8/2003-2/2004, PT

5. Certifications or Professional Registrations:
   - Fundamentals of GD&T - ASME Y14.5-2009 (W17)
   - CMM fundamentals certificate (2015)
   - PC-DIMS for CMM 101-102-103 certificate (2015)
   - Black-belt Lean Six-Sigma, Binghamton University (2012)

6. Membership in Professional Organizations:
   - Society of Women Engineers (SWE)
   - Society of Manufacturing Engineers (SME)
   - American Society for Quality (ASQ)
   - American Society for Engineering Education (ASEE)
   - Institute of Industrial and Systems Engineers (IISE)

7. Honors and awards:
   - Excellence in Teaching Award, “The National Society of Leadership and Success (NSLS),” Sigma Alpha Pi, (S18).
   - Scholars’ week Outstanding Students Award – Faculty advisor role (S18).
   - Three ASSIST travel grants funded by NSF (EEC-1548200), Academic Leadership for Women in Engineering (ALWE) (F16, F17, F18).
   - Two RSP Research Awards submitted by two of my undergraduate students ($500) (W17).

8. Service Activities:
- MFGE Program Director (F21-current)
- MFGE Acting Program Director (F17, W18)
- Faculty advisor for MFGE undergraduate students in different academic levels (F15-current)
- MFGE & EECE hiring committee member (2017-2018-2020)
- CSE Equity, Inclusion, and Diversity (EID) Committee member, E&D representative (2017-2020)
- President's Council for Equity, Inclusion, and Social Justice (By invitation 2019-2020)
- Computer-Human Interface track chair for IEMS Conference (2016-2017)
- Reviewer for IEEE Transactions on Engineering Management (2015-current)

9. Notable Recent Publications & Presentations:

- **Alqudah S.,** Brobst J., Litzler E., Davishahl J., Klein A., "Becoming Engaged Engineering Scholars: Insights from Year 1", 127th Annual American Society for Engineering Education (ASEE); 2020.
- Davishahl J., **Alqudah S.,** "Complete Work: Investigation of Sense of Belonging to Engineering in Introductory Classes," 127th Annual American Society for Engineering Education (ASEE); 2020.
- Klein A. (PI), **Alqudah S. (co-PI),** VanderStaay S., Brobst J., "DUE-1834139: Becoming Engaged Engineering Scholars (Bees): Success Programs for Retention in Engineering", Awarded August 2018. $957,532, National Science Foundation. December 2018 to November 2023.
- **Alqudah S.,** Froning* A., Sumpter* K., Ortega Martinez E.*, Alqudah, A., "A Novel Design of an Ergonomic Surgical Body Support System", Industrial & Systems Engineering Research Conference (ISERC), Orlando, FL, May 18-21, 2019,

10. Professional Development:
- Sustaining Inclusive, Student-centered Instruction in WWU Departments Workshop, Sep 15, 2021
- 2021 ABET Symposium (virtual), April 2021
- Engaging Students in Online Environments, Aug 10-14, 2020
- Teaching a Synchronous Course, Aug 3-7, 2020
- Integrated Enterprise Excellence: Going Beyond Lean Six Sigma and the Balanced Scorecard, ISERC pre-conference workshop, FL, May18, 2019
- CSE STEM Equity & Inclusion Workshops (ISMs), Cultural Awareness of Self, WWU, April 2019.
- The Academic Leadership for Women in Engineering (ALWE) Workshops, During SWE Conferences in 2017 & 2018
    - Scholarship of Teaching & Learning Residency (SoTL), North Cascades Institute, WA, Sep 6-8, 2016.

1. Name: Tarek AlGeddawy

2. Education

- Ph.D., Industrial and Manufacturing Systems, University of Windsor, 2011
- M.Sc., Industrial Engineering, Cairo University, 2004
- B.Sc., Mechanical and Production Engineering, Cairo University, 1999

3. Academic experience

- Associate Professor, Western Washington University, 2021-present, full-time
- Assistant Professor, Western Washington University, 2018-2021, full-time
- Assistant Professor, University of Minnesota Duluth, 2013-2018, full-time
- Visiting Researcher, Intelligent Manufacturing Systems Center, 2014-2015, part-time
- Instructor, University of Windsor, 2012, part-time
- Research & Teaching Assistant, University of Windsor, 2006-2011, full-time
- Teaching Assistant, American University in Cairo, 2003-2004, part-time
- Research & Teaching Assistant, Cairo University, 1999-2006, full-time

4. Non-academic experience

N.A.

5. Professional registrations

N.A.

6. Professional organizations membership

- North American Manufacturing Research Institution (NAMRI) of Society of Manufacturing Engineers (SME), scientific committee member since 2016.
- Egyptian syndicate of Engineers, member since 2000.

7. Honors and awards

- Outstanding academic adviser award Nomination, 2016, UMD.
- Best poster award, 2013, UWindsor, Ontario FEDDEV projects.
- Best paper award of the year, 2012, Journal of Engineering Design.

8. Service activities

- MFGE major student advisor, 2019-present.
- CSE Tech Ops committee member representing Engineering & Design department, 2020-present.
- RCA subcommittee member for additional competitive grants, 2020-present.
- Search committee member for EECE faculty, 2021/active.
- Search committee member for director of 1st year engineering program, 2019/2020.

- Search committee member for MFGE support technician, 2019.

9. Publications

Ghanei, S., AlGeddawy, T. (2020) An Integrated Multi-Period Layout Planning and Scheduling Model for Sustainable Reconfigurable Manufacturing Systems, Journal of Advanced Manufacturing Systems. 19(1), 31-64.

AlGeddawy, T. (2020) A Digital Twin Creation Method for an Opensource Low-cost Changeable Learning Factory. 30th International Conference on Flexible Automation and Intelligent Manufacturing, FAIM2020. Procedia Manufacturing. 51(1):1799-1805.

AlGeddawy, T., ElMaraghy, H. (2020) A Holistic Multi-Domain Association Model for Industrial Data. 30th International Conference on Flexible Automation and Intelligent Manufacturing, FAIM2020. Procedia Manufacturing. 51(1):920-925.

Tohidi, H., AlGeddawy, T. (2020) Optimizing Modular Fixtures Setup Time in an Automated Assembly Line. Advances in Design, Simulation and Manufacturing III, DSMIE-2020. In: Advances in Design, Simulation and Manufacturing III. Edited by: Ivanov V, Trojanowska J, Pavlenko I et al. Cham: Springer International Publishing. pp 336-346.

AlGeddawy, T. (2019) A Simplified Changeable Learning Factory Design Based on a Granularity Complexity Model. 29th International Conference on Flexible Automation and Intelligent Manufacturing, FAIM2019. Procedia Manufacturing, 38(1): 654-662.

Tohidi, H., AlGeddawy, T. (2019) Change Management in Modular Assembly Systems to Correspond to Product Geometry Change, International Journal of Production Research. 57(19), 6048-6060.

AlGeddawy, T. (2017) A New Model of Modular Automation Programming in Changeable Manufacturing Systems, 27th International Conference on Flexible Automation and Intelligent Manufacturing FAIM2017, Procedia Manufacturing, 11(1), 198-206

AlGeddawy, T., Samy, S., ElMaraghy, H. (2017) Best Design Granularity to Reduce Assembly Complexity of Modular Products, Journal of Engineering Design, 28(7-9), 457-479.

AlGeddawy, T., ElMaraghy, H. (2016) Design for Energy Sustainability in Manufacturing Systems, CIRP Annals, 65(1), 409–412.

Ghanei, S, AlGeddawy, T. (2016) A New Model for Sustainable Changeability and Production Planning, Proceedings of the 49th CIRP Conference on Manufacturing Systems, Procedia CIRP, 57(1), 522–526.

10. Professional development

- Joint Center for Aerospace Technology Innovation (JCATI) project SU2021-SP2022, PI: solving the resin buildup cleaning problem in composite part tools in aerospace industry, with a team of 5 undergrads and a Co-PI from PCE.
- Automation, Robotics and Learning Factories (2018-present): advancing the automation and robotics area in MFGE by introducing industry standard software, hardware and systems integration, developing an industrial grade learning factory (LEAF) from the ground up, while involving undergrads in the design, fabrication and installation processes.

- Equity, Diversity and Inclusion: participation in the STEM Concept workshop by ISM (2019), focused on cultural awareness of self and experiences of others.

1. Name: Jill Davishahl

2. Education:
   - M.S., Mechanical Engineering, University of Washington, 1999
   - B.S., Mechanical Engineering, Union College, 1997

3. Academic Experience:
   - Assistant Professor and First Year Programs Director, Western Washington University, 2020-present, full-time
   - Non-tenure Track Faculty and Director of Pre-Engineering Development, Western Washington University, 2018-2020, full-time
   - Tenured Faculty, Bellingham Technical College, 2018, full-time
   - Tenure Track Faculty, Bellingham Technical College, 2014-2017, full-time
   - Non-tenure Track Faculty, Western Washington University, 2012-2014, full-time
   - Tenured Faculty and Engineering Department Chair, Edmonds Community College, 2004-2009, full-time
   - Tenure Track Faculty, Edmonds Community College, 2001-2004, full-time
   - Temporary Faculty, Edmonds Community College, 2000-2001, full-time

4. Non-Academic Experience:
   - Engineering Consultant/Design Engineer, Prosthetics Research Study, Seattle, WA, 1999-2000
   - Software Engineer & Consultant, American Management Systems, 1999-1999

5. Certifications or Professional Registrations:

6. Membership in Professional Organizations:
   - American Society of Engineering Education
   - ASEE LGBTQ+ Advocacy in STEM Virtual Community of Pracitice
   - Technology Alliance Group for Northwest Washington (TAGNW)
   - Washington Council for Engineering and Related Technical Education
   - Engineers Without Borders

7. Honors and awards:
   - ASEE Best Professional Interest Council (PIC) 3 Paper 2019
   - ASEE Best Division Paper: Mechanics Division 2019
   - ASEE Best 3rd Division Paper: Energy Conversion & Conservation Division 2019
   - Club Advisor of the Year. Edmonds Community College 2006

8. Service Activities:
   - Diversity, Equity, and Inclusion Committee; College of Science & Engineering (2019-current)

- Community Ambassador; College of Science & Engineering (2019-current)
- Curriculum Committee; Engineering + Design Department (2018-current)
- Faculty Lead: Engineering + Design Makerspace (2018-current)
- Student Technology Liaison Program (2020 – current)
- Becoming Engaged Engineering Scholars (2020 – current)
- Digital Badge Program (2020 – current)
- Pre-Major Orientation Sessions (2019 – current)
- Makerspace Student Technology Workshops, 5 (2019-2020)
- Makerspace Peer Mentor Program (2019 – 2020)
- Bellingham Public Schools Career and Technical Education Advisory Board Member (2015-present)
- Options High School Remodel Advisory Committee (2016)
- Washington Engineering Institute Advisory Board Member (2015-2016)

9. Notable Recent Publications & Presentations:

J. Davishahl, C. Grubb. “Engineering Faculty Experiences Teaching Social Justice to First Year Students.” *2021 IEEE Frontiers in Education Conference (FIE)*, Oct 2021. Draft accepted.

J. Davishahl, E. Mediavilla, A. Nelson. “Cultivating community for first year students: Experiences in adapting a peer mentoring program to remote format.” *Proceedings of the First Year Engineering Experience Conference*, August 2021. Draft accepted.

J. Davishahl, J. Newcomer. “Broadening Engineering Orientation for First Year Students.” *Proceedings of the 126th American Society of Engineering Education Conference and Exposition,* June 2021.

J. Davishahl, S. Al-Qudah. “Complete Work: Investigation of Sense of Belonging to Engineering in Undergraduate Introductory Classes.” *Proceedings of the 125th Annual American Society of Engineering Education Conference and Exposition*, June 2020.

S. Alqudah, E. Litzler, J. Brobst, **J. Davishahl**, A. Klein. “S-STEM Becoming Engaged Engineering Scholars: Insights from Year 1.” *Proceedings of the 125th Annual American Society of Engineering Education Conference and Exposition*, June 2020.

X. Jiang, **J. Davishahl,** D. Hickenbottom, D. Saunders, T. Thorton. “Photovoltaic System Performance Under Partial Shading: An Undergraduate Research Experience.” *Proceedings of the 125th Annual American Society of Engineering Education Conference and Exposition,* Tampa FL, June 2019

E. Davishahl, T.R. Haskell, **J. Davishahl**, L. Singleton, W.H. Goodridge. “Do They Understand Your Language? Assess Their Fluency with Vector Representations.”

Proceedings of the 125th Annual American Society of Engineering Education Conference and Exposition, Tampa FL, June 2019

J. Davishahl, X. Jiang, S. Dever, L. Bear, T. Christman, D. Hickenbottom, S. Winters. "A Cross-Institutional Collaboration: Analysis of Power Electronics for Solar Panel Arrays." *Proceedings of the 124th Annual American Society of Engineering Education Conference and Exposition*, Salt Lake City UT, June 2018

S. Al-Qudah, **J. Davishahl**, E. Davishahl, M. Greiner. "Investigation of Sense of Belonging to Engineering in Undergraduate Introductory Classes, WIP." *Proceedings of the 124th Annual American Society of Engineering Education Conference and Exposition*, Salt Lake City UT, June 2018

1. David D. Gill

2. Education
   - Ph.D., Mechanical Engineering, North Carolina State University, 2002
   - MSME, Mechanical Engineering, Purdue University, 1997
   - BSME, Mechanical Engineering, Texas Tech University, 1994

3. Academic Experience
   - Associate Professor, Western Washington University, 9/2019 - present
   - Assistant Professor, Western Washington University, 9/ 2014 – 8/ 2019

4. Non-Academic Experience
   - Sandia National Laboratories, Principal Member of the Technical Staff, Solar-Thermal Technologies Organization. Proposing and performing research into novel solar-thermal energy storage systems, June 2009 – June 2014, Full time position
   - Sandia National Laboratories, Principal Member of the Technical Staff, Mesoscale Manufacturing Organization, Proposing and performing research in novel manufacturing methods for high-precision meso-scale components, Oct. 2006 – May 2009, Full time position
   - Sandia National Laboratories, Senior Member of the Technical Staff, Mesoscale Manufacturing Organization, Proposing and performing research in novel manufacturing methods for high-precision meso-scale components, Aug. 2002 – Oct. 2006, Full time position
   - Caterpillar Large Engine Center, Lafayette, IN, Manufacturing Engineer and Field Test Engineer, Manufacturing engineer for the 3500 series connecting rod production line and field test engineer for 3500 long-stroke, stationary engine evaluation, Feb. 1997 – June 1999, Full time position

5. Professional Registration
   - Registered Professional Engineer in the State of New Mexico, License 17153

6. Current Membership in Professional Organizations
   - Society of Manufacturing Engineers (faculty advisor for student chapter)
   - American Society of Mechanical Engineers

7. Honors and Awards
   - 2017 ASEE Annual Conference, Engineering Design Graphics Division of ASEE Chair’s Award for Best Paper Presented in the EDGD Sessions
   - Department of Energy Award of Excellence for Outstanding Service to DOE in the LENS Qualification Project (role was PI/PM), 2009
   - Outstanding Paper Award – 2006 Solid Freeform Fabrication Symposium
   - RV Jones Memorial Scholarship, American Society for Precision Engineering, 2001

8. Service Activities
    - Session Co-chair, "MSEC 3-1-1 Machining of Composites", 2017 ASME-Manufacturing Science & Engineering Conference, Los Angeles, CA, USA, June 4-8, 2017
    - WWU Campus Laboratory and Chemical Safety Committee member, 2015-present
    - WWU, Engineering and Design Department, Resource Committee, new appointment beginning Fall 2018
    - WWU, Engineering and Design Department, Manufacturing Automation Faculty Search committee, 2017/18
    - WWU, Engineering and Design Department, Manufacturing Technologist search committee 2017
    - Board Member, Hillcrest Chapel, 2020-present

9. Publications and Presentations
    - "Investigation and Modeling of Flag Generation in Honeycomb Sandwich Panel Machining", D. Yip-Hoi, D. Gill, ASME 2018 International Mechanical Engineering Congress and Exposition, Nov. 9-15, 2018, Pittsburgh, PA, USA (To Be Presented) (50%)
    - "'To the Boards' – Team-Based Design for Student-Centered Learning", D. Gill, J. Newcomer, Proceedings of the 2017 International Mechanical Engineering Congress & Exposition, Nov. 3-9, 2017, Tamp, FL, USA (95%)
    - "Use of Model-Based Definition to Support Learning of GD&T in a Manufacturing Engineering Curriculum", D. Yip-Hoi, D. Gill, Proceedings of the 2017 ASEE Annual Conference & Exposition, June 25-28, 2017, Columbus, OH (35%)
    - "Studying the Mechanisms of High Rates of Tool Wear in the Machining of Aramid Honeycomb Composites", D.D. Gill, D.M. Yip-Hoi, <u>M. Meaker</u>, <u>T. Boni</u>, <u>E.L. Eggeman</u>, <u>A.M. Brennen</u>, <u>A. Anderson</u>, Proceedings of the ASME 2017 20th International Manufacturing Science and Engineering Conference, June 4-8, 2017, Los Angeles, CA, USA (50%)
    - "Co-Printing Test Specimens as Surrogates for Complex Part Characterization", M. Peyron, D. Gill, C. Grubb, <u>Z. Zywiak</u>, <u>Anderson</u>, <u>A. Hoch</u>, The Composites and Advanced Materials Expo, Sept. 26-19, 2016, Anaheim, CA (15%)

10. Professional Development Activities
    - "Synchronous Couse Help Session", Aug. 6, 2020
    - "Engaging Group & Collaborative Work", July 23, 2020
    - "Screencast-O-Matic Power User", July 22, 2020
    - "Blended/Online Course Development Boot Camp", July 21-Aug. 4, 2020
    - "Interfolio Training", June 23, 2020 (1hr)
    - "VERICUT Verification Web Training", June 16-18, 2020 (24 hrs)
    - "VERICUT Force Optimization Web Training", June 3-4, 2020 (8 hrs)
    - "OMAX Waterjet Training", Bellingham, WA, September 10-12, 2018

- “The Tenure Process”, New Faculty Spring Event, April 12, 2017, WWU
- “Composites 101” workshop, AeroDef 2017 Conference, March 7, 2017, Ft. Worth, TX
- “Teaching 3D Spatial Skills Workshop”, Western Washington University, April 28-29, 2016

1. Name: Jeffrey L. Newcomer

2. Education:
   - Ph.D., Mechanical Engineering, Rensselaer Polytechnic Institute (RPI) (1994)
   - M.S., Science and Technology Studies, RPI (1993)
   - M.Eng., Aeronautical Engineering, RPI (1989)
   - B.S., Aeronautical Engineering, RPI (1988)

3. Academic Experience:
   - Department Chair, Engineering & Design, Western Washington University (WWU)9/12 – present
   - Professor, WWU 9/06 – present
   - Associate Professor, WWU 9/02 – 9/06
   - Assistant Professor, WWU 9/98 – 9/02
   - Assistant Professor, New England Institute of Technology 9/97 – 9/98
   - Assistant Professor, University of Wisconsin – Platteville 8/96 – 5/97
   - Adjunct Assistant Professor, RPI 9/94 – 5/96

4. Non-Academic Experience:
   - Quality Assurance Engineer (Part Time), MapInfo Corporation, Troy, NY 6/92 – 9/93
   - Aerospace and Co-op Engineer, Naval Air Development Center, Warminster, PA6/86 – 8/86, 8/87 – 11/87, 7/88 – 8/88

6. Membership in Professional Organizations:
   - American Society for Engineering Education (ASEE)
   - Society of Manufacturing Engineers (SME)

7. Honors and Awards:
   - Winner of the 2010 Benjamin J. Dasher Best Paper Award, ASEE/IEEE 40th Ann.Frontiers in Ed. Conf.
   - Winner of Best Paper Award, 2008 Pacific Northwest ASEE Section
   - Winner of Best Presentation Award, 2004 ASEE Conf. for Industry and Ed.Collaboration: Engineering Technology Division
   - Winner of Best Paper Award, 2003 SPE Ann. Technical Conference: Mold MakingDivision
   - Nominee for Best paper Award, 2000 ASEE Ann. Conf. and Expo
   - 1999 NSF New Faculty Fellow, 1999 Frontiers in Ed. Conference

8. Service Activities:
   Western Washington University (WWU) Service – last 5 years

   - Department Curriculum Committee 9/11–present
   - ASEE Campus Representative for Pacific NW Region 11/12–present

- Washington Council on Engr. and Related Tech. Ed. (WCERTE) 5/01–present
- Pre-Engineering Advisor 9/01–6/14
- Department Resources Committee, Member 10/04–present
- College of Sciences and Technology (CST) Dean's Advisory Committee 9/12–present
- WWU Academic Fees Committee 11/12–present
- WWU Campus Access Control Planning Committee 11/15–present
- WWU Access Control Group 5/14–6/15
- Department Search Committee 11-12, 13-14, 14-15, 15-16
- Faculty Senate Executive Council 5/04–6/13
- University Planning and Resources Council Chair 5/09–6/13
- WWU University-wide Budget Panel 5/09–6/13
- WWU Bottleneck Funding Committee 1/11–6/13
- WWU University Retirement Plan Advisory Committee 3/12–6/13
- WWU Budget Director Search Committee 12/12–3/13
- Parking and Transportation Advisory Committee 8/12–12/12
- Manufacturing Engineering Technology Program Coordinator 6/11–11/12
- CST Policy, Planning, and Budget Council 9/11–6/12

9. Notable Recent Publications:

Newcomer, Jeffrey L., "An Industrial Robotics Course for Manufacturing Engineers," *Proc.of the 2016 ASEE An. Conf. and Expo.*, New Orleans, LA, June 2016

Newcomer, Jeffrey L., "More Than Just Right Or Wrong: Using Concept Questions To Dis-cern Students' Thinking In Mechanics," *Proc. of the ASEE/IEEE 45th An. Frontiers in Ed. Conf.*, El Paso, TX, Oct. 2015

Yip-Hoi, Derek, and Jeffrey L. Newcomer, "Conforming a New Manufacturing EngineeringCurriculum to the SME Four Pillars," *Proc. of the 2015 ASEE An. Conf. and Expo.*, Seattle, WA, June 2015

Jeffrey L. Newcomer, "Context and Consistency in Students' Approaches to Solving Prob-lems in Engineering Statics," *Proc. of the ASEE/IEEE 43rd Ann. Frontiers in Ed. Conf.*, Okla-homa City, OK, Oct. 2013

Jeffrey L. Newcomer, "Correlation of Students' Basic Understanding of Rigid Body Dynam-ics and Performance in Statics," *Proc. of the 2013 ASEE Ann. Conf. and Expo.*, Atlanta, GA,June 2013

Jeffrey L. Newcomer, "Investigating the Validity of Students' Self-Assessments of Their Ability in Statics," *Proc. of the 2011 ASEE Ann. Conf. and Expo.*, Vancouver, BC, June 2011

Yip-Hoi, Derek, and Jeffrey L. Newcomer, "Teaching CAD Modeling Using LEGO®,"

Proc. of the 2011 ASEE An. Conf. and Expo., Vancouver, BC, June 2011

10. Professional Development:
    3D Spatial Skills Workshop at WWU, April 2016

    Making Academic Change Happen (MACH) at Rose-Hulman Institute of Tech., June 2013FANUC Robotics V-iRVision Operation and Programming – 2D, January 2013

    FANUC Robotics Handling Tool Operation and Programming, August 2012

    Exploring How People Learn Engineering at Colorado School of Mines, August 2010

1. Name: Derek Yip-Hoi

2. Education:
   - Ph.D., Mechanical Engineering, University of Michigan (UM) (1997)
   - M.S., Mechanical Engineering, The State University of New York at Buffalo (1990)
   - B.S., Mechanical Engineering, The University of the West Indies, Trinidad (1985)

3. Academic Experience:
   - Professor, Engineering & Design Department, Western Washington University, - present
   - Associate Professor, Engineering Technology, Western Washington University (WWU) 9/2011 – present
   - Assistant Professor, WWU 1/2007 – 8/2011
   - Assistant Professor & Associate NSERC/PWC Chair, Mechanical Engineering, The University of British Columbia (UBC) 7/2003 – 12/2006
   - Assistant Research Scientist, Mechanical Engineering, UM, 1/1998 – 6/2003
   - Research Fellow, Mechanical Engineering & Applied Mechanics, UM 9/1997 – 1/1998

6. Membership in Professional Organizations:
   - American Society of Mechanical Engineers (ASME)
   - Society of Manufacturing Engineers (SME)
   - American Society of Engineering Education (ASEE)
   - Engineering Without Borders (EWB-USA)

7. Honors and Awards:
   - Most Outstanding Upper Year Professor, Mechanical Engineering, UBC (2005)
   - British Columbia Advanced Systems Institute Fellowship (7/2003 – 7/2006)
   - Rockwell Automotive Fellowship (2000)
   - Laspau/Fulbright Fellowship (1994)

8. Service Activities:

   Western Washington University (WWU) Service – last 5 years
   - Curriculum Committee, Dept. 1/2007 – present
   - Resource Committee, Dept. (Current Chair) 1/2007 – present
   - Manufacturing Engineering Technology Program (including CAD/CAM)
     - Student Advisor 1/2007 – present
     - Program Director 11/2012 – present
   - Manufacturing Engineering Program
     - Student Advisor 9/2014 – present
     - Program Director 9/2014 – present
   - Academic Technology Committee 9/2009 – 6/2014 (Chair 9/2010 – 6/2013)
   - Curriculum Committee, College 9/2012 – 6/2013

- Chair of Faculty Search Committee (three positions) 9/2013 – 6/2014
- Curriculum Development, transition from Engr. Tech. to Engr. 7/2013 – present
- Acting Department Chair, 9/2012 – 11/2012
- Resource Committee, College 9/2009 – 2011
- Faculty Advisor, Engineers Without Borders, 2008 – Present
- Faculty Advisor, Society of Manufacturing Engineers, 2013 - 2015

Outside of Institution

- Chair; previously Vice-Chair and Secretary, Computer-Aided Product & Process Development Technical Comm., ASME Computers in Engineering Division 8/2008 – 8/2011
- ASME Tech. Conferences, CAPPD Technical Comm. Member (2012, 2011, 2010, 2009); CIE/CAPPD Review Coord. (2012, 2011, 2010, 2008); Paper Reviewer (2006-2015)
- ASEE Conference, Session Chair 2013

9. Notable Recent Publications:

Journal Articles

Aras, E, Yip-Hoi, D., "Geometric Modeling of Cutter/Workpiece Engagements in 3-Axis Milling Using Polyhedral Representations". The ASME Journal of Computing and Information Science in Engineering, Vol. 8, Issue 3, September 2008.

Ferry, W., Yip-Hoi, D., "Cutter-Workpiece Engagement Calculations by Parallel Slicing for Five-Axis Flank Milling of Jet Engine Impellers". The ASME Journal of Manufacturing Science and Engineering, Vol. 130, Issue 5, October 2008.

Refereed Conference Papers

Welch, J., Yip-Hoi, D., "Enhancing a Blended Learning Approach to CAD Instruction Using Lean Manufacturing Principles". The Proceedings of the 2015 ASEE Annual Conference and Exposition, Seattle, Washington, June 14th – 17th.

Yip-Hoi, D., Newcomer, J., "Conforming a New Manufacturing Engineering Curriculum to the SME Four Pillars". The Proceedings of the 2015 ASEE Annual Conference and Exposition, Seattle, Washington, June 14th – 17th.

Yip-Hoi, D., "Developing CAD/CAM Techniques for Machining Unexpanded Honeycomb Core". The proceedings of the 2014 ASME Design Engineering Technical Conferences, Buffalo, New York, August 17th – 20th.

Yip-Hoi, D., "Using Simulation to Improve the Efficiency of CAM and CNC Instruction". The proceedings of the 2013 ASEE Annual Conference, Atlanta, Georgia, June 2013.

Yip-Hoi, D., Wang, J., "Solid Modeling of In-Process Workpiece Geometry for Hole Milling". The proceedings of the 2012 ASME Design Engineering Technical Conferences Conference, Chicago, Illinois, August 2012.

Aras, E., Yip-Hoi, D., "State-of-the-Art in Geometric Modeling for Virtual Machining". The proceedings of the 2012 ASME Design Engineering Technical Conferences Conference, Chicago, Illinois, August 2012.

Book Sections

Yip-Hoi, D., "Computer-Aided Process Planning for Machining", *The Mechanical Systems Handbook: Modeling, Measurement and Control*, CRC Press, edited by Hurmuzlu, Y., Nwokah, O., December 2001.

Yip-Hoi, D., Dutta, D., "An Introduction to Parallel Machine Tools and Related CAPP Issues", Advances in Feature Based Manufacturing, edited by Shah, J., Mantyla, M., Nau, D.S., Elsevier, 1994, pg. 261-285.

10. Professional Development:
    - Spatial Visualization Training – Workshop by Dr. Sheryl Sorby hosted by department in April 2016
    - CAM – IMSpost Post-Processor Dev't Training, 6/2013
    - CAM – Vericut Machine Tool & Control Builder Training, 6/2013
    - Metrology – FARO Scan Arm and CAM-X Software, 6/2009

1. Name: Kirk Desler

2. Education:
   M.B.A., Business Administration, Western Washington University (2018)
   B.S., Plastics Engineering Technology, Western Washington University, (2000)

3. Academic Experience:
   Instructor, Engineering & Design Department, Western Washington University, 2021-present

4. Non-Academic Experience:
   Operations Manager, Amazon, 2020-2021
   Operations Manager, Safran Cabin, 2012-2020
   Lead Tool Design Engineer, Safran Cabin, 2007-2012
   Composites Design & Process Engineer, Innovative Composites Engineering, 2001-2006
   Process Engineer, Hexcel, 2000

5. Certifications or Professional Registrations:

6. Membership in Professional Organizations:

7. Honors and awards:

8. Service Activities:

9. Notable Recent Publications & Presentations:

10. Professional Development:

1. Name: Deborah Glosser

2. Education:
   - Ph.D., Civil Engineering, Oregon State University, 2020
   - M.S., Geology and Planetary Science, University of Pittsburgh, 2013
   - J.D., Law Degree, Duquesne University School of Law, 2005
   - B.A., Computational Linguistics, The Ohio State University, 2002

3. Academic Experience:
   - Assistant Professor, Western Washington University, 2020-present, full-time
   - PhD Research Associate, Civil Engineering, Oregon State University, 2017-2020, full-time
   - Graduate Student Researcher, University of Pittsburgh, 2010-2011, full-time

4. Non-Academic Experience:
   - Senior Energy Analyst, Electrical and Natural Gas Utility Regulator, Oregon Public Utility Commission, 2016, full-time
   - Research Scientist, Physics Geologic and Engineered Systems and Structural Materials, US Department of Energy, 2012-2016
   - Regulatory Analyst/Attorney, Ernst & Young and Others, 2005-2010

5. Certifications or Professional Registrations:

6. Membership in Professional Organizations:
   - American Concrete Institute (ACI)
   - American Society of Civil Engineers (ASCE)
   - Society of Petroleum Engineers (SPE)
   - American Geophysical Union (AGU)

7. Honors and awards:
   - ACI Wason Medal for Materials Research (2021) – Honor bestowed by the Board of Directors of the American Concrete Research Institute
   - ASTM International Mather Scholarship (2019) – Competitive merit-based scholarship for demonstrated contributions in cement or concrete materials research.
   - National Defense Science and Engineering Graduate Fellowship (2018) – Alternate Selectee.
   - PacTrans Fellowship (2017 and 2018) – The PacTrans fellowship is an annual merit-based cash award for contributions to civil engineering research offered by the Pacific Northwest Transportation Consortium.
   - University Laurels Block Grant (2018) – The UGLBG program is a competitive tuition remission scholarship administered by the Oregon State University Graduate School awarded based on student merit.
   - Provosts Distinguished Graduate Student Scholarship (2017) – The Provost's Distinguished Graduate Fellowship Program is a prestigious Oregon State University

fellowships, and is comprised of twelve-month stipends, plus tuition scholarships and subsidized health insurance for one year.

8. Service Activities:

9. Notable Resent Publications & Presentations:

Glosser, D., Suraneni, P., Isgor, B., Weiss, J., Determining reactivity of fly ash using glass content in thermodynamic calculations, (2020) Cement and Concrete Research ACI Materials (2021)

Glosser, D., Suraneni, P., Isgor, B., Weiss, J., Estimating reaction kinetics of cementitious pastes containing fly ash, Cement and Concrete Composites (2021)

Glosser, D., Isgor, B., Weiss, J., Non-equilibrium thermodynamic modeling framework for OPC/SCM Systems, *invited paper, ACI Materials (2020)

Glosser, D, Bauer, J., A graph theoretic model for predicting fracture networks, (book chapter) in: Hydraulic fracturing and well simulation, Wiley books, editor: Fred Aminzadeh, ISBN 1119555698, (2019)

Bharadwaj, K., **Glosser,** D. Isgor, B., Weiss, J., Toward the Prediction of Pore Volumes and Freeze-Thaw Performance of Concrete Using Thermodynamic Modelling, (2019) Cement and Concrete Research, Vol. 124, https://doi.org/10.1016/j.cemconres.2019.105820

Glosser, D. Choudhary, A., Ideker, J., Trejo, D., Isgor, B. Weiss, J. Thermodynamic Investigation of Cementitious Mixtures Incorporating Off-Spec Fly Ashes, (2019), World of Coal Ash Proceedings

Choudhary, A., **Glosser**, D. Isgor, B, Weiss, J., Experimental Test Method to Determine the Reactivity of Fly Ash for Use in Mixture Proportioning (2019), World of Coal Ash Proceedings

Isgor, B., Weiss J., Ideker, J, **Glosser,** D.: Development of a performance-based mixture proportioning procedure for concrete incorporating off-spec fly ash, submitted to Energy Power Research Institute, Interim Technical Report on Thermodynamic modeling of mixtures using off-spec fly ashes, Corvallis, OR (2018).

Glosser, D, Choudhary, A., Isgor, B., Weiss J.; Investigation of the reactivity of fly ash and its effects on mixture properties, American Concrete Institute Materials Journal (Special Edition), (2019). * *invited paper,* Vol. 114 issue 4

1. Name: John M. Misasi

2. Education
   - PhD, Polymer Science and Engineering, University of Southern Mississippi (2015)
   - B.S., Plastics Engineering Technology, Western Washington University, (2011)

3. Academic Experience
   - Associate Graduate Faculty, School of Polymer Science and Engineering, University of Southern Mississippi, 9/20-present
   - Associate Professor, Engineering and Design, Western Washington University, 9/19-present
   - Assistant Professor, Engineering and Design, Western Washington University, 9/15-9/19

4. Non-Academic Experience
   - Industrial Trainee Fellow, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia (2013)
   - Graduate Research Intern, Boeing Research and Technology, Seattle, WA (2012)

5. Certifications or professional registrations

6. Current Membership in Professional Organizations
   - Society of Plastics Engineers (SPE)
   - Society for the Advancement of Materials and Process Engineering (SAMPE)
   - American Chemical Society (ACS)
   - American Society for Engineering Education (ASEE)

7. Honors and Awards
   - First place paper at the Waterborne Symposium Technical Conference (2019)
   - SAMPE Young Emerging Professionals Leadership Award (2018)
   - First place winner of the Waterborne Symposium Poster Competition (2015)
   - First place winner of The Society of Plastics Engineers Polymer Modifiers and Additives Division Writing Challenge (PMAD Challenge, 2014)
   - CSIRO Industrial Trainee Research Fellow (2013)

8. Service activities (within and outside of the institution)
   - Mentored 44 undergraduate research students, 2013-present
   - Mentored 29 undergraduate capstone students, 2012-present
   - Mentored 2 graduate students, 2017-present
   - Helped obtain funding for and/or organized the purchase of 10 pieces of equipment
   - SAMPE/SPE student chapter advisor
   - Industry and community outreach volunteer and coordinator

- Department resource committee member (2017-2021)
- Faculty search committee member (x2, 2019-2020)
- Materials science seminar committee member and chair (2016-2020)
- College technical operations committee member (2018-2020)
- College policy, planning, and budget council member (2020-present)
- University advising for incoming freshmen and community college students
- Article reviewer for 6 journals (on-going)
- Conference paper reviewer and session chair SAMPE (on-going)
- Seven guest lectures to students and industry (2017-present)
- Nine hosted speakers for PCE and AMSEC students (2016-present)

9. Publications
   - Misasi, John; Dao, Buu; Dell'Olio, Carmelo; Swan, Sam; Issadazeh, Salumeh; Wiggins, Jeffrey; Varley, Russell. *Polyaryletherketone (PAEK) thermoplastic composites via in-situ ring opening polymerization*. Composites Science and Technology, Volume 201, 2021, 108534, ISSN 0266-3538. (50%)
   - Kim, Steven; Wu, Hao, Devega, Alexa; Sico, Mallory; Fahy, William; Misasi, John; Dickens, Tarik; Koo, Joseph. *Development of polyetherimide composites for use as 3D printed thermal protection material.* Journal of Materials Science (2020): 1-18. (15%)
   - Wu, Hao; Kim, Steven; Fahy, William; Haewon, Kim; Kafi, Abdullah; Bateman, Stuart; Langston, Jon; Atak, Ozen; Reber, Roderick; [2]Misasi, John; Koo, Joseph. *Evaluation of additively manufactured ultra-performance polymers to use as thermal protection systems for spacecraft.* Journal of Applied Polymer Science, 2020, 137:e49117. (15%)
   - a[1]Misasi, John; Jin, Qifeng; Wiggins, Jeffrey; Morgan, Sarah. *Hybrid POSS-Hyperbranched Polymer Additives for Simultaneous Reinforcement/Toughness Improvement in Epoxy-Amine Networks*. Polymer. 2017, 117, 54-63. **(75%)**
   - [2]Misasi, John; Jin, Qifeng; Wiggins, Jeffrey; Morgan, Sarah. *Simultaneous Reinforcement and Toughness Improvement in an Aromatic Epoxy Network with an Aliphatic Hyperbranched Epoxy Modifier.* Polymer. 2015, 73, 174-182. **(75%)**
   - Larson, Nicole; [2]Misasi, John. *Development of thermoplastic panels for Haiti*. International Journal of Science in Society. 2011, 3 (1), 75-86. **(30%)**
   - [s]Owen, Christofer; Grubb, Cecile; Misasi, John. *Impacts of degraded surface removal on mechanical recycled marine debris.* Technical Paper. ANTEC. 2021. (60%)
   - [s]Covarrubias, Juliana; [s]Owen, Christofer; Impink, [s]Evan; [s]House, Molly; Grubb, Cecile; Hokestra, Nicole; Misasi, John. *Some properties of 100% recycled ocean plastic olefins.* Technical Paper. ANTEC. 2021. (60%)
   - [s]Dojan, Carter; Hjelstrom, Kevin; Grubb, Cecile; Misasi, John. *Direct ink writing of benzoxazine nanocomposites.* Technical Paper. SAMPE. 2021. (50%)
   - [s]Hamernik, Levi; Grubb, Cecile; Misasi, John. *Synthesis & characterization of a high-performance reversible epoxy curative.* Technical Paper. SAMPE. 2021. (40%)
   - Wu, Hao; Kim, Steven; Fahy, William; Kafi, Abdullah; Bateman, Stuart; Yee, Colin; Langston, Jon; Atak, Ozen; Reber, Roderick; [2]Misasi, John; Koo, Joseph. *Ablation Performances of Additively Manufactured High-Temperature Thermoplastic Polymers.* Technical Paper. AIAA SciTech Forum. 2020. (15%)

- [s]Smith, Edwin; Grubb, Cecile; Larson, Nicole; Misasi, John. *Developing a procedure for prepreg tack characterization.* Technical Paper. CAMX. 2019. (50%)
- Kafi, Abdullah; Wu, Hao; Atak, Ozen; Kim, Haewon; Kim, Steven; Langstrom, Jon; McDermott, Ryan; Fahy, William; Reber, Roderick; [2]Misasi, John; Bateman Stuart; Koo, Joseph. *Evaluation of ultra-performance polymers for use as thermal protection systems.* Technical Paper. CAMX. 2019. (10%)
- [s]Davis, Charles; [s]Antonson, Jordan; [s]Smith, Paul; Kaas, Ben; [1]Misasi, John. *Characterization of POSS-ULTEM nanocomposites and their FFF printed-part properties.* Technical Paper. CAMX. 2019. (75%)
- [s]Ghanbari, Lina; [s]Croshaw, Chris; [s]Hamernik, Levi; Grubb, Cecile; [1]Misasi, John. *Development of a continuous b-stage reaction vessel for benzoxazine network pre-polymers.* Technical Paper. Waterborne Symposium. 2019. *1st Place Technical Paper.* (50%)
- [s]Lew, Scott; Perkins, Frederick, Hoekstra, Nicole; [1]Misasi, John. *Improving the electrical conductivity of PC/ABS printing filament for fused filament fabrication using carbon nanostructures*. Technical Paper. ANTEC. 2018. (50%)
- [s]Lynch, Sean; Grubb, Cecile; [1]Misasi, John. *Reversible epoxy-amine networks through hexahydrotriazine groups.* Technical Paper. SAMPE. 2018. (75%)
- Grubb, Cecile ; [s]Hill, Gabriel; [1]Misasi, John. B*alancing infusion viscosity and flame retardancy of a RTM benzoxazine.* Technical Paper. SAMPE. 2018. (50%)
- [s]Donegan, Brady; Grubb, Cecile; [1]Misasi, John. *Degree of cure and its effects on a formulated benzoxazine's flame properties.* Technical Paper. SAMPE. 2018. (75%)
- [s]Hill, Gabriel; [s]Donegan, Brady; Grubb, Cecile; [1]Misasi, John. *The effects of continuous reactive blending on benzoxazine/polyethylene glycol blends*. Technical Paper. SAMPE. 2017. (75%)
- [s]Carpenter, Chris; Grubb, Cecile; [1]Misasi, John. *The effects of reactive diluents on flame properties of benzoxazines.* Technical Paper. SAMPE. 2017. (75%)
- [s]Sealy, Mark; Grubb, Cecile; [2]Misasi, John; Peyron, Mark. *Use of Dynamical Mechanical Testing and Chromatography to Assess the Degree of Cure of Phenolic Prepreg.* Technical Paper. SAMPE. 2017. (10%)

10. Briefly list the most recent professional development activities
    - "Designing Engaging Learning Experiences for Undergraduates". Online webinar describing unique methods for engaging students in the virtual and on-campus classroom. Harvard. 2021.
    - "Blended/Online Bootcamp." Online course to learn pedagogical techniques for online/blended/hybrid teaching. Western Washington University. 2020.
    - "More effective NSF proposals". Grant writing workshop. Western Washington University. Research and Sponsored Programs.
    - SPE Annual Technical Conference Participant, 2011-2021
    - SAMPE Annual Technical Conference Participant, 2011-2021

1. Name: Mark Peyron

2. Education:
   - Ph.D., Chemical Engineering, University of Washington (1994)
   - B.S., Chemical Engineering, University of Idaho (1984)

3. Academic Experience:
   - Associate Professor, Engineering & Design, Western Washington University (WWU) 9/2014 – present
   - Advanced Materials Science and Engineering Center, WWU, 2009 – present.
   - Adjunct Faculty, Chemistry, WWU 2005-2014
   - Substitute Teacher (long-term), Honors Chemistry, Squalicum High School 2007
   - Co-Teacher, Honors/AP Chemistry, Bellingham High School (2006-2007)
   - Research Engineer, Medicinal Chemistry, University of Cambridge (1992-96)

4. Non-Academic Experience:
   - Process Development Engineer, Summit Engineering, Ferndale, WA 2007-08
   - Materials Development Engineer, Amoco, Absorption Corp., (self-employed) 1997-2004
   - Environmental Engineer, Envirosphere Co., Bellevue, WA 1988-1990
   - Process Engineer, Weyerhaeuser Co., Federal Way, WA 1983-1984

5. Certifications or Professional Registrations:
   - Secondary Education Certification, Physics & Chemistry, Western Washington University (2007)

8. Service Activities:
   Western Washington University
   - Scientific Technical Services Advisory Committee, 2015 – present.
   - Scientific Technical Services Advisory Council,
   - Advanced Materials Science and Engineering Center (AMSEC) executive committee member or chair (2018-2021) and numerous AMSEC committees (2015 - present).
   - Scholars Week participant (project supervisor) and/or poster session judge (2011 – 2019).
   - Chemistry Dept. Curriculum Committee (2010-2012)

   Outside of Institution

   - Presentation as part of the Sierra Club Educational Forum: The Truth About Plastics. Talk entitled "*Plastics 101: What's, How's and Where's*". Whatcom Community College, April 2019.
   - Community Advisor, for Bellingham High School student team: Washington State University's Clean Energy and other competitions (2008, 2011, 2015, 2017)
   - Tutor in reading/math for low-achieving students, Bellingham & Seattle, (periodically, 1995 – 2007)

9. Recent Notable Publications:

   Watts, Adam; Peyron, Mark (2022). “MATLAB-Based Combinatorial, Isoconversional Analysis for Characterizing Thermoset Cure Kinetics”. SAMPE (Society for the Advancement of Material and Process Engineering). *Peer-reviewed and accepted; publication delayed because conference was cancelled. Already accepted SAMPE 2022.*

   Cofer, Taylor; Brodhagen, Marion; Peyron, Mark; Zinkgraf, Matthew (submitted 2022). “Biodegradable plastic degradation products alter germination and growth of the toxic fungus Aspergillus”, Submitted to: Plastics in the Environment: Understanding Impacts and Identifying Solutions (Jan. 2022).

   Manos, Nikolas U.; Alindayu Christian; Peyron, Mark (2019). “*Influence of Void Content on the Dielectric Permittivity of 3D Printed Parts*” *The Composites and Advanced Materials Expo (CAMX)*, Sept. 23-26, 2019, Anaheim, CA.

   Seely, Mark; Peyron, Mark; Grubb, Cecile; Misasi, John (2017). “Use of Dynamic Mechanical Testing and Chromatography to Assess the Degree of Cure of Phenolic Prepreg”, *SAMPE Seattle*, May 22-26, 2017, Seattle, WA.

   Peyron, Mark; Gill, David; Grubb, Cecile; Zywiak, Zachary; Anderson, Severn; Hoch, Adam (2016). “Co-Printing Test Specimens as Surrogates for Complex Part Characterization”, *The Composites and Advanced Materials Expo (CAMX)*, Sept. 26-29, 2016, Anaheim, CA

   Miles, Carol; Ghimire, Shuresh; Peyron, Mark; Hayes, Douglas (2015). “Biodegradable Mulch Films & Their Suitability for Organic Agriculture”. *BC Organic Grower*, **18**(4).

   Brodhagen, M.; Peyron, M.; Miles, C.; Inglis, D.A. (2015). “Biodegradable plastic agricultural mulches and key features of microbial degradation”. Applied Microbiology and Biotechnology, DOI 10.1007/s00253-014-6267-5.

   Moore-Kucera, J.; Cox, S.B.; Peyron, M.; Bailes, G.; Kinloch, K.; Karich, K.; Miles, C.; Inglis, D.A.; M. Brodhagen (2014). “Native soil fungi associated with compostable plastics in three contrasting agricultural settings”. Applied Microbiology and Biotechnology, **98**(14) 6467-85. DOI 10.1007/s00253-014-5711-x.

10. Professional Development

    Participant in NSF-funded research C-Core project (WWU, Whatcom Community College and Skagit Valley College) aimed at integrating active learning in higher education STEM classes (2013 – 2016).

    Participant in NSF-funded North Cascades Olympics Science Partnership (NCOSP) to train STEM educators in secondary and primary education (2005, 2006).

1. Name: Stephen D. Sandelin

2. Education
    - Bachelor of Science, Electrical Engineering, Washington State University, 1995.

3. Academic experience
    - Instructor, Engineering & Design Department, Western Washington University, 2012-present.

4. Non-academic experience
    - Product Definer, Maxim Integrated Products, Microcontroller Group, 2005-2012
    - Design Manager, Maxim Integrated Products, Microcontroller Group, 2003-2005
    - Engineer, Dallas Semiconductor, 1999-2000
    - Design Engineer, Dallas Semiconductor, 1997-2000
    - Design Engineer, Advanced Microelectronics, 1996-1997
    - Rifleman, Squad Leader, United States Army, 101st Airborne Division, 1987-1991

5. Certifications or professional registrations

6. Current membership in professional organizations

7. Honors and awards

8. Service activities

9. Most important publications and presentations from the past five years:

10. Most recent professional development activities:

1. Name: Tina Smilkstein

2. Education
    - Ph.D., Electrical Engineering, University of California Berkeley, 2007.
    - M.A., Electrical Engineering University of California – Berkeley, 2003.
    - B.S., Business Administration, Nanzan University, 1989.

3. Academic experience
    - Western Washington University, part-time
        - Instructor, 1/2022-present
    - California Polytechnic State University
        - Associate Professor, 2015-2021
        - Assistant Professor, 2009-2015
    - University of Missouri,
        - Assistant Professor, 2006-2009
    - University of California Berkeley
        - Teaching Assistant, part-time, 1998-2006

4. Non-academic experience
    - Fujitsu Artificial Intelligence Research Center, C-cube Software, 1992-1996
    - Hitachi Chubu Software – Programmer/SE/Translator, 1989-1992
    - Hitachi Chubu Software, Programmer, 1988-1989

5. Certifications or professional registrations
    -

6. Current membership in professional organizations
    - IEEE Engineering in Medicine and Biology Society, current member
    - Society of Women Engineers, current member
    - Institute of Electrical and Electronics Engineers, current member
    - IEEE Solid State Circuits Society, current member
    - Women in Computer Science and Engineering, current member
    - IEEE Technology and Society, current member

7. Honors and awards

8. Service activities

9. Most important publications and presentations from the past five years:

- T. Smilkstein, *Jitter Reduction on High-Speed Clock Signals*, Ph.D. Thesis, University
- of California at Berkeley, 2007 (Advisor: Robert W. Brodersen). (100% contribution).
- T. Smilkstein, *Clocktree Generation for an Automated IC Design Flow*, Master's Thesis,
- University of California at Berkeley, May 2003 (Advisor: Robert W. Brodersen). (100% contribution).
- T. Smilkstein, "The Power of Visibility", 2020 American Society for Engineering Education Pacific Southwest (ASEE PSW) Conference, Conference rescheduled to 2021.
- T. Smilkstein, "Diversity, Equity, and Inclusion Project", 2020 American Society for Engineering Education Pacific Southwest (ASEE PSW) Conference, Conference rescheduled to 2021.
- T. Smilkstein. "A Fully Feedforward Jitter Removal Circuit for Low GHz Applications", in IEEE Dallas Circuits and Systems Conference, Dallas, Texas, October 12-13, 2014. Accepted but not presented.

10. Most recent professional development activities:
    - Intro to Equitable and Inclusive Teaching, 2021 (CalPoly)
    - TIDE (Teaching inclusivity, diversity, and equity), 2020 (CalPoly)

Appendix C
Equipment

Manufacturing Engineering Equipment List **Date Updated: Steve James 5-16-2022**

Room	**Category**	**Equipment Name**	**Notes:**
ET 134	Machinging	OMAX 60x60 waterjet	
ET 135	Hot metals lab	Thermal Dynamics - Plasma Torch	
		Hobart - Tig Welder	
		TorchMate - CNC Cutting table	
ET 136	Machining	Enterprise | Lathe | EL2/642	
		Enterprise | Lathe | EL2/668	
		Enterprise | Lathe | EL2/643	
		Enterprise | Lathe | EL2/676	
		Enterprise | Lathe | EL2/645	
		Enterprise | Lathe | EL2/644	
		Clausing | Lathe| 15"	
		Clausing | Lathe|1300	
		Rambaudi | Mill | V2	
		Bridgeport | Mill | Series 1/ 71869-2	
		Fabor | Digital Readout | 20i-M, sn 6080001 13090253	
		Universal Robot | Robot | UR5e/ 20215501142	
		Clausing | Drill Press | 2276/517107	
		Clausing | Drill Press | 2276/517106	
		SNAP DM200 | Video Measurement Stystem | SFD200L1053	
		Haas | CNC Mill | Mini Mill/30160	
		Haas | CNC Mill | Mini Mill/23943	
		Haas | CNC Mill | Mini Mill/24040	
		Haas | CNC Mill | VF2/18195	
		Marvel | Vertical Band Saw | Series 81 / E-313588	
		Taft-Peirce | Surface Grinder | ST-10Y / 3105988	
		Haas | Turning Center | ST-10Y / 3105988	
		Haas | Machining Center | VF-2TR / 1132168	
		Miller | Wire welder |Millermatic 135 / (N/A)	

		Miller | Arc Welder | CP-200 / HK265049	
		Deckel | Tool Grinder | 87/6363	
		Delta-Rockwell | Combination Disc/Belt Sander-grinder | 102-8179	
		Haas | Lathe | SL-10T / 65162	
		Haas | Machining Center | VF1 / 27614	
ET 138	Robotics Cell	ReThink Robotics | Baxter Robot	
		Epson | SCARA Robot	
		Epson |6DOF Robot	
		Epson | 6DOF UR5e Robot	
		Flexlink | 1m conveyor belt	
		Flexlink | 2.5m conveyor belt	
		Cognex | camera (2)	
		6 HMI touch panels (5.6" Redlion 306)	
		6 PLC (16 IO - Allan Bradley Micrologix 1100)	
		1 HMI touch panel (15" Allen Bradly)	
ET 139	Metrology	Brown & Sharpe PFX | CMM	
		Hexagon Metrology | Controller	
		Brown & Sharpe | Controller	
		Brown & Sharpe GAGE 2000 | CMM	
		Faro Arm | Portable CMM	
		Mitutoyo | Digimatic Height Gauge	
		Mitutoyo | Profilometer (2)	
ET 140	3D Print Lab	Digital Microscope DMS300	
ET 155	Project Lab	Republic Lagun | Manual Mill	
		Clausing | Manual Lathe	
		Clausing | Manual Lathe	
		HAAS | CNC Mill	
		HAAS | CNC Lathe	
		Metal Mizer | Vertical Roll-in Band Saw	
		Pexto | Jump Shear	
		Pexto | Finger Brake	

		Pexto | Rolls	
		Pexto | Notcher	
		American | Lathe	
		Darex | Drill Sharpener	
		Enco | Vertical Band Saw	
		Baileigh | Manual Iron Worker	
ET 152	Project Bays	Land-Sea Dyno | Rolling Dyno Pro 500 Auto chassis	
		Superflo | Engine Dyno | SF 901	
		Dake | 75 ton press | Elec -Draulic90(5-075)4	
ET 304	Robotics/Automation	Fanuc | Robot | LR Mate 200i	
		Fanuc | Robot | LR Mate 200ic	
		Fanuc | Delta Robot | M-1iA	
		Denso | 6 Axis Robot (2)	
		Denso | Scara Robot (2)	
		Stratasys | FDM part washer | wavewash WW00215	
		Fanuc | Robot | LR Mate 200iD (2)	

Appendix D
Institutional Summary

1. The Institution

a. Western Washington University
516 High Street
Bellingham, WA 98225

b. Dr. Sabah Randhawa, President

c. Dr. Sura Al-Qudah, Program Director Manufacturing Engineering

d. Western Washington University is accredited by the Northwest Commission on Colleges and Universities (NWCCU), one of the eight agencies recognized by the U.S. Department of Education as a national accrediting body. The initial NWCCU accreditation was granted in 1921, and the accreditation status was last confirmed in 2017; the university is scheduled for its next evaluation by NWCCU during the 2024-2025 academic year.

Further information about the institution's national accreditation and other specialized program accreditation can be found at the following website: https://www.wwu.edu/accreditation/.

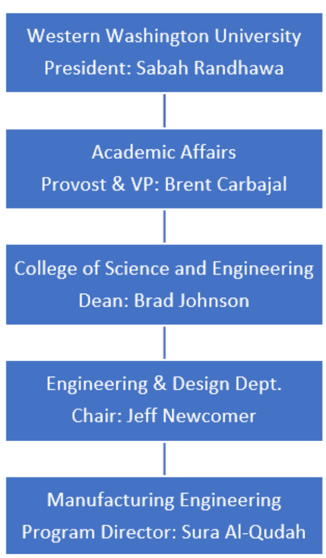
2. Type of Control

Western Washington University is a state, 4-year, comprehensive University.

3. Educational Unit

The Electrical & Computer Engineering program is one of four programs in the Engineering & Design Department. The other three programs are Manufacturing Engineering, Plastics and Composites Engineering, and Industrial Design.

The following chart shows the administrative chain of responsibility:



4. **Academic Support Units**

Chemistry
Chair, Dr. P. Clint Spiegel

Computer Science
Chair, Dr. Filip Jagodzinski

English
Chair, Dr. Kathryn Vulic

Mathematics
Chair, Dr. David Hartenstine

Physics & Astronomy
Chair: Dr. Janelle Leger

5. **Non-academic Support Units**

Western Libraries
Dean of Libraries: Mark Greenberg

University Information Technology
Vice Provost for Information Technology and Chief Information Officer: Chuck Lanham

College Information Technology
Director of Network Computer Services: Todd Epps

Career Services Center
Director: Effie Eisses

University Accreditation, Assessment, Faculty Development, Teaching and Learning Resources
Vice Provost for Undergraduate Education: Dr. Jack Herring

Office of Research and Sponsored Programs
Vice Provost for Research: Dr. David Patrick

Admissions Office
Dir. of Admissions: Cezar Mesquita

Registrar's Office
Interim Registrar: Shelli Soto

Disability Access Center
Dir. DAC and Dep. ADA Coordinator: Josef Mogharreban

Civil Rights and Title IX Compliance
Dir. of Civil Rights and Title IX Compliance: Daniel Records-Galbraith

6. Credit Unit

Western Washington University is on the quarter system. Each quarter is ten weeks excluding Finals week. All Engineering programs require courses in Fall, Winter, and Spring quarters. Summer quarter attendance is not required to meet program requirements.

In the Engineering and Design Department one quarter credit represents one class hour or two laboratory hours per week.

Table D-1. Program Enrollment and Degree Data

Manufacturing Engineering

	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current 2021-22		FT	44	20	25	17		106			16		
		PT											
1 year prior to current 2020-21		FT	30	27	28	17		102			29		
		PT											
2 years prior to current 2019-20		FT	31	31	26	28		116			27		
		PT											
3 years prior to current 2018-19		FT	42	32	30	28		132			25		
		PT											
4 years prior to current 2017-18		FT	35	38	32	22		127			10		
		PT											

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the on-site visit.

FT—full-time
PT—part-time

Table D-2. Personnel

Manufacturing Engineering

2021-2022

	HEAD COUNT		FTE[2]
	FT	PT	
Administrative[2]	0	2	0.334
Faculty (tenure-track)[3]	5	0	4.833
Other Faculty (excluding student Assistants)	6	0	1.00
Student Teaching Assistants[4]	0	0	0.0
Technicians/Specialists	3	0	1.5
Office/Clerical Employees	3	0	0.75
Others[5]			

Appendix E
Assessment Tools and Evaluation Schedules

Appendix E.1
a-k Assessment Rubrics

(a) an ability to apply knowledge of mathematics, science, and engineering to solving problems in manufacturing engineering

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**define the problem and outline a strategy to solve it**	Does not define the problem or outline a road map	Attempts to define the problem and solving strategy but not completely	Supplies a basic definition of the problem and a simple strategy to solve it	Defines the problem completely and lays out a complete road map to solve it
2	**include visual sketches to describe the physical situation given in the problem**	Does not include visual sketches/models or describe physical situation given in the problem	Visual sketches/models and description of the physical situation are incomplete	Visual sketches/models and description of the physical situation are complete most of the time	Complete visual sketches/models and description of the physical situation are always given
3	**develop appropriate equations required to solve problems**	Is incapable of developing required equations	Does list some of the required equations	Is able to develop necessary equations most of the time	Is always able to develop the equations and justify them
4	**use correct mathematical tools to solve the generated equations**	Is not able to solve the equations or use mathematical tools correctly	Uses correct mathematical tools but does not get correct answers usually	Solves the equations using appropriate mathematical tools and gets correct answer most of the time	Uses appropriate mathematical tools and gets correct answer every time
5	**use knowledge of engineering to verify solutions and/or discuss them**	Cannot verify solution and/or discuss it	Verifies and/or discusses part of the solution	Verifies the solution and/or discusses it logically most of the time	Always verifies the solution and/or has a valid explanation

(b) an ability to design and conduct experiments and to analyze and interpret data within a manufacturing context

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**select and operate appropriate process equipment and instruments to perform necessary experiments. (lab-based classes only)**	Unprepared for lab; does not operate instruments and process equipment properly; requires excessive supervision.	Generally follows proper lab procedures; requires significant supervision to operate instruments and process equipment.	Attentive to safety procedures and proper operation of instruments and process equipment; requires little supervision.	Very prepared and organized; attentive to safety procedures and proper operation of instruments and process equipment; requires minimal supervision.
2	**apply appropriate experimental design principles.**	Design of experiments is inadequate.	Planned experiments are not complete.	Experimental design is fairly complete.	Experimental design is complete.
3	**apply appropriate statistical analyses to produce professional quality technical work.**	Statistical analysis is incomplete or applied incorrectly.	Statistical analysis is fairly complete; Reporting of analysis is not professional quality.	Data analysis is fairly complete; professional presentation could be improved.	Statistical analysis of data is thorough; data are presented in a meaningful and professional manner.
4	**form conclusions based on empirical evidence and to compare these with researched information or theoretical models.**	Conclusions are incorrect or poorly justified. Presentation of data and results lacks depth and/or is not compared to researched literature.	Data and results are generally, interpreted correctly, but written descriptions lack sufficient depth and/or are not compared sufficiently with researched literature.	Conclusions are fairly well supported by empirical data; depth of data analysis is acceptable; results are compared to some literature.	Results are thoroughly and correctly interpreted and presented; conclusions are supported by appropriate literature sources.

(c) an ability to design products, and to design or select the processes, equipment, tooling, and systems necessary for their manufacture to desired specifications

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**identify and follow a logical and orderly design process.**	No discernable effort made to identify or follow a procedure. Haphazard approach taken.	Requires significant guidance in identifying, understanding and following a proper procedure.	Needs some minimal help in identifying the procedure, understanding steps and staying on track.	Works independently throughout. Correctly identifies the procedure and executes with a high level of understanding.
2	**create quantified goals that include both targets and constraints.**	Cannot Develop a complete List of Objectives, Functions, or Constraints	Cannot Quantify Objectives, Functions, or Constraints into Specifications	Partially Quantifies Objectives, Functions, or Constraints into Specifications	Quantifies and Justifies Every Appropriate Objective, Function, and Constraint into a Specification
3	**systematically develop, compare and rank design alternatives to arrive at a final solution.**	Only considers one design option.	Several alternatives are developed. But a systematic comparison and ranking has not been attempted or is poorly justified.	A systematic comparison and ranking of alternatives have been performed. Some dispute about final solution may exist.	A systematic comparison and ranking of alternatives have been performed. Final solution is undisputed.
4	**create a final solution that satisfies all requirements and constraints identified in formulating the design problem.**	Identification of requirements and constraints in formulating the problem is missing or inadequate.	The final solution does not satisfy many of the design problem's requirements and constraints.	The final solution satisfies most though not all of the design problem's requirements and constraints.	The final solution satisfies all of the design problem's requirements and constraints.
5	**justify design decisions using analyses based on appropriate engineering and/or scientific principles.**	No analysis of design decisions performed.	Applies principles incompletely or incorrectly in many cases. Some decisions are not justified.	Applies principles correctly for major design decisions. One or two minor decisions may be overlooked.	Consistently applies the correct principles in justifying all decisions.

(d) an ability to function on multidisciplinary teams

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**negotiate and resolve differences with the other teammates to reach effective solutions**	Is a major contributor to indecision within the team and is unable to take steps to resolve differences.	Is not a major contributor to indecision, but has difficulties helping the team negotiate and resolve differences.	Is always a willing and compromising participant to efforts aimed at helping the team reach consensus.	Is willing to take the lead and is extremely effective in guiding the team through negotiations that resolve differences.
2	**complete assigned duties in a timely fashion**	Fails to complete any assigned task on schedule.	Inconsistent in completing assigned tasks on schedule.	Completes most of the assigned tasks on schedule.	Completes all tasks on time or ahead of schedule.
3	**share in the work of the team**	Always relies on others to do the work	Rarely does the assigned work – often needs reminding	Usually does the work assigned – rarely needs reminding	Always does the assigned work without having to be reminded
4	**listen and contributing to other teammates**	Is always talking – never allows anyone else to speak	Usually doing most of the talking – rarely allows others to speak	Listens most of the time	Consistently listens and responds to others appropriately

(e) an ability to identify, formulate, and solve engineering problems

	performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**identify problems with a quantifiable solution that can be approached systematically.**	Cannot identify any of the key problem elements	Identifies only some the key problem elements	Identifies the key problem elements	Identifies all of the problem elements
2	**Select appropriate methods and techniques for solving the problem.**	Selects a method/technique that is inappropriate for the problem	Selects a method/technique that is appropriate, but not optimal for the problem	Selects a method/technique that is appropriate and efficient for the problem	Considers multiple options and selects the method(s)/technique(s) that is optimal for the problem
3	**Correctly formulate the problem according to chosen solution method**	Cannot properly set up necessary equations and/or analyses	Properly sets up some, but not all necessary equations and/or analyses	Properly sets up necessary equations and/or analyses with minor errors	Properly sets up necessary equations and/or analyses without errors
4	**Select appropriate values, ranges and bounds for variables and correctly use these in the formulation to obtain a solution.**	Selects values, ranges, and bounds for variables that are unrelated to realistic conditions for the problem.	Selects values, ranges, and bounds for variables that are somewhat related to realistic conditions for the problem.	Selects values, ranges, and bounds for variables that are realistic conditions for the problem, but are not optimal.	Selects values, ranges, and bounds for variables that are optimal for a realistic analysis of the problem.

(f) an understanding of the professional and ethical responsibilities of an engineer

Performance Indicator (Student has the ability to …..)	**Unsatisfactory**	**Developing**	**Satisfactory**	**Exemplary**
identify important information in an ethical dilemma	Student Ignores Important Facts	Student Identifies Some Facts	Student Identifies all Important Facts	Student Identifies Unknown Facts and Uses their Own Expertise to Add Appropriate Information
meaningfully participates in In-Class Discussions and Exercises on Ethics and Professionalism	Student does not participate or complete exercises on ethics and professionalism	Student input into the discussion and exercises demonstrates a limited understanding.	Student input into the discussion and exercises demonstrates an adequate understanding.	Student input into the discussion and exercises demonstrates a full understanding.

(g) an ability to communicate effectively

Performance Indicator (Student has the ability to communicate …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
making effective use of available methods and tools	Fails to identify and make proper use of available methods and tools.	Better methods and tools are available, or use of the ones selected is ineffective.	The choice of methods and tools is appropriate, but improvements are possible in their use.	Selection and use of methods and tools is highly effective.
in an organized and concise manner	Haphazard and random. Lacks brevity and ease of comprehension.	Some structure. Weak in logic, brevity, and ease of comprehension.	Small improvements in structure, logic, brevity, and ease of comprehension are possible.	Structure enhances readers understanding. Logic is highly sound. To the point and easy to comprehend.
with professionalism including grammar, spelling and usage	Presentation lacks professionalism and demonstrates weak language skills.	Either the presentation lacks professionalism, or weak language skills are evident, but not both.	Presentation is professional, but there is room for small improvements in language skills.	Highly professional in all aspects, with a strong command of the language skills.
using content and style appropriate to the audience.	Both content and style are highly inappropriate.	Either the content or style is inappropriate, but not both.	Both the content and style are appropriate, but improvements are needed to improve the connection with the audience.	The content and style are ideally suited to engaging the target audience.

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
Analyze an engineering solution to determine the global, societal, economic, and environmental impact	Cannot analyze a solution to find any impact on the global, societal, economic, or environment	Can analyze an engineering solution to express impact to only one area of global, environmental, societal, or economic impact	Can analyze engineering solutions to express the impact on at least two areas (global, environmental, societal, economic)	Can analyze engineering solutions to show impact in all areas (global, environmental, societal, economic)
Student Participates in In-Class Discussions and Exercises on the impact of engineering solutions in a global, economic, environmental, and societal context	Student does not participate or complete exercises on the impact of engineering solutions in a global, economic, environmental, and societal context	Students participates in in-class discussions and completes exercises on the impact of engineering solutions in a global, economic, environmental, and societal context less than 50% of the time	Student participates often in in-class discussions and completes exercises on the impact of engineering solutions in a global, economic, environmental, and societal context correctly most of the time	Student always participates in In-class discussions and completes the impact of engineering solutions in a global, economic, environmental, and societal context Correctly
Perform well in humanity, social sciences and comparative gender and multicultural studies courses to satisfy the general university requirements (based on GPA)	under 1.5	1.5-2.5	2.5-3.5	Over 3.5

(i) a recognition of the need for, and an ability to engage in life-long learning

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**recognize the need to seek additional information.**	Does no background research.	Does background research for some major areas of the project.	Does background research for most major areas of the project.	Does background research for all major areas of the project.
2	**find relevant and useful additional information.**	Finds only unverified internet resources.	Finds verifiable and relevant internet resources.	Finds verifiable and relevant resources from multiple sources, including, but not limited to the internet.	Finds multiple verifiable and relevant sources for multiple parts of the project from multiple sources, including, but not limited to the internet.
3	**successfully integrate additional information.**	Is not able to use additional information found to inform project.	Is able to recognize new material as relevant to project but does not fully integrate or synthesize new information.	Uses pieces of new information to inform project, but does not fully synthesize new information.	Synthesizes new information and uses it to inform project.

(j) a knowledge of contemporary issues

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**identifies valid contemporary issues**	Unable to identify a contemporary Issue	Able to acknowledge a contemporary issue	Able to identify few contemporary issues	Able to identify many contemporary issues
2	**seeks multiple sources of information on the issue**	Only 1 source reviewed	Limited sources or types of resources used (3)	Adequate number of sources and types (5)	Extensive use of a variety of resources in a variety of formats
3	**discerns the credibility of the resources**	Cannot discern if the resource is credible	Discerns the credibility of a few resources	Discerns the credibility of many of the resources	Always discerns the credibility of the resource
4	**integrates the information into a nuanced argument**	Cannot integrate information into a nuanced argument (only black & white)	Can integrate a small amount of the information into a nuanced argument	Can integrate a portion of the information into a nuanced argument	Integrates all information into a nuanced argument

(k) an ability to use and practical experience with the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**apply technology in design.**	Demonstrates lack of preparation, ability, and understanding to use technology in the design process. Student requires significant supervision; models contain significant errors.	Understands basic use of technology for design; requires some supervision and assistance to create feasible product or process designs which may contain multiple minor errors.	Skillfully uses technology for design with little need for assistance or supervision, creates designs with few errors.	Uses capabilities technology to achieve superior design results; assists other students in the use of technology and is self-motivated in seeking and using advanced capabilities of the tools.
2	**apply technology in analysis or simulation.**	Analysis/simulation tools incorrectly applied, models may have significant errors and show lack of understanding, thought, or effort in evaluation of computational results.	Analysis/simulation planning and execution contain some errors but show application of basic understanding, thought, or effort in the evaluation of computational results.	Analysis/simulation planning and execution achieve meaningful results.	Analysis/simulation is utilized to achieve superior engineering solution with sufficient analysis of results to understand sensitivities and limitations.
3	**demonstrate use of technology in the realization of a product or process.**	Realized product or process does not demonstrate effective use of technology. Technology usage requires constant supervision or may not have been done safely.	Realized product or process shows some effectiveness to use of technology. Student generally follows proper procedures but may require significant supervision. Result is usable but has errors if not corrected by others beforehand.	Realized product or process demonstrates effective use of technology. Student is attentive to procedures, requires little supervision. Result is functional with few minor errors.	Realized product or process shows superior results demonstrating the use of technology. Student is very attentive to safety procedures, requires minimal supervision, helps other students, or conceives process improvements.
4	**demonstrate use of technology in measuring or evaluating the efficacy of the designed product**	Technology is not used, and no plan is conceived for how technology might be used to measure of	Technology is proposed or implemented for measurement of design efficacy, but technology selection is	Appropriate technology is proposed for a measurement of design efficacy.	Appropriate technology is utilized to measure design efficacy resulting in meaningful evaluation of the

	or process to satisfy goals.	evaluate design efficacy.	mismatched to the evaluation.		design process and its results.

Appendix E.2
Mapping of a-k and new 1-7 rubrics

Current Language **EAC Criteria effective 2017-18 and 2018-19 Cycles**	**New Language** **Approved by the EAD October 20, 2017** **Applicable beginning in the 2019-20 cycle**
Criterion 3. Student Outcomes The program must have documented student outcomes that prepare graduates to attain the program educational objectives. Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.	**Criterion 3. Student Outcomes** The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.
(a) an ability to apply knowledge of mathematics, science, and engineering (e) an ability to identify, formulate, and solve engineering problems	1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(d) an ability to function on multidisciplinary teams	5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
(f) an understanding of professional and ethical responsibility (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (j) a knowledge of contemporary issues	4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
(g) an ability to communicate effectively	3. an ability to communicate effectively with a range of audiences
(i) a recognition of the need for, and an ability to engage in life-long learning	7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	Implied in 1, 2, and 6

Appendix E.3
1-7 Rubrics

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (a, e), (k implied)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**identify appropriate principles of engineering, science and mathematics needed to solve a complex engineering problem.**	Fails to identify any of the principles that are relevant to solving the problem.	Fails to identify one or more major principles which will prevent proper formulation of the problem.	Identifies all major principles, though a minor misinterpretation will result in an incorrect solution to the problem.	Correctly identifies all relevant principles needed to format and solve the problem.
2	**formulate a complex engineering problem using appropriate visual abstractions that capture the physical situation.**	Fails to include a visual abstraction needed for the formulation.	Fails to include important details or provide sufficient clarity in the visual abstraction needed for the formulation.	Includes required information though clarity can be improved in the visual abstraction needed for the formulation.	Correctly and clearly includes all required information in the visual abstraction needed for formulation.
3	**formulate a complex engineering problem using appropriate mathematical equations that capture the physical situation.**	Fails to develop any mathematical equations needed for the formulation.	Fails to fully develop the mathematical equations needed for the formulation.	Develops fully the mathematical equations needed for the formulation though with minor errors.	Correctly and fully develops all mathematical equations needed for the formulation.
4	**solve a complex engineering problem utilizing appropriate mathematical methods and available technologies.**	Fails to apply any method or available technology to solve the problem.	Fails to utilize the most appropriate mathematical methods and available technologies arriving at an incorrect solution.	Utilizes an appropriate mathematical method or available technology but does not arrive at the correct solution.	Correctly utilizes the most appropriate mathematical method or available technology to arrive at the correct solution.

5	**evaluate a derived solution to verify its veracity and explain inconsistencies and discrepancies when they occur.**	Fails to perform any evaluation of a derived solution for veracity.	Fails to provide any explanations for inconsistencies and discrepancies found when evaluating a solution.	Verifies the veracity of a solution but explanations for inconsistencies and discrepancies need to be better articulated.	Correctly verifies the solution and provides clear and accurate explanations for any inconsistencies and discrepancies that have occurred.
6	**apply the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice**	Fails to produce correct results even with repeated guidance in the choice and application of a technique, skill or technology.	Produces correct results but often requires guidance in the choice and application of the most appropriate technique, skill or technology.	Independently produces correct results but improvements can be made in the choice and application of the most appropriate technique, skill or technology.	Independently produces superior results by consistently applying the most appropriate choice of technique, skill or technology.

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors (c), (k implied)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**execute a logical and orderly design process to arrive at a solution.**	Fails to execute a logical and orderly design process.	Omits or improperly executes a major step of the design process.	Executes each step of the design process but improvements in the logic and order applied are possible.	Executes each step of the design process in a logical and orderly fashion.
2	**identify and quantify relevant customer requirements that include both performance targets and realistic constraints.**	Fails to identify and quantify relevant customer requirements.	Identifies most relevant customer requirements but does not adequately quantify the majority of these.	Identifies all relevant customer requirements but improvements are possible in how some have been quantified.	Identifies and meaningfully quantifies all relevant customer requirements.
3	**identify and attempt to integrate consideration of public health, safety and welfare into the final solution.**	Fails to identify any public health, safety and welfare considerations.	Identifies some important public health, safety and welfare considerations but does not integrate any into the final solution.	Identifies all important public health, safety and welfare considerations and integrates some of these into the final solution.	Identifies all important public health, safety and welfare considerations and broadly integrates these into the final solution.
4	**identify and attempt to integrate consideration of global, cultural, social, environmental, and economic factors into the final solution.**	Fails to identify any global, cultural, social, environmental, or economic considerations.	Identifies some important global, cultural, social, environmental, or economic considerations but none are integrated into the final solution.	Identifies all important global, cultural, social, environmental, or economic considerations and integrates some of these into the final solution.	Identifies all important global, cultural, social, environmental, or economic considerations and broadly integrates these into the final solution.

5	**create a final solution that satisfies all requirements identified in formulating the design problem.**	Fails to create a final solution that meets any of the identified requirements.	Creates a final solution but does not meet several important requirements.	Creates a final solution that meets most of the important requirements that have been identified.	Creates a final solution that meets all of the important requirements that have been identified.

3. an ability to communicate effectively with a range of audiences (g)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**make effective use of available communication methods and tools**	Fails to identify and make proper use of available methods and tools.	Better methods and tools are available, or use of the ones selected is ineffective.	The choice of methods and tools is appropriate, but improvements are possible in their use.	Selection and use of methods and tools is highly effective.
2	**communicate in an organized and concise manner**	Haphazard and random. Lacks brevity and ease of comprehension.	Some structure. Weak in logic, brevity and ease of comprehension.	Small improvements in structure, logic, brevity and ease of comprehension are possible.	Structure enhances readers understanding. Logic is highly sound. To the point and easy to comprehend.
3	**communicate with professionalism including, proper usage of grammar, correct spelling, and adherence to relevant standards.**	Lacks professionalism and demonstrates poor grammar and spelling; Ignores all relevant standards	Lacks professionalism, or demonstrates poor grammar and spelling, but not both; Usage of relevant standards is incomplete and with major errors.	Professionalism is adequate, but there is room for small improvements in grammar and spelling; All relevant standards have been used with some minor errors present.	Highly professional in all aspects, with a strong command of grammar and spelling; All relevant standards are applied without error.
4	**communicate using content and style appropriate to the audience.**	Both content and style are highly inappropriate.	Either the content or style is inappropriate, but not both.	Both the content and style are appropriate, but improvements are needed to improve the connection with the audience.	The content and style are ideally suited to engaging the target audience.

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts (f, h, j)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**recognize and articulate ethical and professional responsibilities in engineering situations**	Consistently fails to recognize or practice ethical and professional responsibilities	Recognizes and practices only the important ethical and professional responsibilities and is unable to articulate the ethical reasoning that guides behavior.	Occasionally fails to recognize or practice an ethical and professional responsibilities, occasionally cannot articulate the proper ethical reasoning that guides behavior.	Recognizes and practices all ethical and professional responsibilities, can always clearly articulate the ethical reasoning that guides behavior.
2	**gather, validate and analyze information from multiple relevant sources, on the potential impact of an engineering solution**	Fails to gather meaningful information from any relevant sources.	Significant information sources have been overlooked, and the validation, analysis or both are missing or weak.	In-depth validation and analysis has been completed on some relevant sources, but other important sources have been overlooked.	Information has been gathered from a broad set of relevant sources, validation and analysis has been completed and is of a high quality.
3	**make informed judgements supported by analysis of the societal and global impact of engineering solutions**	Fails to offer any informed judgements of the societal and global impact.	Judgements are made but are either incorrect or poorly supported by the analysis provided.	Judgements are correct and to a large extent supported by the analysis, but the rationale presented could be stronger.	Judgements are correct and a strong rationale is presented that is clearly supported by the analysis.
4	**make informed judgements supported by analysis of the economic and environmental impact of engineering solutions**	Fails to offer any informed judgements of the economic and environmental impact.	Judgements are made but are either incorrect or poorly supported by the analysis provided.	Judgements are correct and to a large extent supported by the analysis, but the rationale presented could be stronger.	Judgements are correct and a strong rationale is presented that is clearly supported by the analysis.

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (d)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**function effectively in providing team leadership.**	Fails to demonstrate any leadership abilities.	Demonstrates leadership abilities only as part of a shared responsibility.	Demonstrates independent leadership skills.	Demonstrates both strong independent leadership skills and the ability to delegate responsibilities to others.
2	**promote a collaborative and inclusive environment that supports effective teamwork.**	Demonstrates attitudes that obstruct collaboration and that exclude contributions from other team members.	Demonstrates tendencies to want to work alone and is reluctant to accept contributions from other team members.	Willingly collaborates on assigned team activities and is receptive to the contributions of others.	Actively encourages collaboration and contributions from all team members across all team activities.
3	**share in planning and setting goals for the team.**	Lacks knowledge of the team's plan and goals.	Is knowledgeable of the plan and goals but contributes little to developing them.	Willingly participates in planning and goal setting.	Assumes responsibility for planning and goal setting.
4	**share in the work of the team.**	Always rely on others to do the work	Rarely does the assigned work – often needs reminding	Usually does the work assigned – rarely needs reminding	Always does the assigned work without having to be reminded
5	**complete assigned tasks in a timely fashion**	Fails to complete any assigned task on schedule.	Inconsistent in completing assigned tasks on schedule.	Completes most of the assigned tasks on schedule.	Completes all tasks on time or ahead of schedule.

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (b), (k implied)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**select and operate appropriate process equipment and instruments to perform necessary experiments. (lab-based classes only)**	Unprepared for lab; does not operate instruments and process equipment properly; requires excessive supervision.	Generally follows proper lab procedures; requires significant supervision to operate instruments and process equipment.	Attentive to safety procedures and proper operation of instruments and process equipment; requires little supervision.	Very prepared and organized; attentive to safety procedures and proper operation of instruments and process equipment; requires minimal supervision.
2	**Develop an experiment plan (understand the driving question, define key variables, select the appropriate process equipment, define data collection procedure)**	Missing driving question, missing key variables, missing experiment plan, no clear data collection procedure	Vague driving question, limited key variables, unclear experiment plan, unclear data collection procedure	Adequate driving question, almost all key variables are identified, clear experiment plan, clear data collection procedure	well understanding of driving question, all key variables are identified, Detailed experiment plan, detailed data collection procedure
3	**Conduct appropriate data collection on the appropriate variables**	Data collected have significant errors or mistakes, Data are collected for variables that are not part of the experiment, missing data	Data collected have many errors or mistakes, some Data sets are collected for variables that are not part of the experiment, limited data collection	Data collected are adequate (accuracy), Data are collected for variables that are part of the experiment, Data collected covers almost all of the key variables	Data collected are carefully stratified and tabulated (accuracy), thorough data collection for variables that are part of the experiment , Data collected covers all of the key variables

4	**Analyze and interpret experimental data and results with respect to the driving question and any other appropriate theoretical models**	No data analysis or comparisons are conducted to draw conclusions	Week data analysis or comparisons are conducted to draw conclusions	Adequate data analysis or comparisons are conducted to draw conclusions	Thorough and detailed data analysis or comparisons are conducted to draw conclusions
5	**form conclusions based on empirical evidence and compare these with the theoretical models**	Conclusions are incorrect or poorly justified. Presentation of data and results lacks depth and/or is not compared to researched literature, where relevant.	Data and results are generally, interpreted correctly, but written descriptions lack sufficient depth and/or are not compared sufficiently with researched literature, where relevant.	Conclusions are fairly well supported by empirical data; depth of data analysis is acceptable; results are compared to some literature, where relevant.	Results are thoroughly and correctly interpreted and presented; conclusions are supported by appropriate literature sources, where relevant.

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies (i)

	Performance Indicator (Student has the ability to …..)	Unsatisfactory	Developing	Satisfactory	Exemplary
1	**to identify relevant sources of new knowledge.**	Makes no effort to seek out relevant sources.	Conducts a background study but fails to identify and verify any relevant sources.	Background study identifies and verifies most but not all relevant sources.	Background study is comprehensive in identifying and verifying all relevant sources.
2	**use an appropriate learning strategy to acquire new knowledge.**	Is unable to demonstrate learning from a verified source.	The adopted strategy leads to superficial or improper learning.	The adopted strategy leads to learning that is adequate for the need.	The adopted strategy leads to mastery of the new knowledge.
3	**apply newly acquired knowledge to problem solving.**	Is unable to apply newly acquired knowledge to problem solving.	The newly acquired knowledge is partially or incorrectly applied leading to erroneous results and conclusions.	The newly acquired knowledge is correctly applied, but veracity of results and conclusions need further verification.	The newly acquired knowledge is correctly applied and results and conclusions verified.

Appendix E.4

Assessment Schedule

Prog	Course #	Course Name	1					2						3				4				5					6					7		
		Outcome / Performance Indicator	1	2	3	4	5	1	2	3	4	5	6	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4	5	1	2	3
MFGE	4xx	Course Name																																
MFGE	493	Manufacturing Project Implementation				?	?	?	?	?	?	?	?																					
														?	?	?	?																	
																		?																
																						?	?	?	?	?								
																											?	?	?	?	?			
MFGE	492	Manufacturing Project Definition		?	?									P	P	P	P																	
																						?	?	?	?	?								
																																?	?	?
MFGE	491	Project Research, Planning and Ethics	?					?	?	?	?	?	?																					
																		P	P	P	P													
MFGE	365	Machine Design	?	?	?	?	?																											
								?	?	?	?	?	?																					
MFGE	463	Design of Tooling						?	?	?	?	?	?																					
														P	P	P	P										p	p	p	p	p			
MFGE	454	Systems Integration																																
MFGE	453	Industrial Robotics	?	?	?	?	?																											
MFGE	434	Advanced CAM and CNC																																

Prog	Course #	Course Name	F21	W22	S22	F22	W23	S23	F23	W24	S24	Primary	Secondary
			SLO 1-7 and Course Review Term									Responsible Faculty	
MFGE	4xx	Course Name											
MFGE	493	Manufacturing Project Implementation									D+R	Yip-Hoi	Alqudah
					D								
					D								
								D					
											D		
MFGE	492	Manufacturing Project Definition		D+R								Newcomer	Yip-Hoi
							D						
							D						
MFGE	491	Project Research, Planning and Ethics							D			Yip-Hoi	Alqudah
			D+R										
MFGE	365	Machine Design							D+R			Algeddawy	Gill
									D				
MFGE	463	Design of Tooling	R						D			Gill	Newcomer
			D										
MFGE	454	Systems Integration										Algeddawy	Newcomer
MFGE	453	Industrial Robotics		R						D		Algeddawy	Newcomer
MFGE	434	Advanced CAM and CNC					R			D		Gill	Yip-Hoi
MFGE	381	Manufacturing Process Planning						R				Alqudah	Newcomer
PCE	372	Introduction to Composites Materials and Processes					R					Larson	Misasi
PCE	371	Introduction to Plastics Materials and Processes							R			Misasi	Larson
MFGE	462	CAD Modeling and Analysis Using Surface (elective)								R		Yip-Hoi	
MFGE	454	Systems Integration (elective)										Algeddawy	
MFGE	434	Advanced CAM and CNC (elective)					R					Gill	Yip-Hoi
MFGE	365	Machine Design							R			Algeddawy	Gill
ENGR	352	Introduction to Automation and Controls									R	Lund	Algeddawy
ENGR	351	Electronics for Engineering				R						Lund	Newcomer
MFGE	250	Introduction to Manufacturing Automation					R					Newcomer	Algeddawy
PCE	342	Data Analysis and Design of Experiments			R							Peyron	Alqudah
MFGE	341	Quality Improvement								R		Alqudah	Peyron
MFGE	340	Numerical Methods for Engineers									R	Yip-Hoi	
MFGE	333	Design for Manufacture		R								Alqudah	Yip-Hoi
MFGE	332	Introduction to CAM and CNC								R		Gill	Yip-Hoi
MFGE	261	Introduction to Computer Aided Design			R							Yip-Hoi	Algeddawy
MFGE	250	Introduction to Manufacturing Automation					R					Newcomer	Algeddawy
MFGE	231	Introduction to Manufacturing Processes			R							Gill	Yip-Hoi
ENGR	225	Mechanics of Materials				R						Davishal	Algeddawy
ENGR	214	Statics						R				Davishal	Newcomer
ENGR	170	Introduction to Materials Science and Engineering								R		Peyron	Davishal
ENGR	115	Innovation in Design							R			Davishal	Hoekstra
ENGR	101	Engineering Design & Society							R			Davishal	Hoekstra

P Assessment completed and target has been met.
? Assessment has yet to be completed for this cycle.
N Assessment has been completed but target have been missed.

D Data collection term for SLO 1-7 assessment and evaluation
D+R Data collection term for both SLO 1-7 assessment and Course Review

Appendix E.5
Course Review Schedule

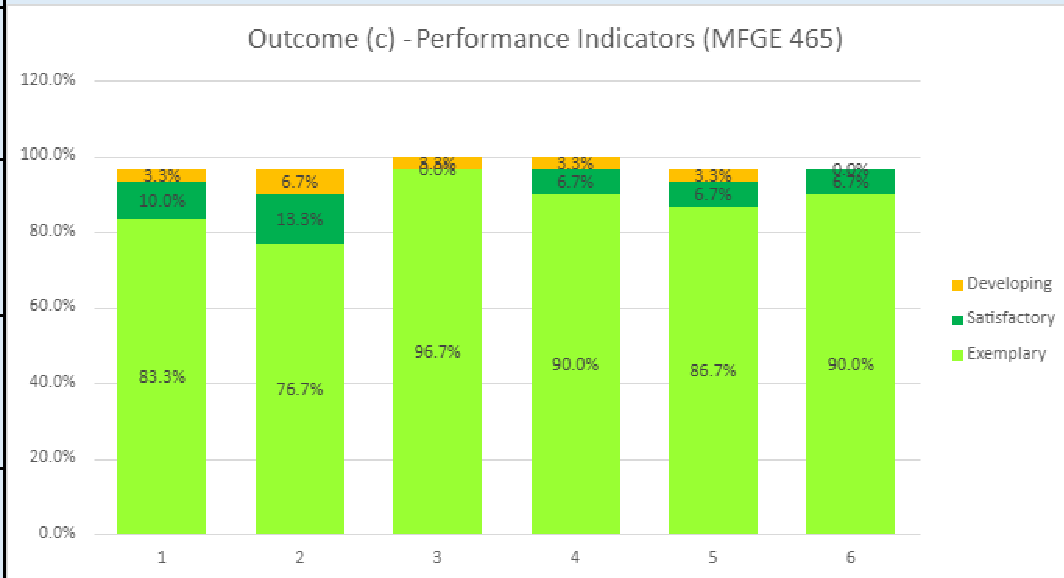
Course		Title	3 Year Course Assessment Cycle									3 Year Assessment Cycle									3 Year Assessment Cycle								
			2014-15			2015-16			2016-17			2017-18			2018-19			2019-20			2020-21			2021-22			2022-23		
		Courses required for MFGE Major	F1	W1	S1	F2	W2	S2	F3	W3	S3	F1	W1	S1	F2	W2	S2	F3	W3	S3	F1	W1	S1	F2	W2	S2	F3	W3	S3
ENGR	101	Eng. Des & Society	X									X													X				
ENGR	115	Innovation in Design																											
MFGE	261	Introduction to Computer-Aided Design							X								X										X		
ENGR	170	Introduction to Materials Science and Engineering		X									X									X							
ENGR	214	Statics							X											X							X		
ENGR	225	Mechanics of Materials									X							X											X
MFGE	231	Introduction to Manufacturing Processes						X									X									X			
MFGE	332	Introduction to CAM and CNC	X									X										X							
MFGE	340	Applied Numerical Methods for Engineers																				X							
MFGE	462	CAD Modeling and Analysis Using Surfaces		X									X										X						
PCE	371	Introduction to Plastics Materials and Processes	X									X									X								
PCE	372	Introduction to Composites Materials and Processes								X									X									X	
MFGE	341	Quality & Continous Improvements		X									X									X							
PCE	342	Data Analysis and Design of Experiments			X												X									X			
MFGE	250	Introduction to Manufacturing Automation																	X									X	
ENGR	351	Electronics for Engineering							X									X									X		
ENGR	352	Introduction to Automation and Controls												X									X						
MFGE	491	Project Research, Planning and Ethics				X									X									X					
MFGE	333	Design for Manufacture			X											X									X				
MFGE	381	Manufacturing Process Planning									X									X									X
MFGE	434	Advanced CNC								X									X									X	
MFGE	453	Industrial Robotics					X											X							X				
MFGE	463	Design of Tooling				X									X									X					
MFGE	365	Machine Design				X															X								
MFGE	492	Manufacturing Project Definition					X									X									X				
MFGE	493	Manufacturing Project Implementation						X									X									X			
MFGE	454	Systems Integration																									X		

- assessment is done and will be presented next quarter
- New course or major curriculum update
- No evaluation
- Assessment and evaluation completed and archived
- Differed for next offering due to various reasons (online modality, instructor request, etc.)

Appendix E.6
SLOs Assessment Worksheets

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science,

	Performance Indicator (Student has the ability to …..)
1	identify (C1) appropriate principles of engineering, science and mathematics needed to solve a complex engineering problem.
2	formulate (C2) a complex engineering problem using appropriate visual abstractions that capture the physical situation.
3	formulate (C2) a complex engineering problem using appropriate mathematical equations that capture the physical situation.
4	solve (C3) a complex engineering problem utilizing appropriate mathematical methods and available technologies.
5	evaluate (C3) a derived solution to verify its veracity and explain inconsistencies and discrepancies when they occur.
6	apply (C3) the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice

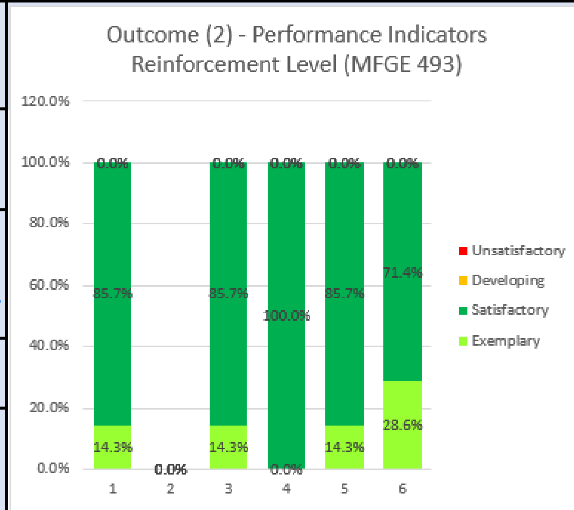


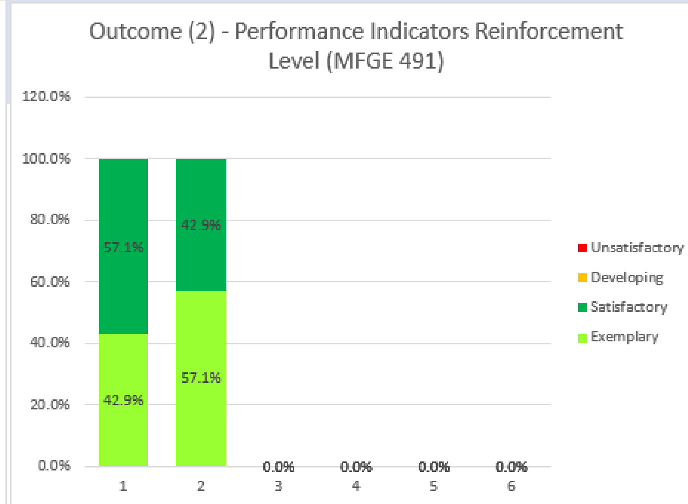
EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

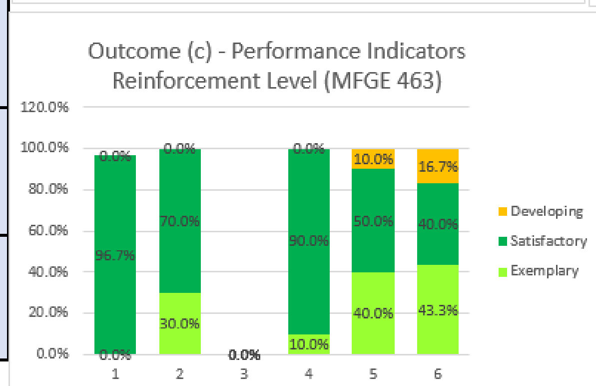
	Observation or Problem Identified and Type	PI	Description of propose	Rationale	change improves student learning and by when.	Faculty Responsible
1	None					
2						
3						
4						
5						

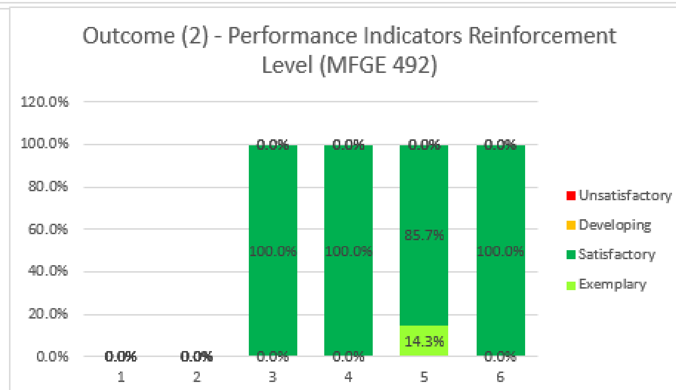
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as

	Performance Indicator (Student has the ability to .....)
1	execute (C3) a logical and orderly design process to arrive at a solution.
2	identify (C1) and quantify (C2) relevant customer requirements that include both performance targets and realistic constraints.
3	identify (C1) and attempt to integrate (C2) consideration of public health, safety and welfare into the final solution.
4	identify (C1) and attempt to integrate (C2) consideration of global, cultural, social, environmental and economic factors into the final solution.
5	create (C3) a final solution that satisfies all requirements identified in formulating the design problem.
6	justify (C3) decision-making through analysis (C3) of the solution (intermediate and final) using appropriate engineering and/or scientific principles.







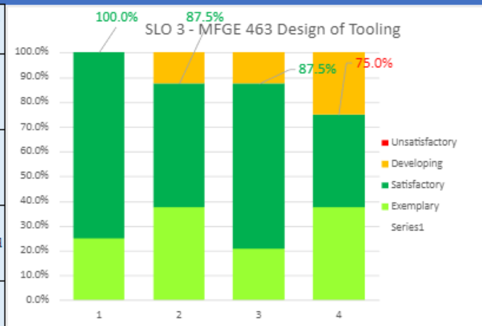


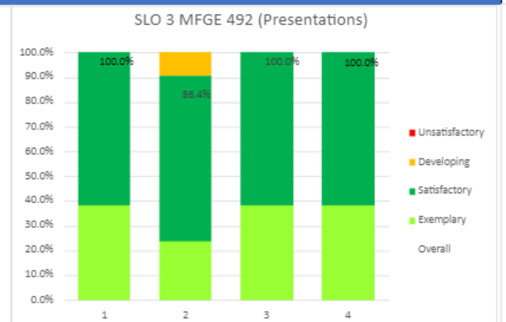
EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

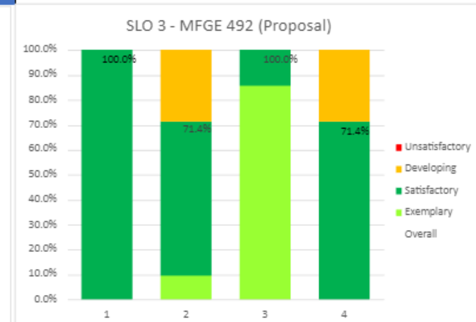
	Observation or Problem Identified and Type	PI	tion of proposed Impro	Rationale	Evidence that will demonstrate if this change improves student learning and by when.	Faculty Responsible
1	None					
2						
3						
4						
5						

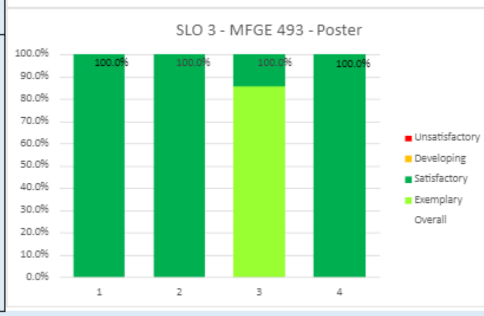
3. an ability to communicate effectively with a range of audiences

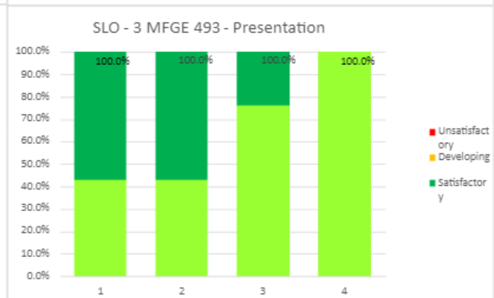
	Performance Indicator (Student has the ability to .....)
1	make effective use of available communication methods and tools
2	communicate in an organized and concise manner
3	communicate with professionalism including, proper usage of grammar, correct spelling, and adherence to relevant standards.
4	communicate using content and style appropriate to the audience.

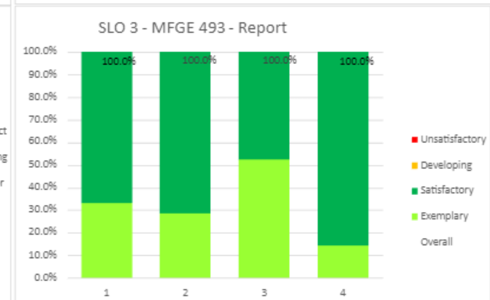










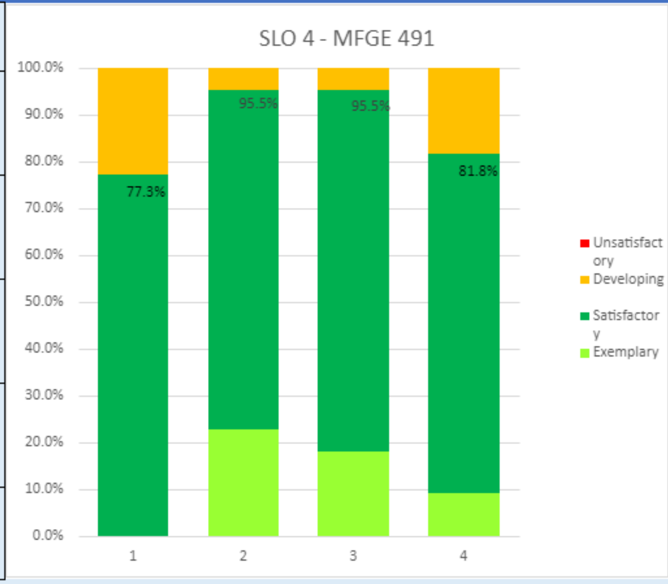


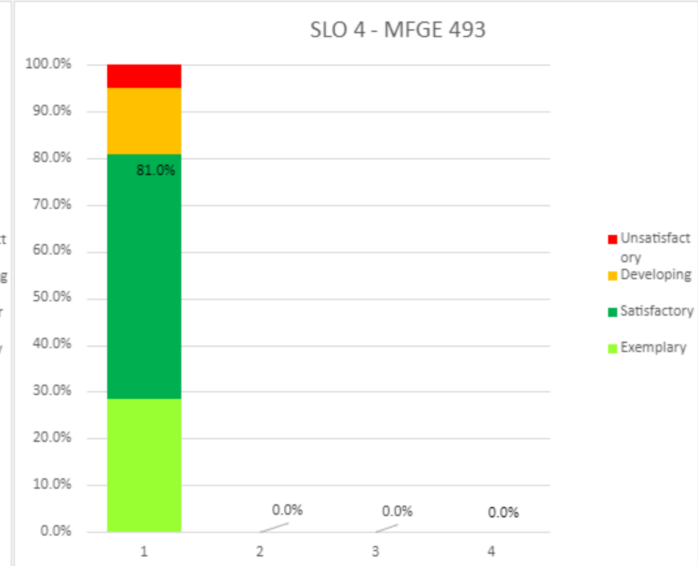
EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

	Observation or Problem Identified and Type	PI	Description of proposed Improvement	Rationale	Evidence that will demonstrate if this change improves student learning and by when.	Faculty Responsible
1	Work instructions below 80% in MFGE 463	4	May need to relook at work instructions in junior courses.	Enforcement level	2021 evaluation was above 80%	D. Gill
2	Score below 80% for the MFGE 492 proposal	2,4	MFGE 493 will provide another opportunity for evaluation	This proposal carries through 493	so students who struggled in fall and winter did well in spring, and there were no issues with presentations or posters for non-technical audiences.	Newcomer , Yip-Hoi
3						
4						
5						

4 - an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

	Performance Indicator (Student has the ability to …..)
1	.recognize and articulate ethical and professional responsibilities in engineering situations.
2	gather, validate and analyze information from multiple relevant sources, on the potential impact of an engineering solution.
3	make informed judgements supported by analysis of the societal and global impact of engineering solutions.
4	make informed judgements supported by analysis of the economic and environmental impact of engineering solutions.



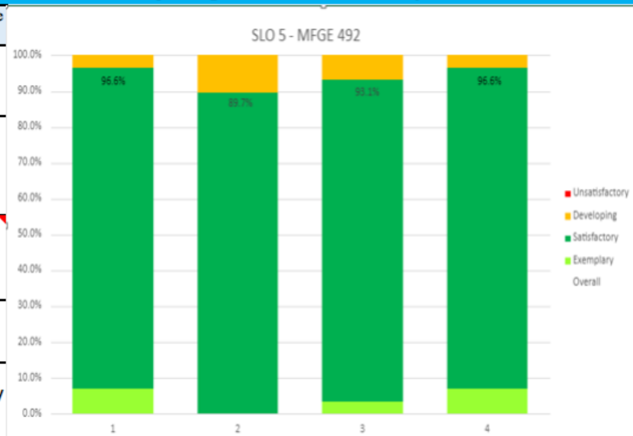


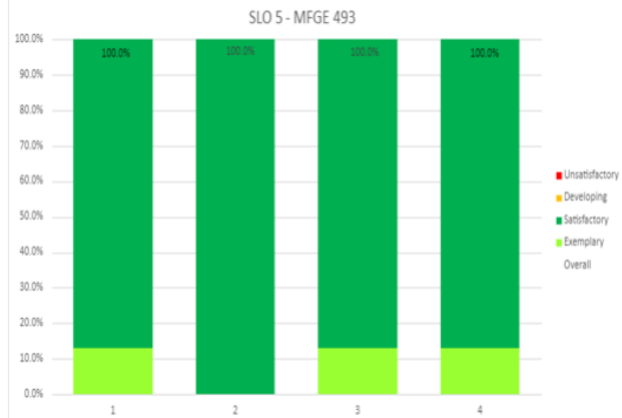
EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

	Observation or Problem Identified and Type	PI	Description of proposed Improvement	Rationale	Evidence that will demonstrate if this change improves student learning and by when.	Faculty Responsible
1	Students score below the threshold in correctly identifying and articulating ethical dilemmas.	1	More structured assignment that practices identifying and articulating ethical dilemmas.	Provides practice that will help in presentation and exam.	Scores for PI 1 will rise above the 80% threshold.	Yip-Hoi
2						
3						
4						
5						

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

	Performance Indicator (Student has the ability to …..)
1	function effectively in providing team leadership.
2	promote a collaborative and inclusive environment that supports effective teamwork.
3	share in planning and setting goals for the team.
4	share in the work of the team.
5	complete assigned tasks in a timely fashion





EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

	Observation or Problem Identified and Type	PI	Description of proposed Improvement	Rationale	Evidence that will demonstrate if this change improves student learning and by when.	Faculty Responsible
1	None					
2						
3						
4						
5						

Page Break

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

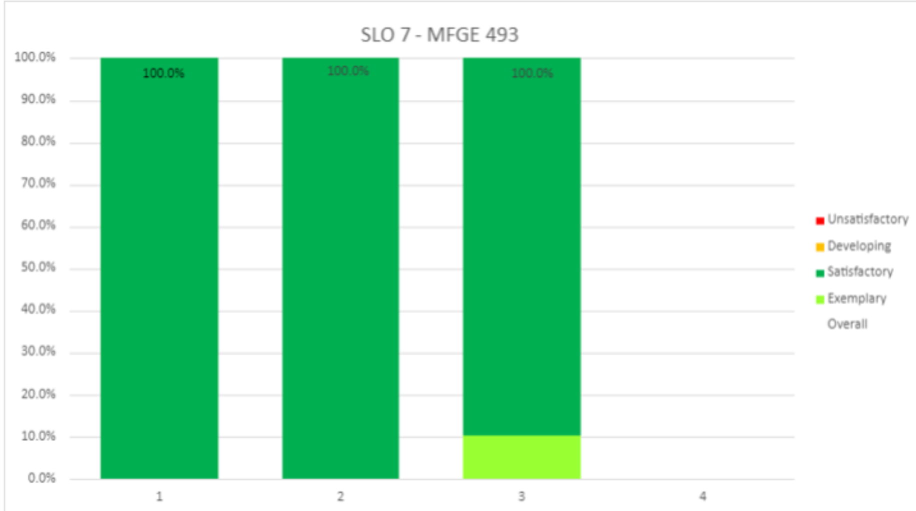
	Performance Indicator (Student has the ability to …..)
1	select and operate appropriate process equipment and instruments to perform necessary experiments. (lab-based classes only)
2	Develop an experiment plan (understand the driving question, define key variables, select the appropriate process equipment, define data collection procedure)
3	Conduct appropriate data collection on the appropriate variables
4	Analyze and interpret experimental data and results with respect to the driving question and any other appropriate theoretical models
5	form conclusions based on empirical evidence and compare these with the theoretical models

EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

	Observation or Problem Identified and Type	PI	Description of proposed	Rationale	Evidence that will demonstrate if this change improves student learning and by when.	Faculty Responsible
1	None					
2						
3						
4						
5						

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies (i)

	Performance Indicator (Student has the ability to …..)
1	to identify relevant sources of new knowledge.
2	use an appropriate learning strategy to acquire new knowledge.
3	apply newly acquired knowledge to problem solving.



EVALUATION AND IMPROVEMENT (CLOSING THE LOOP)

	Observation or Problem Identified and Type	PI	Description of proposed Improvement	Rationale	Evidence that will demonstrate if this change improves student learning and by when.	Faculty Responsible
1	N/A					
2						
3						
4						
5						

Appendix E.7
Program Annual
Assessment Reports

Annual Assessment Report

Academic Year: 2020-21

Department/Program: Engineering & Design/Manufacturing Engineering

Assessment Coordinator/Program Director: Jeff Newcomer/Sura Al-Qudah

Departmental Mission: The Engineering & Design department at Western Washington University serves current students, industry, the University, and the citizens of Washington State by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience that we provide emphasizes critical thinking and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context. We value and foster teamwork, communication, and a commitment to equity, justice, and the respect for the rights and dignity of others.

Program Student Outcomes: Upon graduation, MFGE Program majors will be able to:

(SO1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(SO2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(SO3) an ability to communicate effectively with a range of audiences

(SO4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(SO5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(SO6) an ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions

(SO7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Student Learning Outcomes Assessed This Year

Assessment Measures	SOs Assessed	Results
MFGE 465 Various homework assignments and in-class activities MATLAB activities	SO1	Six Performance Indicators were assessed. For a class of **30 students**, a **satisfactory or better rating** was attained in the student's ability to: 1. identify appropriate principles of engineering, science and mathematics needed to solve a complex engineering problem for **28 Students**, formulate a complex engineering problem using appropriate visual abstractions that capture the physical situation for **27 Students**, formulate a complex engineering problem using appropriate mathematical equations that capture the physical situation for **29 Students**, solve a complex engineering problem utilizing appropriate mathematical methods and available technologies for **29 Students**, evaluate a derived solution to verify its veracity and explain inconsistencies and discrepancies when they occur **28 Students**, apply the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice for **29 Students**.
MFGE 491/492/493 background research chapter in their project report, evidence of identification and use of new software and technologies as described in their project presentation	SO2	Three Performance Indicators were assessed. For a class of **29 students**, a **satisfactory or better rating** was attained in the student's ability to: to identify relevant sources of new knowledge for **29 Students**, 2. use an appropriate learning strategy to acquire new knowledge for **29 Students**, apply newly acquired knowledge to problem solving for **29 Students.**
MFGE 342 Summative projects assessment (water jet project & design your	SO6	Three Performance Indicators were assessed. For a class of **19 students**, a **satisfactory or better rating** was attained in the student's ability to: 3. apply appropriate experimental design principles for **17 Students**, apply appropriate statistical analyses to produce professional quality technical work for **16 Students**,

own exp. Project) Take-home exam question on a published journal article		4. form conclusions based on empirical evidence and to compare these with researched information or theoretical models for 18 **Students.**

"CLOSING THE LOOP": PROGRAM IMPROVEMENT DOCUMENTATION

Type of Change	SOs Targeted	Description of Program Improvement	Rationale and Level of Faculty Involvement*	Evidence that will demonstrate if this change improves student learning.
Student Outcomes (SOs)	All	Completely moved from outgoing ABET a-k outcomes to incoming ABET 1-7 outcomes.	Completed the three-year assessment and evaluation cycle. All MFGE faculty participated in the assessments of the new 1-7 outcomes.	Each SO was measured using a rubric with 3-5 Performance Indicators (PIs). SOs 3 and 4 were assessed and reported on in 2018-19. SOs 5 and 7 were assessed and reported on in 2019-20. SOs 1, 2 & 6 were assessed and reported on above.
Student Outcomes (SOs)	SO6	Implemented in PCE 342 Design & Analysis of Experiments. PI # 1 was not assessed because PCE 342 is not lab based. A comprehensive revision of the rubric & PIs was performed and is to be implemented in MFGE 463 in Fall 21 for evaluation.	After faculty discussions it was decided to utilize the MFGE 463 class to evaluate the rubric. Acquisition of a CNC lathe, automated inspection equipment and material handling automation was authorized by the program and most of the equipment were installed in the summer. Faculty will implement, critique, and approve or improve the new PIs for SO6.	The experiences of faculty using these new PIs with appropriate course work completed by students will be used to determine their effectiveness at assessing learning. It is expected that some changes may be needed based on this feedback. These assessment tools will help faculty identify where learning needs to be improved.
Access to Classes	Incoming class of 2024	Expand technical elective opportunities by giving majors the option to take	Currently majors are guaranteed available one technical elective each year. The introduction of MFGE 454 together with	Fewer students who have difficulties finding classes to complete their 6-credit technical elective requirement. More in-

		one required course from MFGE 434, 454 and 462 and to use the other two as potential tech elective options.	the move of MFGE 362 to a senior level class (now MFGE 462) has made it possible to give majors two options from among MFGE 434, 454, 462.	depth exposure to either the Automation track and/or CAD/CAM track.
Pedagogy	SO1	Improve exposure to automation by making Robotics (MFGE 453) a required course for all MFGE majors.	Currently majors have a choice between robotics and advanced CNC (MFGE 434). This will help to expand the exposure of all MFGE majors to robotics. Given the increase in use of automation in local industry, this direction was decided upon in consultation with the program's IAC.	All MFGE majors starting with the class admitted in 2022 will have MFGE 453 completed as part of their graduation requirement.
Pedagogy	SO1	Provide more timely reinforcement of analytical problem-solving skills by moving MFGE 465 Machine Design from the senior to the junior year as MFGE 365.	Currently most students have at least a one-year gap between completing ENGR 225 Strength of Materials and applying this material in MFGE 465. There is concern that students are forgetting this foundational material. Moving MFGE 465 to the junior year will reduce the gap to reinforcement and provide more opportunities to engage juniors in analytical work.	Faculty teaching MFGE 365 will observe the preparation of students based on the MFGE 225 prerequisite and report of preparation of students at next MFGE 365 course reviews in 2024. This should indicate adequate preparation.
Pedagogy	SO1	Redistribution of content between MFGE 250, EECE 351 and EECE 352.	Moving PLCs from EECE 352 to MFGE 250 allows for a more manufacturing-applied treatment of this topic. This also ensures that PCE majors who do not take EECE 352 get exposure. Moving microcontrollers from EECE 352 to EECE 351 benefits MFGE majors by creating room in EECE 352 for a more in-depth	Faculty teaching MFGE 250, EECE 351 and 352 will be assessing student learning on PLCs, microcontrollers, and feedback control. Their course outcomes assessment on these topics at the next course reviews and their observations will be used as evidence that this change has benefitted

			treatment of feedback control while also benefiting PCE majors taking EECE 351 who current are not exposed to MCs.	student exposure and learning. These should indicate that students are meeting the 80% threshold.
Pedagogy	SO1,2	Formalize expansion of learning opportunities for majors in Robotics, Automation and Systems Integration (RASI) by converting MFGE 497B Systems Integration from an experimental course to MFGE 454. This course now appears in the university catalog and in program planning guides as an option for majors to take.	This is the next in a sequence of steps taken by the program over the past few years to expand learning opportunities in RASI. This completes improvements started in 2018-19. Though this class will remain an option, together with the introduction of MFGE 250 in S20 and the improvement above to make robotics required by all majors, it will impact the amount of exposure majors can receive to RASI.	Faculty teaching MFGE 454 will be able to observe the abilities of students having taken all courses in the sequence that supports RASI i.e., MFGE 250, EECE 351, EECE 352, MFGE 453 and MFGE 454. At the next course review the faculty will provide evidence of improvement in the preparation of majors who have taken this full sequence through assessment of the course's outcomes and prerequisite outcomes.

Pedagogy	SO1,2	Move courses with a high level of specialization to the senior year to provide room in the junior year for more foundational experiences such as completing outstanding Math/Science requirements, computational methods, and machine design, and to participate in research. The courses that will be moved are MFGE 362 (renumbered to MFGE 462) and PCE 372. The course load for juniors will return to 3/3/4.	The 2020-21 junior course load is 3/4/4. This is an increase from the previous 3/3/4 load. The two openings in fall and winter have been used by some students to complete requirements from the sophomore year. Some students particularly those working also benefit from the lighter course load. Returning to a 3/3/4 load will increase the flexibility of students to complete requirements without having to take summer classes and help students with heavy work commitments. Moving PCE 372 to the senior year allows MFGE 365 to be scheduled in the junior year.	Fewer students that will need to take summer classes between their sophomore and junior years because of the additional opportunity to complete a lower-division requirement. Fewer students with external commitments such as work struggling to keep pace with the program.

*All Changes discussed and approved by faculty and program and curriculum committee meetings

Annual Assessment Report

Academic Year: 2019-20

Department/Program: Engineering & Design/Manufacturing Engineering

Assessment Coordinator/Program Director: Jeff Newcomer/Derek Yip-Hoi

Departmental Mission: The Engineering & Design department at Western Washington University serves current students, industry, the University, and the citizens of Washington State by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience that we provide emphasizes critical thinking and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context. We value and foster teamwork, communication, and a commitment to equity, justice, and the respect for the rights and dignity of others.

Program Student Outcomes: Upon graduation, MFGE Program majors will be able to:

(SO1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(SO2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(SO3) an ability to communicate effectively with a range of audiences

(SO4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(SO5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(SO6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(SO7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Student Learning Outcomes Assessed This Year

Assessment Measures	SOs Assessed	Results
MFGE 492 and 493 Senior capstone design project weekly teamwork evaluations by instructor from meetings, and end of quarter peer evaluations.	SO5	Five Performance Indicators were assessed. For a class of 29 students, a **satisfactory or better rating** was attained in the student's ability to: 5. function effectively in providing team leadership for **28 Students**, 6. promote a collaborative and inclusive environment that supports effective teamwork for **26 Students**, 7. share in planning and setting goals for the team for **27 Students**, 8. share in the work of the team for **28 Students**, 9. complete assigned tasks in a timely fashion for **29 Students**.
MFGE 493 background research chapter in their project report, evidence of identification and use of new software and technologies as described in their project presentation	SO7	Three Performance Indicators were assessed. For a class of 29 students, a **satisfactory or better rating** was attained in the student's ability to: 10. to identify relevant sources of new knowledge for **29 Students**, 11. use an appropriate learning strategy to acquire new knowledge for **29 Students**, 12. apply newly acquired knowledge to problem solving for **29 Students.**

"CLOSING THE LOOP": PROGRAM IMPROVEMENT DOCUMENTATION

Type of Change	SOs Targeted	Description of Program Improvement	Rationale and Level of Faculty Involvement*	Evidence that will demonstrate if this change improves student learning.

Student Outcomes (SOs)	All	Moved from outgoing ABET a-k outcomes to incoming ABET 1-7 outcomes a year before requirement to do so.	Required to switch to ABET 1-7 for AY19-20, but thought that it made better sense to switch a year early and complete the three-year assessment and evaluation cycle a year before the Self-Study Reports are due so that there is sufficient time for evaluation of assessment data.	Each SO will be measured using a rubric with 3-5 Performance Indicators (PIs). We are developing PIs and identifying assignments. SOs 3 and 4 were assessed and reported on in 2018-19. SOs 5 and 7 are reported on above. SOs 1, 2 & 6 will be assessed and evaluated in AY20-21.
Student Outcomes (SOs)	SO1 SO2	Developed new rubrics with appropriate performance indicators to assess these two outcomes. This is the final step in the transition from the old ABET a-k to the new 1-7 student outcomes. These will be assessed during AY20-21.	Required by ABET. This will complete the last assessments in a three-year evaluation cycle a year before the Self-Study Reports for the program's accreditation renewal are due to ensure sufficient time for evaluation of assessment data. Faculty created, critiqued, and approved the new PIs and rubrics.	The experiences of faculty using these new rubrics with appropriate course work completed by students will be used to determine their effectiveness at assessing learning. It is expected that some changes may be needed based on this feedback. These assessment tools will help faculty identify where learning needs to be improved.
Pedagogy	SO1	Implemented MFGE 350 Introduction to Automation.	The rationale for the introduction of MFGE 350 as discussed in the 2018-19 report is to introduce majors to manufacturing automation earlier in their program. Program faculty was responsible for the development of the new curriculum, creating new labs and instructing two offerings of the course.	Students were able to meet two of the three course outcomes (the third was too ambitious and will be updated), so students are getting a foundation in automation earlier and future courses are going to be able to build off it and achieve more depth. How well prepared students are for EECE 352 and MFGE 453 and whether those courses can go into more depth in the future will be the best indicators of the level of success of adding

				MFGE 350 to the MFGE curriculum.
Facilities and Equipment	SO1, SO6	Acquired resources to support a new approach to developing a student's abilities to conduct experimentation, analyze and interpret data in a manner that can be more easily assessed.	The program's plans to assess SO6 in AY19-20 was postponed due to a rethinking of how best to expand their exposure to these skills. The plan to use different classes and senior project presented challenges in consistency. After faculty discussions it was decided to utilize the MFGE 463 class to create a common experience for all majors. Acquisition of a CNC lathe, automated inspection equipment and material handling automation was authorized by the program.	The pandemic has further delayed implementation of this new plan. However, the lathe has been purchased and installed, a grant written to acquire material handling automation and the program has funding to purchase inspection equipment this coming summer. Evidence will be generated from assessment of student performance on a lab or project experience in MFGE 463 during the AY21-22 using these new resources.

*All Changes discussed and approved by faculty and program and curriculum committee meetings

Annual Assessment Report

Academic Year: 2018-19

Department/Program: Engineering & Design/Manufacturing Engineering

Assessment Coordinator/Program Director: Jeff Newcomer/Derek Yip-Hoi

Departmental Mission: The Engineering & Design department at Western Washington University serves current students, industry, the University, and the citizens of Washington State by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience that we provide emphasizes critical thinking and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context. We value and foster teamwork, communication, and a commitment to equity, justice, and the respect for the rights and dignity of others.

Program Student Outcomes: Upon graduation, MFGE Program majors will be able to:

(SO1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

(SO2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

(SO3) an ability to communicate effectively with a range of audiences

(SO4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

(SO5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

(SO6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

(SO7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Student Learning Outcomes Assessed This Year

Assessment Measures	SOs Assessed	Results
MFGE 492 and 493 proposal/report, presentations, and poster and MFGE 463 Work Instr.	SO3	The Performance Indicators (PI) on 'organized & concise communication' and 'style appropriate to the audience' were not met for the MFGE 492 proposal or the MFGE 463 work instructions, but all PIs were met for all other assignments, so students who struggled in fall and winter did well in spring, and there were no issues with presentations or posters for non-technical audiences. May need to relook at work instructions in junior courses.
MFGE 491 Ethics presentations, lit. analysis, & MFGE 493 self-reflection	SO4	Students did well in all areas except for the Performance Indicator (PI) "recognize and articulate ethical and professional responsibilities in engineering situations." Performance on that PI was just below the 80% threshold in the fall and just above the 80% threshold in the spring, so barely meeting expectations and in need of tracking.

"CLOSING THE LOOP": PROGRAM IMPROVEMENT DOCUMENTATION

Type of Change	SOs Targeted	Description of Program Improvement	Rationale and Level of Faculty Involvement	Evidence that will demonstrate if this change improves student learning.
Student Outcomes (SOs)	All	Moved from outgoing ABET a-k outcomes to incoming ABET 1-7 outcomes a year before requirement to do so.	Required to switch to ABET 1-7 for AY19-20, but thought that it made better sense to switch a year early and complete the three-year assessment and evaluation cycle a year before the Self-Study Reports are due so that there is sufficient time for evaluation of assessment data.	Each SO will be measured using a rubric with 3-5 Performance Indicators (PIs). We are developing PIs and identifying assignments. SOs 5, 6, & 7 will be assessed and evaluated in AY19-20, and SOs 1 & 2 will be assessed and evaluated in AY20-21.
Pedagogy	SO1	Replaced OPS 460 with MFGE 350 Introduction to Automation. Change will take effect with students	Continued development of MFGE 344 had made OPS 460 largely redundant, so felt that the credits would be better used to introduce manufacturing automation earlier in the program.	Will evaluate MFGE 350 course at the end of AY19-20 through course review process. Will note if there are any changes in outcomes when S01 is assessed and evaluated at end of AY20-21.

		who enter the major in spring 20.		
Pedagogy	SO1	Replaced CSCI 140 with MFGE 340 Applied Numerical Methods. Change will take effect for students who enter the major in spring 20 during AY20-21.	Wanted to create a course that introduced programming with a focus on solving engineering problems rather than on learning how to program. This approach has been shown to be effective in other engineering programs.	Will evaluate MFGE 340 course at the end of AY20-21 through course review process. Will note if there are any changes in outcomes when S01 is assessed and evaluated at end of AY23-24 (for it will not have any impact on the AY20-21 SO1 assessment and evaluation).
Entrance Requirements	n/a	Added MATH 204 and PHYS 162 to courses students must complete before entering program.	Existing minimum entrance requirements resulted in some students needing to take summer classes to graduate with their cohort. Students should not need to take summer classes in order to graduate on time.	Reduction, ideally to zero, in number of students who must take summer classes in order to graduate with their cohorts.
Facilities & equipment	SO1, SO2, SO5, SO6, & SO7	Devoted ET 138 lab space to the development of a flexible automation cell, The Learning Factory (LEAF).	Need to increase students' exposure to and opportunities to work with automation systems.	Development of an elective class and student-involved research that makes use of LEAF.

ANNUAL ASSESSMENT REPORT

ACADEMIC YEAR: 2017-18

MFGE

"CLOSING THE LOOP": IMPROVEMENT BRAINSTORMING SHEET

Type of Change	Example/Your Draft Improvements
Curricular	Change prerequisites or GE requirements; Add required courses; Replace existing courses with new ones; Change course sequence; Add internships, labs and other hands-on learning opportunities. **Your Improvements:** 13. Keeping pace with technology changes 14. Begin transitioning to a new Cloud-based platform for CAD/CAM/CAE instruction. 15. Introduce a new Systems Integration class as a technical elective (Winter 2020). 16. Developing professional and communication skills 17. Require majors to take a GUR course on ethics e.g. PHIL 115 Environmental Ethics. 18. Introduce junior engineering writing experiences focused on writing a lab report and on a technical research paper. 19. The Capstone Design Experience 20. Change credit distribution for 491/492/493 to add more credits to the design phase (492). 21. Change the logistics of senior project solicitation, sponsor commitments, faculty involvement and project team sizes and number 22. Responding to IAC Interest in Project Management Skills 23. Replace OPS 460 with OPS 461 Project Management and eliminate overlapping content from MFGE 491. 24. Move OPS 461 to the spring term of the junior year.
Faculty Support	Increase number of TAs or peer mentors; Add specialized support to faculty (Library, Academic Technology, etc.); Increase support to promote dialogues and community among faculty. **Your Improvements:**

<table>
<tr><td>Faculty Development</td><td>Provide targeted professional development opportunities.

Your Improvements:

25. Provide in-house training sessions for new CAD system platform (3DExperience)</td></tr>
<tr><td>Pedagogy</td><td>Change course assignments; Add more active-learning components to course design; Change textbooks; Increase opportunities for formative feedback and peer-assisted learning.

Your Improvements:

26. Switch to Dassault PLEXP (Peer Learning Experience) on-line training materials for CAD instruction in MFGE 362.
27. Adopt flipped classroom technique for MFGE 362.
28. Require students to acquire and retain reference texts on Engineering Communications, Engineering Ethics and Engineering Design</td></tr>
<tr><td>Student Support</td><td>Increase tutors; Add more online resources; Improve advising to make sure students take the right courses; Provide resources to encourage community building among students and between students and faculty; Bring graduates back to discuss work opportunities related to the major.

Your Improvements:</td></tr>
<tr><td>Resources</td><td>Change the course management system; Improve or expand lab spaces; Provide resources to support student independent research.

Your Improvements:

29. Transform Automation Cell into a Learning Factory.
30. Acquire new robots to support instruction and development of the Learning Factory.
31. Expand instructional accessibility of CNC area by moving non-CNC equipment to new location and rearranging remaining equipment.</td></tr>
</table>

Assessment Plan	Refine SLO statements; Change methods and/or measures; Change where (e.g. courses) the data are collected; Collect additional data; Improve data reporting and dissemination mechanisms. **Your Improvements**: 32. Update SLOs to match changes to ABETs Criterion 3.

"CLOSING THE LOOP": PROGRAM IMPROVEMENT DOCUMENTATION TEMPLATE

This year's assessment task is to document program improvements informed by SLO assessment and other forms of evidence. Use this form to document your improvements and the evidence and discussion that informed them.

Type of Change	SLOs Targeted	Description of Program Improvement	Rationale and Level of Faculty Involvement	Evidence that will demonstrate if this change improves student learning.
Curricular	b, k	Add new curricular content in the area of Manufacturing Systems Integration	Strengthening the curriculum in this area will enhance a student's ability to design manufacturing systems and deepen their knowledge and application of related technologies.	80% demonstrate "Satisfactory" or "Exemplary" proficiency on performance indicators used to assess skill in problem solving, experimentation and use of technology for outcomes b and k.
Curricular	k	Begin transitioning to a new Cloud-based platform for CAD/CAM/CAE instruction.	New technology trends are moving to cloud-based solutions for CAD/CAM/CAE. These have the potential to increase accessibility of this technology 24/7 to students and to introduce new areas of exposure in Simulation and Product Data Management.	80% demonstrate "Satisfactory" or "Exemplary" proficiency on relevant performance indicators for assessing skill in use of technology for outcome k.

Curricular	g	Introduce junior engineering writing experiences focused on writing a lab report and on a technical research paper.	Structured writing experiences during the junior year will both expose majors to a broader range of technical writing techniques (e.g. lab reports, research papers etc.) and allow earlier assessment of their abilities and remediation if necessary.	80% demonstrate "Satisfactory" or "Exemplary" proficiency on performance indicators used to assess writing skills for outcome 3 in at least two courses during the junior year.
Curricular	c, d, g	Change credit distribution for MFGE 491/492/493 to add more credits to the design phase (492).	The current credit distribution of 4/2/4 does not place enough emphasis on the design effort needed in 492. Students need to be engaged beyond the 2 credits that are assigned to 492 to adequately complete all aspects of their design work. The current perception may be contributing to students not adequately completing proper engineering documentation.	80% demonstrate "Satisfactory" or "Exemplary" proficiency on performance indicators used to assess performance in 492, with particular attention to engineering documentation communication skills which tend to suffer when teams are rushed to complete their proposal.
Curricular	c, d	Change the logistics of senior project solicitation, sponsor commitments, faculty involvement and project team sizes and number.	Design work can be improved by better project selection, sponsorship participation and requirements gathering that shifts the timeline for the project earlier. A mandated project budget will encourage students to implement	"Evidence during final reviews in 492 and 493 prior to final week project presentations shows advanced progress in attaining goals and deliverables. 80% demonstrate "Satisfactory" or "Exemplary" proficiency on performance

			their designs sooner in 493, leaving more time for testing and analysis that feed into improved project documentation. Fewer projects with larger teams will provide more team resources to complete designs and for implementation. Greater faculty involvement will enhance communications with sponsors reducing delays that manifest themselves in a rush to complete documentation.	indicators used to assess ability to meet goals, quality of the result and teamwork.
Assessment Plan	ALL	33. Updating of SLOs from a-k to 1-7 to conform with changes to ABET Criterion 3. 34. Creating new performance indicators and rubrics for the 1-7 ABET SLOs.	35. ABET has approved these changes to Criterion 3 to begin for programs seeking accreditation in 2018-19. 36. In order to be prepared for program accreditation review in 2022, the program plans to phase in assessment using the new 1-7 outcomes over the next three years. 37. Existing performance indicators and rubrics will need to be updated, and in some cases completely redone.	39. Successful accreditation of the program in 2022 will demonstrate that these changes have been fully and appropriately implemented. 40. The assessment data collected with the new rubrics will provide evidence of student learning.

			38. All program faculty are involved in assessment data collection and will be participating in the process.	

BI-ANNUAL "CLOSING THE LOOP" PROGRAM IMPROVEMENT REPORT RUBRIC

The Accreditation and Assessment Advisory Committee (AAAC) will use this rubric in responding to the departmental CTL reports.

Criteria	At Standard	Developing	Unacceptable
Level of Faculty Participation	Broad faculty participation in both planning and implementation.	Select faculty participation with departmental discussion or dissemination.	Select faculty participation.
Relation to evidence and SLO assessment	Rationale meaningfully connects the improvement to a quantitative summary of SLO assessment results, and to supporting departmental discussion.	Rationale connects the improvement to SLO assessment.	Rationale does not connect the improvement to SLO assessment.
Stage of implementation	Improvement is largely implemented (e.g. proposed curriculum change was approved by the department and sent to the ACC).	Department has a plan for implementing the improvement.	Department has no plan for implementing the improvement.

Bi-Annual Assessment Report

Academic Year: 2016-17

Department/Program: Engineering & Design/Manufacturing Engineering

Assessment Coordinator/Program Director: Jeff Newcomer/Sura Al-Qudah

Departmental Mission: The Engineering & Design department at Western Washington University serves current students, industry, the University, and the citizens of Washington State by developing industry-ready graduates through a combination of creative problem-solving, analytical skills development, and experiential learning. The educational experience we provide emphasizes teamwork, communication, critical thinking, and an understanding of the impact of design, engineering, and manufacturing solutions in a global, economic, environmental, and societal context.

Program Student Learning Outcomes: Upon graduation, Manufacturing Engineering Program majors will be able to:

41. **an ability to apply knowledge of mathematics, science, and engineering to solving problems in manufacturing engineering**
42. **an ability to design and conduct experiments and to analyze and interpret data within a manufacturing context**
43. **An ability to design a manufacturing system, product, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability**
44. **an ability to function on multidisciplinary teams**
45. **an ability to identify, formulate, and solve engineering problems**
46. **an understanding of the professional and ethical responsibilities of an engineer**
47. **an ability to communicate effectively**
48. **the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context**
49. **a recognition of the need for, and an ability to engage in life-long learning**
50. **a knowledge of contemporary issues**
51. **an ability to use, and practical experience with, the techniques, skills, and modern engineering technologies necessary for manufacturing engineering practice**

Student Learning Outcomes Assessed This Year: All

Assessment Measures	SLOs Assessed	Results
Use of analysis techniques in senior project	**(a)**	This outcome was successfully achieved. All 5 items on the rubric had 84-100% of students doing satisfactory or exemplary work.
Application of Design of Experiments in MFGE 434 & 453	**(b)**	This outcome was mostly achieved. Students did a good job of designing, conducting, and analyzing the experiment, with 84-100% of students doing satisfactory or exemplary work in these areas. However, students did not sufficiently close the loop and tie findings back to relevant literature consistently; only 50% of students did satisfactory or exemplary work in this part, so we will need to address this.
Students' ability to follow a logical design process including justification of design decisions and good documentation of their designs in senior project	**(c)**	This outcome was mostly achieved. Students followed a design process in both MFGE 492 (project proposal) and MFGE 493 (project implementation), considered and ranked alternatives, proposed and implemented viable solutions, and justified design decisions with analyses with 84-94% producing satisfactory or exemplary work in these areas in MFGE 493 (there was more variation in MFGE 492). The one area where students struggled was in producing appropriate design documentation; only 37% produced satisfactory or exemplary design documentation in MFGE 492, and only 74% did so in MFGE 493. Since this was not an issue last year, we will need to keep an eye on this to see if it is a trend that needs to be addressed or an anomaly.

Students' ability to consistently contribute to a senior design team to help it achieve its goals	**(d)**	This outcome was successfully achieved. All 4 items on the rubric had 94-100% of students doing satisfactory or exemplary work.
Students' ability to appropriately and correctly apply and complete engineering analyses	**(e)**	

in the implementation of their senior projects		This outcome was successfully achieved. All 4 items on the rubric had 100% of students doing satisfactory or exemplary work.
Quality and quantity of students' participation in discussion of engineering ethics topics in MFGE 491	**(f)**	This outcome was partially met. 84% of students met or exceeded expectations for identifying ethical issues, but only 79% of them sufficiently contributed to discussions regarding engineering ethics. Since this is just below the target threshold, we will watch this again next year to see if this is an anomaly or a trend, for it was not an issue last year.
Quality and quantity of students' recognition and assessment of ethical issues in their senior projects from their reflective assessments	**(f)**	This outcome was not met, for only 63% of students sufficiently addressed ethical issues in their senior projects in their reflective essays. That said, the problem seems to be more based on omission than on poor understanding, for 80% of those who addressed ethical issues in their projects did so sufficiently, but 21% of the total number of students did not address ethical issues at all in their reflective essays. We will keep an eye on this, for it was met last year.
Since engineering communication is multifaceted, this was based upon technical drawing and written assignments in MFGE 463, the senior project proposal and accompanying presentation in MFGE 492, and the senior project final report and accompanying presentation in MFGE 493.	**(g)**	This outcome was successfully achieved. In MFGE 463 89-100% of students met or exceeded expectation in the various items, and in both MFGE 492 and MFGE 493 95-100% of students met or exceeded expectation in the various items.

Based upon students' contemporary issues assignments in contributions to in-class discussions in MFGE 491, and also on students performance in their GUR classes (native students only)	**(h)**	This outcome was partially met. 84% of students met or exceeded expectations in their contemporary issues assignments, but only 53% did so in their contributions to class discussions. This is a reversal of last year, though more extreme, so we will need to keep an eye on it next year. The final item on the rubric was met. 92% of students met or exceeded expectations in their performance in GUR courses as measured by their GPA in those classes.
Students' ability to find, comprehend, and integrate new information for their senior project proposals in MFGE 492	**(i)**	This outcome was successfully achieved. All 3 items on the rubric had 84-95% of students doing satisfactory or exemplary work.
Based upon students' performances on contemporary issues assignments and ethics presentations in MFGE 491	**(j)**	This outcome was successfully achieved. All 4 items on the rubric had 84-95% of students doing satisfactory or exemplary work.

Based upon students' use of appropriate technical tools, including design and analysis software, fabrication equipment, and measurement and testing	**(k)**	This outcome was successfully achieved. All 4 items on the rubric had 95% of students doing satisfactory or exemplary work.

equipment in the implementation of their senior projects.		
SME CMfgT Exam Results	**(a) & (e)**	This outcome was successfully achieved. All students passed the SME CMfgT Exam on the first try. Topic area scores met or exceeded expectations in all topics except for Applied and Engineering Sciences. This was the same result as last year (although overall scores were a bit higher this year), and the issue seems to be that students tend to skip these problems because they require more time to complete. It may be that this topic area is not an appropriate measure on this exam due to this confounding factor.

Appendix E.8:
Sample of Course Review Documents

MFGE Course Review of MFGE 362 CAD Modeling and Analysis Using Surfaces

(Winter 2021)

By

Derek Yip-Hoi

Active Minds Changing Lives

1. Did students entering the class show deficiencies in the pre-requisite outcomes, and what is the evidence?

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- No deficiencies were noted.

Prerequisite Outcomes			Course
1.	Use computer techniques to assess structural loads.	✓	MFGE 225
2.	The ability to model parts and assemblies that capture design intent using parametric, feature-based CAD modeling techniques.	✓	MFGE 261
3.	Knowledge of CAD modeling techniques that capture the structure and manufacturability of molded and machined parts.	✓	MFGE 261

2) Is the course meeting its learning objectives, and what is the evidence?

	Course Outcomes	ABET SLO
1.	Model and analyze different types of wireframe and surface geometries using a parametric CAD system.	1.6
2.	Use different types of input data to guide modeling, and to efficiently organize CAD data.	1.6
3.	Create a CAD model of a laminate composite product.	1.6
4.	Perform and validate a simple structural analysis on a laminate composite model using Finite Element Analysis.	1.6
5.	Work individually and as part of a team to design, model and analyze a product comprised primarily of free-form surfaces.	2.1, 2.5

Results from Assessment

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- **Model and analyze different types of wireframe and surface geometries using a parametric CAD system.**
  - Performance on modeling and analysis activities in project (80% goal):
    - Activity: Modeling/Analysis of car body ✓
      - 20 out of 21 had a Satisfactory or Mastery rating = 95%
- **Use different types of input data to guide modeling.**
  - Performance on setting-up and using point cloud and images for project (80% goal):
    - Activity: Setup and use of Inputs
      - 21 out of 21 had a Satisfactory or Mastery rating = 100% ✓

Results from Assessment (cont'd)

- **Efficiently organize wireframe and surface CAD data.**
  - Performance on model organization in project:
    - Activity: Modeling/Analysis of car body
      - 17 out of 21 had a Satisfactory or Mastery rating = 81% ✓
- **Create a CAD model of a laminate composite product.**
  - Performance on use of composite modeling workbench in CATIA:
    - Homework 6: Design and modeling of a composite springboard
      - 19 out of 21 had a Satisfactory or Mastery rating = 90% ✓

Results from Assessment (cont'd)

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- **Perform and validate a simple structural analysis on a laminate composite model using Finite Element Analysis.**
  - Performance on use of FEA tools in CATIA to analyze a composite part:
    - Homework 7: Analysis and redesign of Springboard
      - 17 out of 21 had a Satisfactory or Mastery rating = 81% ✓
- **Work individually and as part of a team to design, model and analyze a product comprised primarily of free-form surfaces.**
  - Performance on project participation:
    - 21 out of 21 had a Satisfactory or Mastery rating = 100% ✓

3) If not, what changes would you recommend to improve student learning?

- None
- One Caveat:
  - This winter offering has been piloting the use of 3DExperience for the past three years.
  - This year, due to COVID-19 the course temporarily reverted to CATIA V5 to eliminate the challenge of students having to learn a new modeling platform remotely.
  - Assignment and project work also reverted to the last usage of CATIA V5.
  - The impact of changes to project work made since the last review using 3DExperience could not be assessed.

4. Are there other changes that you would recommend be made to the course and/or its learning outcomes, and if so, why?

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- None based on this offering and assessment
  - The next offering of this winter section will be in 2023 when it will be taken by the MFGE seniors as MFGE 462.
  - This transition reflects efforts to address changes recommended in the W18 review.

5. What changes have been made to address recommendations made at the last review and what has been their effect?

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- Continued the transition to 3DExperience
  - Offerings in W19 and W20 utilized this new platform
  - Temporary use of CATIA V5 in W21 was necessary to manage remote learning. This did not impact meeting the learning outcomes.
  - All MFGE 462 instruction will use 3DE starting in W23.

- Incorporated the impact of 3DE and the introduction of PDM into the outcomes

  5. Work collaboratively utilizing product data management techniques to support modeling and analysis activities.

- Project experience is being adapted to reflect more design/analysis decision-making as opposed to pure modeling
  - See next slide

New Project Work (W20)

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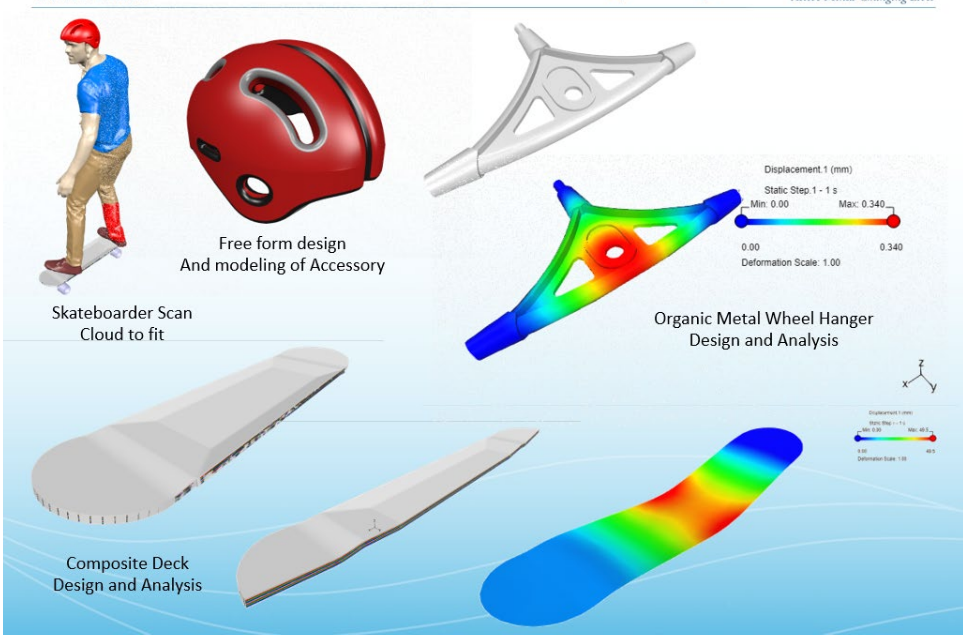

- Rewording of outcome 4 to bring out the increasing emphasis on design. These are the updated outcomes for MFGE 462
  1. Model and analyze different types of wireframe and surface geometries using a parametric CAD system.
  2. Use different types of input data to guide modeling, and to efficiently organize CAD data.
  3. Create application specific CAD models such as for composites, additive manufacturing or reverse engineering.
  4. Apply analysis techniques using the CAD models created to a product design problem.
  5. Work collaboratively utilizing product data management techniques to support modeling and analysis activities.

5. What changes have been made to address recommendations made at the last review and what has been their effect?
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- Changes in converting MFGE 362 to MFGE 462 should make it easier to develop the design/analysis portion of the class independent of the CAD modeling skills
  - **New Course (Catalog) Description:**
    - This class introduces advanced CAD modeling and analysis techniques with product design applications. 3D parametric modeling skills will be expanded to include surface modeling. Analysis techniques will be applied to a product design problem. Examples of these include Composites Design and Analysis, Generative Design, Design and Analysis using Digitized Data and Finite Element Modeling.
  - First step will be on working with PCE to improve the composites design and analysis portion of the class in both the training content and project work before W23.

6. For the ABET 1-7 SLO Performance Indicators mapped to in the course spec, identify any deficiencies with proposals for improvements including recommendations for changes to PIs.

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	Course Outcomes	ABET SLO
1.	Model and analyze different types of wireframe and surface geometries using a parametric CAD system.	**1.6**
2.	Use different types of input data to guide modeling, and to efficiently organize CAD data.	**1.6**
3.	Create a CAD model of a laminate composite product.	**1.6**
4.	Perform and validate a simple structural analysis on a laminate composite model using Finite Element Analysis.	**1.6**
5.	Work individually and as part of a team to design, model and analyze a product comprised primarily of free-form surfaces.	**2.1, 2.5**

- Course outcomes 1 to 4 are being met and are adequately reinforcing attainment of ABET SLO 1.6.
- Course outcome 5 is being met and is also adequately reinforcing attainment of ABET SLO 2.1 and 2.5

6. For the ABET 1-7 SLO Performance Indicators mapped to in the course spec, identify any deficiencies with proposals for improvements including recommendations for changes to PIs.

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- New outcomes for W23

	Course Outcomes – Students will be able to:	ABET SLO
1.	Model and analyze different types of wireframe and surface geometries using a parametric CAD system.	**1.6**
2.	Use different types of input data to guide modeling, and to efficiently organize CAD data.	**1.6**
3.	Create application specific CAD models such as for composites, additive manufacturing or reverse engineering.	**1.6**
4.	Apply analysis techniques to CAD models within the context of a product design problem and validate results.	**1.4, 1.5, 1.6**
5.	Work collaboratively utilizing product data management techniques to support, design modeling and analysis activities.	**2.1, 2.5, 5**

Modeling (outcomes 1–4)

Design & Analysis (outcomes 4–5)

- Course outcomes 4 can potentially be used to reinforce attainment of ABET SLO 1.4 and 1.5.
  - Solving a complex engineering problem and evaluating the solution
- Course outcome 5 can potentially be used to reinforce attainment of ABET SLO 5
  - Teamwork

6. For the ABET 1-7 SLO Performance Indicators mapped to in the course spec, identify any deficiencies with proposals for improvements including recommendations for changes to PIs.

- Recommendations for changes to PIs
  - "Innovate and think creatively" (skill) could be better emphasized in SLO 2
    - Its attainment could be reinforced in the course project where students have to creatively design and model a product with freeform surfaces.

Appendix E.9
Sample of MFGE
Program Meeting Minutes

Manufacturing Engineering Program Meetings

Meeting Minutes

Date	**3/4/2022**
Time	Friday 1:00 – 2:00 pm
Location	Virtual
Present	Al-Qudah, Newcomer, Kaas, Yip-Hoi, Algeddawy, Gill

Agenda Items	Discussion/comments	Action (for minutes)
52. Minutes and Changes to the Agenda	53. Meeting minutes from 2/25/2022 attached 54. Today's minutes taker: Gill	- Minutes approved
55. Announcements	56. No meeting on F/dead week, please make sure your outlook is up to date for a wrap-up meeting on finals week 57. MFGE492 presentations next week – email Jeff if you want links to meetings	
58. Standing business		
59. Students	60. Four students have not turned in acceptance letters and one has not registered. 61. Mycah Wells will not be staying at WWU 62. Orion Kalt has also not registered 63. Sean J is at a D+ in machine design – this is his last chance 64. Senior project teams are moving forward with many doing well. Trimming team is struggling the most.	-Jeff, David will contact new students to encourage submitting acceptance letters
65. Winter classes/labs	66. SME CMfgT results have been shared including a report from SME that showed number of questions in each section which indicates what sections are worth tracking. Many sections have only one question and adjacent topics have wildly varying results. 67. Jeff noticed that students with more lab experience scored better overall	

68. Resources and Technical Support	69. Ben presented a job description for a project lab TA. Some suggestions were given. 70. PCE resource authorization forms have been incomplete. Things are overwhelming Ben, so we will need to help students to schedule time with Ben and to plan ahead – this includes senior design, research, and class needs.	
71. Diversity, Equity, and Inclusion	72. MFGE Badge program for pre-majors – students go through a Canvas module and complete the modules to get badges that go in their (virtual) backpack 73. Do we want to have badges for MFGE like PME does? (they even use these in evaluation of acceptance to the major) 74. Jill has communicated that many students have asked about MFGE badges 75. PME and Makerspace used TA's to create their badges. 76. There isn't TA money right now – PME was done previously with JCATI grant money 77. We might get as much as 40 hours of TA support next year for the whole program 78. Could this be an independent study topic? 79. These seem like higher level topics like Automation, Quality, CAD/CAM, and maybe the "pick 3" senior classes 80. Could start with pillars of manufacturing 81. How to use Outlook and email	-David will take with Nicole/John about how the JCATI money worked -Sura will create a shared document that we can use to develop a list of ideas
82. Industry Relations	83. Spring Quarter Boeing talk	
D. Business for upcoming meetings		
1. Upcoming agenda	84. Laptop Requirement report from the resource committee 85. SLO 6 – Rubric evaluation 86. Pre-major project shadowing MFGE 491 course review MFGE expansion	
2. Upcoming meetings	87. Fridays 1-2 pm 88. Minutes taking cycle: Yip-Hoi, Newcomer, Gill, Alqudah, Algeddawy	

Appendix E.10
Sample of IAC Meeting Minutes

Manufacturing Engineering Program Meetings-IAC *Meetings Minutes*

Date	**6/4/2021**
Time	Friday 2:00 – 4:00 pm
Location	Virtual
Attendees	Andrew Gall (Paccar), Josh Little (Boeing), Fredrick Rudnick (Boeing), Tony Minotte (Boeing), Levi Gamble (Hexcel), Dan Cuenca (Boeing), Kyle Lehning (Boeing), Thi Nguyen (Boeing), Tyler Mohr (Fluke), Julie Bennett (Boeing), Georgia Donaldson (Boeing), Joe Gray (Korry), And the Faculty: Tarek, Jeff, Derek, Ben, David, Sura
Minutes' taker	Sura

Agenda Items	Discussion/comments	Action
1. Introductions	- Tyler Mohr, chair of IAC started the meeting - Introductions of attendees	
2. Approval of Minutes from Fall 2020 Meeting + Changes to the Agenda	- Fall meeting minutes were approved - No changes to the agenda	
3. Program and Departmental Updates	**-Yip-Hoi provides updates on the MFGE program:** **Students:** 89. Forty-five students are currently in the pre-major pipeline. 90. New admitted class in Winter 21: 33 applicants, 26-accepted, 5-rejected 5, 2-PCE as 1st option. 91. Juniors: 19 students entering the senior year 92. Seniors: 26/28 are graduating this spring. The other two not graduating are a student who will repeat some classes in the Fall and a student who will complete GURs and Tech electives. **Programs:** 93. EECE interest grew by 20% recently because of the program name change. 94. The MFGE interest is consistent. 95. PCE interest dropped: the word "plastic" in the name, and the direct recruitment might be the reasons behind this drop	

	Faculty: 96. Algeddawy was promoted to associate professor. 97. Alqudah will serve as the incoming program director **- Newcomer provides department updates** 98. Two searches for EECE took place this year, and only one faculty was hired. 99. Two EECE searches next year (pending approval) 100. PCE search is lower on the list (one or two years ahead) 101. The institute of the Energy Studies hired a faculty who will be housed in the Engineer & Design Department 102. WWU engineering is in the Boeing records currently (thanks, Boeing!) 103. The university is cautiously optimistic about the Fall, and hopefully, the enrollment will go back to pre-COVID in the next few years. **- Other updates:** 104. Labs were modified to maintain social destining 105. The number of face-to-face labs was modified accordingly. Some labs were converted to online modalities. 106. The faculty noticed that the students understood the value of being in the labs, which was reflected in their focus and performance. 107. Students had a good experience in general and complied with the new lab protocols 108. Faculty will utilize the lessons learned this year to incorporate some changes for the in-person labs for the incoming years 109. Ben Kaas has been a great resource this year, accommodating the change in the lab (thanks, Ben!) **- IAC Updates:** 110. Michael Hinckley moved from Boeing and is now relocated to CA 111. Andrew Gall is now the representing Paccar	
4. Improving Equity, Inclusion, and Diversity	112. Our First Year Program Director Jill Davishahl piloted two classes as a sequence to introduce engineering in the hope that this will contribute to an increase in the diversity of the interested students 113. PCE/MFGE/and ID total program credits increased by two due to this new sequence. 114. A makerspace for pre-majors is also available for the students now. the university will staff it and provide equipment for it (3D printing, microcontrollers, 3D printers, etc.) 115. BEES program saw a decrease in the number of MFGE interested students, but also the overall enrollment in the program was lower than the year before	

5. Curriculum and Program Development	116. Students who will be admitted next year will have the Robotics class as required, not an elective course. 117. Machine Design moved from senior year to junior year 118. Intro to Composites Processes moved to senior year 119. Advanced CAD to senior year 120. Systems integrations is now a reoccurring Tec Elective class 121. The faculty did not decide about shifting to 3DXperince 122. The PCE program is piloting the use of Altair for their modeling needs **- SME CMfgT exam:** 123. 26 out of 28 passed the first turn, one passed on the second time 124. Only 3 students in 6 years did not pass after the second time (97.6% passing rate over the 6 years) 125. The averages are going up each year, and we do not have any concerns about any of the exam areas. The faculty noted that the exam results are correlated with the ESL students **- Program development** 126. The program submitted a strategic plan proposal to expand the MFGE program in two phases; Yip-Hoi shared a PowerPoint presentation on the details of the expansion. 127. We are looking at 25-27 biennium for submitting the expansion proposal	There was a suggestion to think about changing the name of The Systems Integrations class to something like Advance Automation and Control Systems to give it a more appealing name.
6. Assessment and Accreditation	128. The program completed the transition from a-k to 1-7 of ABET 129. No deficiencies were found based on the collected assessment 130. Rubric 6 will be assessed in the Fall. MFGE 463 will be used for that. 131. The program is comfortable with where things are in terms of assessment and accreditation in 2022	
7. Resources	132. Received an STF grant for Cobot to be part of the curriculum (part handling, fixturing, etc.) This is the same type in the LEAF cell 133. From gift funding, we are obtaining optical inspection equipment to do many measurements and analyses (QBM Snap 800) 134. There is a thought about starting to require Laptops for all students to buy. 135. The cost is estimated to be $1500-$2000 136. Several questions are still to be answered about this Laptop program: when to require it (pre-major or only	- Joe Gary: would the cloud-based software reduce the requirement? Tyler: Have you asked the students? They are the ones who will pay? Maybe interviews or surveys

	majors)? What level of laptop (full CAD or remote desktop)? How can we deal with the issue of Equity (big expenses at the beginning of college, the ones who do not have the funding are at a disadvantage already)? What spaces do we need to keep? What can we do in classes? Many other universities have requirements for that (UW is one). 137. We want to keep the shared experience in the lab 138. Currently, there is no way to require students to use laptops in the classroom, so we cannot plan the curriculum around it 139. We might be able to have a commercial company to do a rental computer program	Levi: would they pay less fess over the year? Tyler: Have you reached out to other schools and learned from their experience? Thi: How about a renting program?
8. Senior Projects and Sponsored R&D	140. This year's senior projects went very well 141. We will need 6-8 projects for next year 142. The senior project timeline is different than the formula SAE project timeline, so it is not a good fit to be a senior project	
9. IAC Business	The IAC members asked to let them know when opportunities such as presentations before the career fair, interviews, talk series, etc. become available, and they will be happy to work with the faculty on logistics and advertisements	-Joe Gary: reached out to the career services center about internships, but they did not get any feedback from the center. Andrew- Mentorship nights? Virtual mentorship nights. Tyler: follow up with Rose about DEI
10. Items from the Floor		
11. Next Meeting a. Date b. Location	Fall 2021, Date and location TBD	Joe: Korry is welling to host
12. Adjourn	4:00 pm	

Appendix E.11
Sample of ENGD
Curriculum Committee
Meeting Minutes

Curriculum Committee

10/18/21

Exception Requests:

143. None

Curriculum/Catalog Changes (Due in November):

144. EECE
145. change pre-reqs for EECE 361 and 374
146. name change of EECE 460 (likely "Communication Systems II" instead of "Digital Communications")
147. minor wording change to Embedded Systems Minor front catalog matter
148. EECE 384 – new class – AI - done
149. EECE 397c - done
150. ID
151. None, but design and art are changing some of their courses so there may be a program change – changes made previously – no changes needed for this year.
152. MFGE
153. PCE
154. Changing the program name – Discussing again on 10/19/21
155. Change program to reflect EECE 351 changing to ENGR 351
156. First Year Programs
157. Remove ENGR 104 prepreq and add 115 prereq in timetable (Lisa to check with the registrar) - complete
158. MSCM
    159. They want an IE course (tech elective for us as well)
    160. Put thought into a combined engineering design and CAD class for MSCM

ABET Course Reviews for 21/22 (general and shared courses):

161. MFGE 231 Spring
162. PCE 342 Spring
163. Check on ENGR 170 to review in W22
164. ENGR 101 W22
165. ENGR 115 S22
166. MFGE 261 F21

Other Issues:

167. Switching modalities between hybrid, face-to-face, and ad hock hybrid
168. Come up with department policy statement regarding what is considered face-to-face, hybrid, etc.
169. Put in request for modality flexibility for ID380 for winter of this year – see ACC minutes – to chance to hybrid – not happening for W22
170. Put in course changes for catalog changes for modality ID 380 & PCE 461 – cannot permanently change to hybrid. Only temporary for now.
171. Lisa to ask Jamie to remove all ETEC equivalencies in TimeTable. – complete for 21/22 catalog
172. MATH 341 is already listed as an approved prereq to replace MATH 345. A note in DegreeWorks may need to be added to approve MATH 341 towards the degree requirement.

November meeting:

173. Draft a policy for going from F2F to Hybrid
174. What does our next technician look like?

Appendix E.12
Sample of WWU
Program and Course Change Forms

MFGE - 491 - Course Revision

z(Archived) 2020-2021 01. Request for Course Revision

Submitter

Curriculog Quick-Start Guide downloadable PDF: Click here
Curriculog Crosslisting Guide downloadable PDF: Click here
ACC syllabus requirement policy: Click here
ACC policy on credit hours: Click here (refer to this policy if a modality/delivery mode is included in this proposal)
Curriculog University (link at bottom of website) includes user manual, etc.

Read before you begin

TURN ON help text before starting this proposal by clicking in the top right corner of the heading.
IMPORT curriculum data from the Catalog by clicking in the top left corner. **Do not revise imported fields until after launching the proposal.**
FILL IN all fields required marked with an * after importing data. You will not be able to launch the proposal without completing required fields.
LAUNCH proposal by clicking in the top left corner. REVISIONS can only be made to a proposal after LAUNCH.
DO NOT make proposed changes before launching proposal. **Changes will only be tracked after proposal is launched.** Proposal can be shared only after LAUNCH by the ORIGINATOR. To share a proposal use the message icon within Curriculog or email a direct link (URL) of the proposal and establish communication through email.
After LAUNCH, the ORIGINATOR must go to Decisions in the Proposal Toolbox to approve which will send it to the next step. Before approval, the ORIGINATOR may still edit the proposal.

Important update for 2019-2020 academic year

All GUR course revision proposals must use the "2020-2021 02. GUR: Request for Course Revision" approval process (you are currently in the regular course revision proposal). If a GUR course uses the regular course revision approval process the Originator will be asked to launch a new proposal.

Type of Proposal* Course Revision

Select "Course Revision." This selection, combined with the course prefix and number, will be used in the title of your proposal.

Prefix:* MFGE

Course Number:* 491

Reminder: A course changing numbers requires a cancellation proposal of existing course and a new course proposal for new course.

Academic Department:* Engineering and Design

Course Type* Manufacturing Engineering

Rationale for Revision:*

Credits are being redistributed between MFGE 491 and 492 to reduce the number of different topics being addressed in the former. This has proven to be challenging for promoting student engagement in their project development work and in advising by the instructor. Project planning will now be taught at the beginning of 492.

The course description is being updated to reflect this and to emphasize aspects of the course that are important to accreditation e.g. requirements gathering, impact of engineering solutions and teamwork.

The MFGE 342 prerequisite has been removed because projects often do not require a Design of Experiments. The new prerequistes emphasize knowledge and application of the design process (MFGE 333) and industrial safety (MFGE 381). These are topics that are fundamental to applying the design process and to ethics assignments and discussions.

Please check all that will be changed:*

- [ ] Title
- [ ] Grade Mode
- [ ] Repeatability
- [x] Description
- [ ] Schedule Type
- [ ] Course Modality/Delivery Mode
- [x] Credits
- [x] Prerequisites

Course modality definition: Propose to offer a permanent on-campus course either online (for example, during summer quarter) or abroad. Click here for an approved modality change proposal from 2018-2019.

Course Details

For the following fields in Course Details (Course Title, Credits, Course Description, Prerequisites, Prequisites with Concurrency, Corequisites), which you have imported from the catalog, please DO NOT make proposed revisions until after launching the proposal.

Course Title:* Project Research, Planning and Ethics

New Transcript Title: Research, Planning and Ethics

Credits: 3

Grade Mode Letter

Course Description:* First in the series of three capstone project courses. Includes problem definition, background research, requirements gathering and generation of technical specifications for a design problem. Explores professional and ethical responsibilities and the impact of engineering solutions in a global, societal, economic and environmental context. Teamwork, technical proposal writing, project journaling and research skills are also discussed and practiced.

Prerequisite(s): ENG 101; MFGE 333; MFGE 381

Prerequisite(s) with concurrency:

Corequisite(s):

For acceptable MATH or other course prereqs (e.g. HNRS) listed above as 'higher' or 'equivalent' please provide a complete list of these courses for prereq checking and Registration purposes:

Is this proposal a teacher education certification or endorsement course offering?* ○ Yes ◉ No

Are prereqs Banner enforced?* ◉ Yes ○ No

Minimum grade is "C-" by default and "C" for Woodring courses. If minimum grade is not "C-" or "C (Woodring)," enter grade in "Minimum grade" field and explain grade in rationale above.

Minimum Grade:

Collegial Communication/Impact on Resources

Collegial Communication Guidelines

The ACC requires clear evidence of collegial communication in all instances where a new, revised, or cancelled course or program is likely to impact the curriculum or the enrollment of a course or program in another department.

The ACC strongly recommends collegial communication in cases where a proposal is substantially similar to an existing course or program in another department.

Have faculty in the Department/ Program been notified and approve of this change?* ◉ Yes ○ No ○ In progress

Are departments within the college and/or departments outside the college in agreement?* ○ Yes ○ No ◉ N/A ○ In progress

If the communication is made and approved, insert all communication(s) in the comment box, including the from/date/subject/contents if in an email. If the communication is ongoing, mark in progress and insert final approval(s) later.

Comments

For prereqs or requirements or potential impact to programs outside your department, run an Impact Report. Make sure to select **2020-2021 Working Catalog** when generate the report. There are two ways to run an Impact Report:

After importing the course, go to the top left of the proposal and click on the Run Impact Report icon.

Click on the following link to go to Impact Report: https://wwu.curriculog.com/reports

Does the course revision impact other courses or programs? *

☐ Yes. The course revision is a prereq for other courses and/or appears in programs of study.

☑ No. The course revision is not a prereq nor appears in programs of study.

Based upon the impact report, initiate communication with impacted departments/programs. This can be done by a message or copy/paste URL of proposal in an email or sending the proposal in a message within Curriculog.

Copy/paste the impact report results into this field.

Note: While MFGE 491 (changing from 4 to 3 credits) is a requirement in the Manufacturing Engineering, BS the total credits will not change due to a credit revision to MFGE 492 (2 to 3 credits).

Impact Report for MFGE 491

Source: 2020-2021 Working Catalog

Prerequisites & Notes:
MFGE 492 - Manufacturing Project Proposal

Programs
Industrial Technology — Vehicle Design, BS (In Moratorium)
Manufacturing Engineering, BS

Graduate Level Course Information

Will this course be stacked with an undergraduate course? *

○ Yes ○ No ◉ N/A

If yes, explain the different expectations for graduate students:

Attached Syllabus

A syllabus is required for course revisions that include a change in credit hours, a significant change in course content, or a change in modality.

To add an attachment click on (files) icon at the top of the Proposal Toolbox in the right panel.

ACC syllabus requirement policy: Click here

Syllabus attached?* (•) Yes, syllabus is attached ( ) No ( ) Not required

Does syllabus include class times or length and frequency of classroom sessions?* (•) Yes ( ) No ( ) Not required

ACC will have additional guidance on syllabus requirements in fall 2019.

Steps for MFGE - 491 - Course Revision

Originator
Status: *Approved*

Participants

Derek Yip-Hoi 10/14/2019 9:13 AM

Department/Program review
Status: *Approved*

Participants

Engineering and Design Department Review

Jeff Newcomer * 10/15/2019 6:58 AM

Derek Yip-Hoi * 10/14/2019 1:19 PM

College Curriculum Committee
Status: *Approved*

Participants

College of Science and Engineering Curriculum Committee

Jackie Caplan-Auerbach * 11/5/2019 1:03 PM

Academic Coordinating Commission
Status: *Approved*

Participants

Academic Coordinating Commission

Lizzy Ramhorst * 11/14/2019 10:46 AM

Catalog Integration
Status: *Approved*

Participants

Jamie Lawson 12/16/2019 4:26 PM

Appendix E.13

Continuous Improvement Actions

A. Improvement Actions Identified Directly from Evaluation of Collected 1-7 Assessment Data							
Student Outcome	**Year Assessed**	**Description of proposed improvement recommended by evaluation**	**Type**	**Rationale that improvement can assist in achieving the outcome, or its assessment**	**Evidence that will demonstrate improved learning, or its assessment**	**Responsible Faculty and Deadline**	**Status of Improvement Action/Conclusions from Evidence Collected in 2021-22**
1	2020-21	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
2	2020-21	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
3	2018-19	Continue working to improve student's abilities to write work instructions to effectively communicate information with a broad range of audience	C	Practice will help in preparing students to better communicate technical data in work instructions	Scores for SLO 3.4 will rise above the 80% threshold.	David Gill (F2021)	N/A
4	2018-19	Continue working to improve student's abilities to identify and articulate ethical dilemmas with more structured assignments.	C	Practice will help in preparing students for their presentation and exam.	Scores for SLO 4.1 will rise above the 80% threshold.	Derek Yip-Hoi (F2021)	Student achievement met the 80% target. As expected, shifting the Project Planning content from 491 to 492 created space during the term for more focus on developing this ability.

5	2019-20	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
6	2020-21	The rubric as introduced did not provide an informative assessment tool for the outcome. A revised rubric was proposed and evaluated in 2021-22.	C	PIs should be worded differently to assess all types of experimentation not only the specific statistical DOE method	- Instructors will find it appropriate to use the rubric as an assessment tool for analyzing experimentation in various settings - Scores for SLO 4.1 will rise above the 80% threshold.	David Gill (F2021)	The instructor proposed adding when relevant" to PI 6.4 when the description used "research literature" so broader analysis can be evaluated. Student achievement met the 80% target. As expected Shifting the Project Planning content from 491 to 492 created space during the term for more focus on developing this ability.
7	2019-20	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A

Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology

A. Improvement Actions Identified Directly from Evaluation of Collected 1-7 Assessment Data							
Student Outcome	Year Assessed	Description of proposed improvement recommended by evaluation	Type	Rationale that improvement can assist in achieving the outcome, or its assessment	Evidence that will demonstrate improved learning, or its assessment	Responsible Faculty and Deadline	Status of Improvement Action/Conclusions from Evidence Collected
1		Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
2		Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
3	2018-19	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
4	2018-19	Continue working to improve student's abilities to identify and articulate ethical dilemmas with more structured assignments.	C	Practice will help in preparing students for their presentation and exam.	Scores for SLO 4.1 will rise above the 80% threshold.	Derek Yip-Hoi (F2021)	Carried over from assessment of SLO f in 2017-18. Student achievement remained slightly below the target at 77.3%. Further changes will be made and evaluated at the next assessment of SLO 4 in 2021-22. Plans to shift the Project Planning content from 491 to 492 will create space during the term for more focus on developing thi ability.
5	2019-20	Completed. No changes recommended	N/A	N/A	N/A	N/A	N/A

		from faculty evaluation.					
6		Next assessed in 2021-22					
7	2019-20	Completed. No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology							

A. Improvement Actions Identified Directly from Evaluation of Collected 1-7 Assessment Data							
Student Outcome	**Year Assessed**	**Description of proposed improvement recommended by evaluation**	**Type**	**Rationale that improvement can assist in achieving the outcome, or its assessment**	**Evidence that will demonstrate improved learning, or its assessment**	**Responsible Faculty and Deadline**	**Status of Improvement Action/Conclusions from Evidence Collected**
1		Next assessed in 2020-21					
2		Next assessed in 2020-21					
3	2018-19	No changes recommended from faculty evaluation.	N/A	N/A	N/A	N/A	N/A
4	2018-19	Continue working to improve student's abilities to identify and articulate ethical	C	Practice will help in preparing students for their presentation and exam.	Scores for SLO 4.1 will rise above the 80% threshold.	Derek Yip-Hoi (F2021)	Carried over from assessement of SLO f in 2017-18. Student achievement remained slightly below the target at 77.3%. Further changes will be made and evaluated at the next assessment of SLO 4 in 2021-22. Plans to shift the Project

		dilemmas with more structured assignments.					Planning content from 491 to 492 will create space during the term for more focus on developing thi ability.
5		Next assessed in 2019-20					
6		Next assessed in 2020-21					
7		Next assessed in 2019-20					
Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology							

A. Improvement Actions Identified Directly from Evaluation of Collected a-k Assessment Data 2017-18						
Student Outcome	**Description of proposed improvement recommended by evaluation**	**Type**	**Rationale that improvement can assist in achieving the outcome, or its assessment**	**Evidence that will demonstrate improved learning, or its assessment**	**Responsible Faculty and Deadline**	**Status of Improvement Action/Conclusions from Evidence Collected**
a	Faculty will recruit, vet and select potential senior projects and sponsors during the Spring and Summer proceeding the start of the academic year (a.5)	FS, SS, R	Due to the emphasis on using industrial sponsored projects, there is often significant delay in project teams establishing a working relationship with their sponsor. This delays requirements gathering that can ultimately slow progress over the entire project timeline which manifests itself at the end through poor verification of solutions.	Senior project teams are able to perform more testing of concepts during the design phase (MFGE 492) to validate their choices, and finsh their implementation with time to spare to enable proper verification of their final solution.	Derek Yip-Hoi (S2019)	Transition to new 1-7 outcomes. a.5 is no longer being assessed. Senior project faculty have included visits to sponsor companies in the proceeding summer to assist in identifying appropriate projects for incoming senior class.
b	All summative targets met. No improvements recommended.	N/A	N/A	N/A	N/A	

c	Increase the credits in MFGE 492 from 2 to 3 (c.3, c.4, c.5)	C	Student maybe underestimating the amount of effort needed during the design phase (MFGE 492) to properly generate, analyze and rank design alternatives and to detail their final solution.	Indicators c.3, c.4 and c.5 in MFGE 492 should improve to show that teams are in a timely fashion arriving at a final solution that meets requirements, and producing appropriate document.	Derek Yip-Hoi (S2019)	Discussions are ongoing with PCE on making this change. Agreement with PCE faculty and changes made to credit distribution in 2019-20. Classes will reflect these changes in 2020-21 academic year.
d	All summative targets met. No improvements recommended.	N/A	N/A	N/A	N/A	
e	Faculty will monitor performance indicator e.3 (or new equivalent) "Correctly formulate the problem according to chosen solution method" and recommend corrective action if performance continues to lag.	C	e.3 was assessed at 71.4%. However, the previous year it was assessed at 92.9%. Monitoring will determine if this was a one-time occurrence or if there is a pattern indicating a deficiency that needs to be addressed.	e.3 is assessed at over 80% at next review	Jeff Newcomer (S2019)	Transition to new 1-7 outcomes. e.3 is no longer being assessed.

f	Add exercise that gives seniors in MFGE 491 more practice identifying and stating ethical dilemmas that exist in different case studies.	C	f.1 was assessed below 80% in both MFGE 491 and 493, and f.2 in 491. This may be a one-time occurrence as these were assessed above the target the previous year. However, the recommended improvements can only enhance ethical thinking and articulation.	Assessment will include new exercise and will in total surpass 80% threshold	Derek Yip-Hoi (F2019)	Pending data from F2019. Delayed to F2020. Plans to shift Project Planning content from 491 to 492 will allow the space to better implement this change. Delayed again to F2021 due to COVID-19 impacts that prioritized adapting instruction to a remote learning modality.
	Expand active learning activities to ensure more consistent participation of all students in ethics discussions.	P		Assessment will include new active learning exercises and will in total surpass 80% threshold	Derek Yip-Hoi (F2019)	Pending data from F2019. Delayed to F2020. Plans to shift Project Planning content from 491 to 492 will allow the space to better implement this change. In F2020, MS Teams was used to facilitate breakout activities for groups of remote students using shared documents. Each student was able to participate on-line in ethics case study discussions and provide comments. Teammates survey was used to allow groups to provide feedback on engagement of the classmates to supplement instructor's observations. 82% achieved a 'Satisfactory' or 'Exemplary' rating.

g	All summative targets met. No improvements recommended.	N/A	N/A	N/A	N/A	
h	Have each student write a short reflective essay on the global, economic, environmental and societal impacts of the ethical problem researched for their ethics presentation.	C	Students are expected to make these impacts clear in their ethics presentation. However, this has been skipped or not fully addressed by some. A separately graded assignment will clarify each students knowledge of these impacts.	Assessment including new assignment shows attainment of 80% target.	Derek Yip-Hoi (F2019)	Students were asked to write a short essay where they reflect on one of the NAE Grand Challenges chosen for their ethics presentation, and how pursuing this challenge either supports or detracts from an engineers professional responsibilities as stated in the NSPE Code of Ethics for Engineers. 89% were able to articulate their responsibilities.
	Pair and assess separately economic/environmental and societal/global impacts.	A	Provides more granularity to clarify whether students need more exposure to the impacts of one pair or the other.	Assessment is successful at showing attainment of 80% target using two indicators instead of one.	Derek Yip-Hoi (F2019)	Pending data from F2019. Delayed to F2020. Plans to shift Project Planning content from 491 to 492 will allow the space to better implement this change. In F2020 as part of their Ethics Research Project, each student had to write an Impacts Analysis related to their topic that separately addressed economic, environmental, global and societal impacts. 96% achieved a 'Satisfactory' or "Exemplary' rating.

i	Faculty will monitor performance indicator i.3 (or new equivalent) "Successfully integrate new information" and recommend corrective action if performance continues to lag.	C	i.3 was assessed at 53%. However, the previous year it was assessed at 93%. Monitoring will determine if this was a one time occurrence or if there is a pattern indicating a deficiency that needs to be addressed.	i.3 is assessed at over 80% at next review	Jeff Newcomer (W2019)	Transition to new 1-7 outcomes. i.3 is no longer being assessed. Monitoring will be continued as part of the assessment of SLO 7 in 2019-20.
j	Faculty will monitor performance indicator j.4 (or new equivalent) "Integrates information into a nuanced argument" and recommend corrective action if performance continues to lag.	C	j.4 was assessed at 73.3%. However, the previous year it was assessed at 86%. Monitoring will determine if this was a one time occurrence or if there is a pattern indicating a deficiency that needs to be addressed.	j.4 is assessed at over 80% at next review	Derek Yip-Hoi (F2018)	Transition to new 1-7 outcomes. j.4 is no longer being assessed.
k	All summative targets met. No improvements recommended.	N/A	N/A	N/A	N/A	

Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology

	Description of Proposed Improvement	Year Proposed	Area(s) of Impact*	Rationale that improvement will have Impact in the Area(s) Indicated	Evidence that will demonstrate the Impact has been Realized	Responsible Faculty and Deadline	Status of Improvement Action/Conclusions from Evidence Collected
	B. Improvement Actions Identified from Other Evidence Gathered						
1	Perform assessment of new SLOs 1, 2 and 6 to determine effectiveness.	2020-21	A	Change to new 1-7 outcomes have been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	S. Alqudah (F2021)	S2021: Final assessment data using SLOs 1, 2, and 6 are completed

2	Improve exposure to automation by making Robotics (MFGE 453) a required course for all MFGE majors.		C	Currently majors have a choice between robotics and advanced CNC (MFGE 434). This will help to expand the exposure of all MFGE majors to robotics. Given the increase in use of automation in local industry, this direction was decided upon in consultation with the program's IAC.	All MFGE majors starting with the class admitted in 2022 will have MFGE 453 completed as part of their graduation requirement.	S. Alqudah (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to make robotics required by all MFGE majors. This change will be in effect for the class admitted in winter 2022.
3	Provide more timely reinforcement of analytical problem solving skills by moving MFGE 465 Machine Design from the senior to the junior year as MFGE 365.		C	Currently most students have at least a one year gap between completing ENGR 225 Strength of Materials and applying this material in MFGE 465. There is concern that students are forgetting this foundational material. Moving MFGE 465 to the junior year will reduce the gap to reinforcement and provide more opportunities to	Faculty teaching MFGE 365 will observe the preparation of students based on the MFGE 225 prerequisite and report on preparation of students at next MFGE 365 course review in 2024. This should indicate adequate preparation.	T. Algeddawy (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to replace MFGE 465 with MFGE 365. W2021: Both classes have been scheduled for the 2021-22 academic year to faciliate the move to the junior year.

				engage juniors in analytical work.			
4	Formalize expansion of learning opportunities for majors in Robotics, Automation and Systems Integration (RASI) by converting MFGE 497B Systems Integration from an experimental course to MFGE 454. This course will now appear in the university catalog and in program planning guides as an option for majors to take.		C	This is the next in a sequence of steps taken by the program over the past few years to expand learning opportunities in RASI. This completes improvement 3 started in 2018-19. Though this class will remain an option, together with the introduction of MFGE 250 in S20 and the improvement above to make robotics required by all majors, it will greatly impact the amount of exposure majors can receive to RASI	Faculty teaching MFGE 454 will be able to observe the abilities of students having taken all courses in the sequence that supports RASI i.e. MFGE 250, EECE 351, EECE 352, MFGE 453 and MFGE 454. At the next course review the faculty will provide evidence of improvement in the preparation of majors who have taken this full sequence through assessment of the course's outcomes and prerequsite outcomes.	T. Algeddawy (S2021)	F2020: Changes have been made through the formal WWU curriculum approval adding MFGE 454 to the program. W2021: Class has been included in the 2021-22 academic year.

5	Move courses with a high level of specialization to the senior year to provide room in the junior year for more foundational experiences such as completing outstanding Math/Science requirements, computational methods, and machine design, and to participate in research. The courses that will be moved are MFGE 362 (renumbered to MFGE 462) and PCE 372. The course load will return to 3/3/4		C, SS	The 2020-21 junior course load is 3/4/4. This is an increase from the previous 3/3/4 load. The two openings in fall and winter have been used by some students to complete requirements from the sophomore year. Some students particularly those working also benefit from the lighter course load. Returning to a 3/3/4 load will increase the flexibility of students to complete requirements without having to take summer classes and help students with heavy work commitments. Moving PCE 372 to the senior year allows MFGE 365 to be scheduled in the junior year.	Fewer students that will need to take summer classes between their sophomore and juniors years because of the additional opportunity to complete a lower-division requirement. Fewer students with external commitments such as work struggling to keep pace with the program.	D. Yip-Hoi (W2021)	F2020: Changes have been made through the formal WWU curriculum approval process to renumber MFGE 362 to MFGE 462. W2021: MFGE 362 and MFGE 462 have been scheduled for 2021-22 and PCE 372 temporarily dropped to return in 2022-23.

6	Expand technical elective opportunities by giving majors the option to take one required course from MFGE 434, 454 and 462 and to use the other two as potential elective options.		C, SS	Currently majors are guaranteed available one technical elective each year. The introduction of MFGE 454 together with the move of MFGE 362 to a senior level class has made it possible to give majors two options from among MFGE 434, 454, 462.	Fewer students that have difficulties finding classes to complete their 6-credit technical elective requirement.	S. Alqudah (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to require students to take one of MFGE 434, 454 and 462. The other two are available as technical elective options. .
7	Transfer responsibility for the development and assessment of MFGE 342 Design of Experiments to the PCE program.		C, FS	Due to the experimental nature of several of PCE advanced courses DOE techniques are more widely practiced that in the MFGE program. PCE faculty have taken the lead in recent years in developing and instruction of MFGE 342. Shifting the responsibility helps better balance the teaching workload of each program for courses than	The balance in shared courses that each program manages continues to be roughly equitable as their curriculum evolves.	D. Yip-Hoi (W2021)	F2020: Changes have been made through the formal WWU curriculum approval process to require students to rename MFGE 342 to PCE 342 formally transferring ownership. W2021: PCE 342 has been scheduled for 2021-22 replacing MFGE 342. .

				are taken in common.			
8	Redistribution of content between MFGE 250, ENGR 351, and ENGR 352.		C	Moving PLCs from EECE 352 to MFGE 250 allows for a more manufacturing-applied treatment of this topic. This also ensures that PCE majors who do not take EECE 352 get exposure. Moving microcontrollers from EECE 352 to EECE 351 benefits MFGE majors by creating room in EECE 352 for a more in-depth treatment of feedback control while also benefiting PCE majors taking EECE 351 who current are not exposed to MCs.	Faculty teaching MFGE 250, EECE 351 and 352 will be assessing student learning on PLCs, microcontrollers and feedback control. Their course outcomes assessment on these topics at the next course reviews and their observations will be used as evidence that this change has benefitted student exposure and learning. These should indicate that students are meeting the 80% threshold.	J. Newcomer - MFGE 250 (S2023) EECE faculty - ENGR 351 (F2023) EECE faculty - ENGR 352 (S2024)	F2020: Changes have been made through the formal WWU curriculum approval process to approve the new course contents of EECE 351 and 352. .

9	Change in modality of teaching for MFGE 250, 491, 492 and 492 have been performed to give instructors more flexibility in how instruction in these courses is delivered.		FS,P	The need to switch to online instruction during the Pandemic has highlighted advantages of judicious use of remote instruction to compliment face-2-face experiences to improve efficiency in learning. Initially, instructors of these four courses have decided to formalize the ability to continue using different modalities of instruction. For example, in the capstone senior project sequence 491-493, remote technologies can assist in more efficient collaborative project work that better integrates industry sponsors.	Faculty teaching these courses who decide to use online modalities will gather feedback from students in course evaluations to determine the impact of the approaches. These along with observations of improvement in efficiency by the instructor will be presented at the next course review to highlight the improvement.	J. Newcomer - MFGE 250 (S2023) EECE faculty - EECE 351 (F2023) EECE faculty - EECE 352 (S2024)	F2020: Changes have been made through the formal WWU curriculum process to change the modalities of instruction for MFGE 250, 491, 492 and 493. .

1	Perform assessment of new SLOs 5, 7 and 6 to determine effectiveness.	2019-20	A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F2020)	Assessment data collected using SLOs 5 and 7 rubrics have been evaluated. No changes to the rubrics and performance indicators have been recommended at this time. SLO 6 was recommended for revising the rubric and performance indicators and re-assessed in 2021-22

1	Introduce an option for Robotics, Automation and Systems Integration within the program.	2018-19	C, FS, D, SS, R	Evidence from interactions with industry and discussions with the IAC have indicated a need to expand the curriculum to support trends of increasing use of robotics and automation by Washington manufacturers.	Graduated majors from an option in Robotics, Automation and Systems Integration. A successful re-accreditation of the program with this new option.	Derek Yip-Hoi (S2023)	S2018: Preliminary plan developed and discussed with IAC F2018: Plan used to initiate curriculum changes to begin implementation of option and to develop pre-proposal for decision package. F2019: Decision package proposal developed in collaboration with PCE, submitted for internal review; proposal shelved due to COVID-19. S2020: Program continuing discussions on creation of this option without funding from the State for additional resources.

2	Create a new Learning Factory laboratory to support learning in Manufacturing Systems Integration. (This improvement supports 1)		R	A learning factory will add resources in robotics and automation and an ability for students to work on an integrated system that currently does not exist for the program. This will make graduates better prepared to support the trends in manufacturing in WA.	An operational Learning Factory that is being used in one or more classes in the curriculum and that supports faculty R&D.	T. Algeddawy (W2021)	S2019: Space has been allocated; Design completed; Equipment purchased; Integration of Components has started. LEAF operational and used for the first time in W20 offering of MFGE 497B Systems Integration.
3	Incorporate into the teaching schedule a Manufacturing Systems Integration Technical Elective to be offered in W2020. (This improvement supports 1)		C	The ability of majors to integrate components as part of the design, implementation, and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included that make use of the Learning Factory.	T. Algeddawy (W2021)	S2019: Space has been allocated; Design completed; Equipment purchased; Integration of Components has started; MFGE 497B Systems Integration offered for the first time in W20.

4	Add to the curriculum a new Introduction to Manufacturing Automation course (MFGE 350) in the Spring Quarter of the Sophomore Year. (This improvement supports 1)		C	By providing an introduction to fundamental automation tools, programming of robots and the design and implementation of an automation systems in their sophomore year, students are better prepared to learn and apply more advanced concepts and techniques in robotics, automation and systems integration in their junior and senior years.	Course has been taught to an incoming class of sophomores meeting the stated outcomes; Follow-on junior and senior classes have successful integrated the outcomes of this class to support their learning outcomes; Faculty will provide feedback on the impact of MFGE 350 outcomes in reviews of follow-on classes.	J. Newcomer (S2021)	F2019: Formal approval for the introduction and inclusion of this course in the MFGE program was obtained following the required WWU curriculum approval process; W2019: Course has been integrated into the 2019-20 schedule and faculty assigned to teach it; MFGE 350 was taught to the PCE majors in W20 and the MFGE majors in S20. Significant modifications were needed particularly for the S20 offering due to COVID-19.
5	Add to the curriculum a new Numerical Methods for Engineers course (MFGE 340) in the Winter Quarter of the Junior Year. This replaces CSCI 141.		C	A numerical methods class provides a better and more applicable foundation for developing computational skills than a computer science taught programming class. Use of Matlab as the programming tool would expand use of computational	Course has been taught to a class of juniors meeting the stated outcomes; Follow-on junior and senior classes have successful integrated the outcomes of this class to support their learning outcomes; Faculty will provide feedback on the impact of MFGE 340 outcomes in	D. Yip-Hoi (S2021)	F2019: Formal approval for the introduction and inclusion of this course in the MFGE program was obtained following the required WWU curriculum approval process; First offering of MFGE 340 is scheduled for W21.

				techniques to a much broader set of follow-on classes, projects and research than is currently the case.	reviews of follow-on classes.		
6	Expand enrollment in the MFGE program to support the need for Manufacturing Engineers in Washington State.		FS, FD, SS, R	Washington State lags behind other states in the graduation rates of engineers. Pre-major enrollment in the MFGE program shows healthy growth in interest that cannot be serviced with existing capacity. Expansion of the program will provide the support and resources to service these needs.	Successful acquisition of the resources needed to expand the capacity of the program. Graduate a class of at least 36 MFGE majors.	S. Alqudah (S2023)	S2018: Completion of preliminary plan for expansion and discussion of this plan at the Spring IAC meeting F2018: Development of pre-proposal for a decision package to support funding by the WA legislature for expansion; Subsequently submitted to College and University Planning Committee for feedback. F2019: Decision package proposal developed in collaboration with PCE, submitted for internal review; F2020: Proposal submission delayed to next biennium due to COVID-19.

7	Perform assessment of new SLOs 3 and 4 to determine effectiveness.		A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F2019)	Assessment data collected using SLOs 3 and 4 rubrics has been evaluated. No changes to the rubrics and performance indicators have been recommended at this time.
8	Continue conversion of rubrics and performance indicators from current a-k SLOs to new 1-7 SLOs. Develop these tools for SLOs 5 and 7 for assessment in 2019-20.		A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F2020)	S2019: Preliminary versions of rubrics and performance indicators to measure SLOs 5, 6 and 7 have been developed and discussed at the ENGD Curriculum Committee with minor changes recommended. Deployed in 2019-20.

1	Enhance curriculum to support the trends of increasing use of robotics and automation by Washington manufacturers: Introduce a Systems Integration Technical Elective in F2019 or W2020.	2017-18	C	The ability of majors to integrate components as part of the design, implementation, and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included.	J. Newcomer (S20)	Postponed due to plan to hire faculty with specialization in Robotics, Automation and Systems (see 2018-19-B for follow on activity). MFGE 497B Systems Integration course offered for the first time in W20.

2	Reconfigure 1st floor laboratory to create space for a new Learning Factory laboratory to support learning on Robotics, Automation and Manufacturing Systems Integration.		C	Additional space is needed to support the development of the curriculum in robotics, automation, and systems. The Manufacturing Cell on the 1st floor has potential to be better utilized.	An operational Learning Factory that is being used in one or more classes in the curriculum and that supports faculty R&D.	D. Gill (F18)	Creation of space and installation of utilities completed summer 2018. Space made available to Dr. Tarek Algeddawy to develop into a Learning Factory. (see 2018-19-B for follow on activity). LEAF was operational for W20 offering of MFGE 497B Systems Integration.
3	Recruit and hire faculty with specialization in Robotics, Automation and Systems Integration		FS, D, R	New faculty is needed to support curriculum changes that will expanding and introduce new courses in Robotics, Automation and Systems.	Successful hire of a new faculty with expertise to support this specialization.	D. Yip-Hoi (S18)	Completed. Dr. Tarek Algeddawy hired to start in Fall 2018.
4	Develop strategic plan for growth of the MFGE program over the next decade and get buy-in from the Industrial Advisory Committee.		C, R	Growth of the program is essential to support the need for engineers in Washington State and the creation of a specialization in RAS.	Minutes from IAC Meeting documenting discussion and support of proposal.	D. Yip-Hoi (S18)	Plan completed to expand program by 50% and add an option in Robotics, Automation and Systems Integration. Plan was approved by IAC and led to the development of a decision package proposal in collaboration with the PCE program for funding by the State for the 2021-23 biennium. Proposal was submitted for review to the College and University Planning. Placed on hold

							due to COVID-19. Plans to create RASI option without funding are under consideration.
5	Begin conversion of rubrics and performance indicators from current a-k SLOs to new 1-7 SLOs and develop schedule for deployment. Start with SLOs 3 and 4 for assessment in 2018-19.		A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F18)	Rubrics for all SLO 1-7 completed by S20. SLO 3, 4, 5 and 7 deployed by S20. SLO 1, 2 and 6 to be deployed in 2020-21.
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Introduce an option for Robotics, Automation and Systems Integration within the program.	2018-19	C, FS, D, SS, R	Evidence from interactions with industry and discussions with the IAC have indicated a need to expand the curriculum to support trends of increasing use of robotics and automation by Washington manufacturers.	Graduated majors from an option in Robotics, Automation and Systems Integration. A successful re-accreditation of the program with this new option.	Derek Yip-Hoi (S2023)	S2018: Preliminary plan developed and discussed with IAC F2018: Plan used to initiate curriculum changes to begin implementation of option and to develop pre-proposal for decision package. F2019: Decision package proposal developed in collaboration with PCE, submitted for internal review; proposal shelved due to COVID-19. S2020: Program continuing discussions on creation of this option without funding from the State for additional resources.

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Incorporate into the teaching schedule a Manufacturing Systems Integration Technical Elective to be offered in W2020. (This improvement supports 1)		C	The ability of majors to integrate components as part of the design, implementation and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included that make use of the Learning Factory.	T. Algeddawy (W2021)	S2019: Space has been allocated; Design completed; Equipment purchased; Integration of Components has started; MFGE 497B Systems Integration offered for the first time in W20.

Add to the curriculum a new Introduction to Manufacturing Automation course (MFGE 350) in the Spring Quarter of the Sophomore Year. (This improvement supports 1)		C	By providing an introduction to fundamental automation tools, programming of robots and the design and implementation of an automation systems in their sophomore year, students are better prepared to learn and apply more advanced concepts and techniques in robotics, automation and systems integration in their junior and senior years.	Course has been taught to an incoming class of sophomores meeting the stated outcomes; Follow-on junior and senior classes have successful integrated the outcomes of this class to support their learning outcomes; Faculty will provide feedback on the impact of MFGE 350 outcomes in reviews of follow-on classes.	J. Newcomer (S2021)	F2019: Formal approval for the introduction and inclusion of this course in the MFGE program was obtained following the required WWU curriculum approval process; W2019: Course has been integrated into the 2019-20 schedule and faculty assigned to teach it; MFGE 350 was taught to the PCE majors in W20 and the MFGE majors in S20. Significant modifications were needed particularly for the S20 offering due to COVID-19.
Add to the curriculum a new Numerical Methods for Engineers course (MFGE 340) in the Winter Quarter of the Junior Year. This replaces CSCI 141.		C	A numerical methods class provides a better and more applicable foundation for developing computational skills than a computer science taught programming class. Use of Matlab as the programming tool would expand use of computational	Course has been taught to a class of juniors meeting the stated outcomes; Follow-on junior and senior classes have successful integrated the outcomes of this class to support their learning outcomes; Faculty will provide feedback on the impact of	D. Yip-Hoi (S2021)	F2019: Formal approval for the introduction and inclusion of this course in the MFGE program was obtained following the required WWU curriculum approval process; First offering of MFGE 340 is scheduled for W21.

			techniques to a much broader set of follow-on classes, projects and research than is currently the case.	MFGE 340 outcomes in reviews of follow-on classes.		
Expand enrollment in the MFGE program to support the need for Manufacturing Engineers in Washington State.		FS, FD, SS, R	Washington State lags behind other states in the graduation rates of engineers. Pre-major enrollment in the MFGE program shows healthy growth in interest that cannot be serviced with existing capacity. Expansion of the program will provide the support and resources to service these needs.	Successful acquisition of the resources needed to expand the capacity of the program. Graduate a class of at least 36 MFGE majors.	D. Yip-Hoi (S2023)	S2018: Completion of preliminary plan for expansion and discussion of this plan at the Spring IAC meeting F2018: Development of pre-proposal for a decision package to support funding by the WA legislature for expansion; Subsequently submitted to College and University Planning Committee for feedback. F2019: Decision package proposal developed in collaboration with PCE, submitted for internal review; F2020: Proposal submission delayed to next bieniuum due to COVID-19.

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Continue conversion of rubrics and performance indicators from current a-k SLOs to new 1-7 SLOs. Develop these tools for SLOs 5 and 7 for assessment in 2019-20.		A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F2020)	S2019: Preliminary versions of rubrics and performance indicators to measure SLOs 5, 6 and 7 have been developed and discussed at the ENGD Curriculum Committee with minor changes recommended. Deployed in 2019-20.

Enhance curriculum to support the trends of increasing use of robotics and automation by Washington manufacturers: Introduce a Systems Integration Technical Elective in F2019 or W2020.	2017-18	C	The ability of majors to integrate components as part of the design, implementation, and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included.	J. Newcomer (S20)	Postponed due to plan to hire faculty with specialization in Robotics, Automation and Systems (see 2018-19-B for follow on activity). MFGE 497B Systems Integration course offered for the first time in W20.

Reconfigure 1st floor laboratory to create space for a new Learning Factory laboratory to support learning on Robotics, Automation and Manufacturing Systems Integration.		C	Additional space is needed to support the development of the curriculum in robotics, automation and systems. The Manufacturing Cell on the 1st floor has potential to be better utilized.	An operational Learning Factory that is being used in one or more classes in the curriculum and that supports faculty R&D.	D. Gill (F18)	Creation of space and installation of utilities completed summer 2018. Space made available to Dr. Tarek Algeddawy to develop into a Learning Factory. (see 2018-19-B for follow on activity). LEAF was operational for W20 offering of MFGE 497B Systems Integration.
Recruit and hire faculty with specialization in Robotics, Automation and Systems Integration		FS, D, R	New faculty is needed to support curriculum changes that will expanding and introduce new courses in Robotics, Automation and Systems.	Successful hire of a new faculty with expertise to support this specialization.	D. Yip-Hoi (S18)	Completed. Dr. Tarek Algeddawy hired to start in Fall 2018.
Develop strategic plan for growth of the MFGE program over the next decade and get buy-in from the Industrial Advisory Committee.		C, R	Growth of the program is essential to support the need for engineers in Washington State and the creation of a specialization in RAS.	Minutes from IAC Meeting documenting discussion and support of proposal.	D. Yip-Hoi (S18)	Plan completed to expand program by 50% and add an option in Robotics, Automation and Systems Integration. Plan was approved by IAC and led to the development of a decision package proposal in collaboration with the PCE program for funding by the State for the 2021-23 biennium. Proposal was submitted for review to the College and University Planning. Placed on hold due to COVID-19. Plans to create RASI option

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B. Improvement Actions Identified from Other Evidence Gathered						
Introduce an option for Robotics, Automation and Systems Integration within the program.	2018-19	C, FS, D, SS, R	Evidence from interactions with industry and discussions with the IAC have indicated a need to expand the curriculum to support trends of increasing use of robotics and automation by Washington manufacturers.	Graduated majors from an option in Robotics, Automation and Systems Integration. A successful re-accreditation of the program with this new option.	Derek Yip-Hoi (S2023)	S2018: Preliminary plan developed and discussed with IAC F2018: Plan used to initiate curriculum changes to begin implementation of option and to develop pre-proposal for decision package. F2019: Decision package proposal developed in collaboration with PCE, submitted for internal review; proposal shelved due to COVID-19. S2020: Program continuing discussions on creation of this option without funding from the State for additional resources.

Create a new Learning Factory laboratory to support learning in Manufacturing Systems Integration. (This improvement supports 1)		R	A learning factory will add resources in robotics and automation and an ability for students to work on an integrated system that currently does not exist for the program. This will make graduates better prepared to support the trends in manufacturing in WA.	An operational Learning Factory that is being used in one or more classes in the curriculum and that supports faculty R&D.	T. Algeddawy (W2021)	S2019: Space has been allocated; Design completed; Equipment purchased; Integration of Components has started. LEAF operational and used for the first time in W20 offering of MFGE 497B Systems Integration.
Incorporate into the teaching schedule a Manufacturing Systems Integration Technical Elective to be offered in W2020. (This improvement supports 1)		C	The ability of majors to integrate components as part of the design, implementation and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included that make use of the Learning Factory.	T. Algeddawy (W2021)	S2019: Space has been allocated; Design completed; Equipment purchased; Integration of Components has started; MFGE 497B Systems Integration offered for the first time in W20.

Add to the curriculum a new Introduction to Manufacturing Automation course (MFGE 350) in the Spring Quarter of the Sophomore Year. (This improvement supports 1)		C	By providing an introduction to fundamental automation tools, programming of robots and the design and implementation of an automation systems in their sophomore year, students are better prepared to learn and apply more advanced concepts and techniques in robotics, automation and systems integration in their junior and senior years.	Course has been taught to an incoming class of sophomores meeting the stated outcomes; Follow-on junior and senior classes have successful integrated the outcomes of this class to support their learning outcomes; Faculty will provide feedback on the impact of MFGE 350 outcomes in reviews of follow-on classes.	J. Newcomer (S2021)	F2019: Formal approval for the introduction and inclusion of this course in the MFGE program was obtained following the required WWU curriculum approval process; W2019: Course has been integrated into the 2019-20 schedule and faculty assigned to teach it; MFGE 350 was taught to the PCE majors in W20 and the MFGE majors in S20. Significant modifications were needed particularly for the S20 offering due to COVID-19.
Add to the curriculum a new Numerical Methods for Engineers course (MFGE 340) in the Winter Quarter of the Junior Year. This replaces CSCI 141.		C	A numerical methods class provides a better and more applicable foundation for developing computational skills than a computer science taught programming class. Use of Matlab as the programming tool would	Course has been taught to a class of juniors meeting the stated outcomes; Follow-on junior and senior classes have successful integrated the outcomes of this class to support their learning outcomes; Faculty will provide feedback on the impact of MFGE	D. Yip-Hoi (S2021)	F2019: Formal approval for the introduction and inclusion of this course in the MFGE program was obtained following the required WWU curriculum approval process; First offering of MFGE 340 is scheduled for W21.

			expand use of computational techniques to a much broader set of follow-on classes, projects and research than is currently the case.	340 outcomes in reviews of follow-on classes.		
Expand enrollment in the MFGE program to support the need for Manufacturing Engineers in Washington State.		FS, FD, SS, R	Washington State lags behind other states in the graduation rates of engineers. Pre-major enrollment in the MFGE program shows healthy growth in interest that cannot be serviced with existing capacity. Expansion of the program will provide the support and resources to service these needs.	Successful acquisition of the resources needed to expand the capacity of the program. Graduate a class of at least 36 MFGE majors.	D. Yip-Hoi (S2023)	S2018: Completion of preliminary plan for expansion and discussion of this plan at the Spring IAC meeting F2018: Development of pre-proposal for a decision package to support funding by the WA legislature for expansion; Subsequently submitted to College and University Planning Committee for feedback. F2019: Decision package proposal developed in collaboration with PCE, submitted for internal review; proposal shelved due to COVID-19.
Perform assessment of new SLOs 3 and 4 to determine effectiveness.		A	Change to new 1-7 outcomes have been mandated by ABET and will be in effect at next	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and	D. Yip-Hoi (F2019)	Assessment data collected using SLOs 3 and 4 rubrics has been evaluated. No changes to the rubrics and performance indicators have been recommended at this time.

			accreditation visit in 2022.	department levels to determine if assessment is complete and effective.		
Continue conversion of rubrics and performance indicators from current a-k SLOs to new 1-7 SLOs. Develop these tools for SLOs 5 and 7 for assessment in 2019-20.		A	Change to new 1-7 outcomes have been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F2020)	S2019: Preliminary versions of rubrics and performance indicators to measure SLOs 5, 6 and 7 have been developed and discussed at the ENGD Curriculum Committee with minor changes recommended. Deployed in 2019-20.

Enhance curriculum to support the trends of increasing use of robotics and automation by Washington manufacturers: Introduce a Systems Integration Technical Elective in F2019 or W2020.	2017-18	C	The ability of majors to integrate components as part of the design, implementation, and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included.	J. Newcomer (S20)	Postponed due to plan to hire faculty with specialization in Robotics, Automation and Systems (see 2018-19-B for follow on activity). MFGE 497B Systems Integration course offered for the first time in W20.

Reconfigure 1st floor laboratory to create space for a new Learning Factory laboratory to support learning on Robotics, Automation and Manufacturing Systems Integration.		C	Additional space is needed to support the development of the curriculum in robotics, automation and systems. The Manufacturing Cell on the 1st floor has potential to be better utilized.	An operational Learning Factory that is being used in one or more classes in the curriculum and that supports faculty R&D.	D. Gill (F18)	Creation of space and installation of utilities completed summer 2018. Space made available to Dr. Tarek Algeddawy to develop into a Learning Factory. (see 2018-19-B for follow on activity). LEAF was operational for W20 offering of MFGE 497B Systems Integration.
Recruit and hire faculty with specialization in Robotics, Automation and Systems Integration		FS, D, R	New faculty is needed to support curriculum changes that will expanding and introduce new courses in Robotics, Automation and Systems.	Successful hire of a new faculty with expertise to support this specialization.	D. Yip-Hoi (S18)	Completed. Dr. Tarek Algeddawy hired to start in Fall 2018.
Develop strategic plan for growth of the MFGE program over the next decade and get buy-in from the Industrial Advisory Committee.		C, R	Growth of the program is essential to support the need for engineers in Washington State and the creation of a specialization in RAS.	Minutes from IAC Meeting documenting discussion and support of proposal.	D. Yip-Hoi (S18)	Plan completed to expand program by 50% and add an option in Robotics, Automation and Systems Integration. Plan was approved by IAC and led to the development of a decision package proposal in collaboration with the PCE program for funding by the State for the 2021-23 biennium. Proposal was submitted for review to the College and University Planning. Placed on hold due to COVID-19. Plans to create

						RASI option without funding are under consideration.
Begin conversion of rubrics and performance indicators from current a-k SLOs to new 1-7 SLOs and develop schedule for deployment. Start with SLOs 3 and 4 for assessment in 2018-19.		A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accreditation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to determine if assessment is complete and effective.	D. Yip-Hoi (F18)	Rubrics for all SLO 1-7 completed by S20. SLO 3, 4, 5 and 7 deployed by S20. SLO 1, 2 and 6 to be deployed in 2020-21.
Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology						

	Description of Proposed Improvement	Area(s) of Impact	Rationale that improvement will have Impact in the Area(s) Indicated	Evidence that will demonstrate the Impact has been Realized		
B. Improvement Actions Identified from Other Evidence Gathered						
1	Enhance curriculum to support the trends of increasing use of robotics and automation by Washington manufacturers: Introduce a Systems Integration Technical Elective in F2019 or W2020.		C	The ability of majors to integrate components as part of the design, implementation, and operation of a manufacturing system, needs to be enhanced in the curriculum for graduates to be better prepared to support the trends in manufacturing in WA.	A course on Systems Integration has been developed and taught to a cohort of majors in the program meeting the stated course outcomes. Hands-on laboratory activities have been included.	

2	Reconfigure 1st floor laboratory to create space for a new Learning Factory laboratory to support learning on Robotics, Automation and Manufacturing Systems Integration.		C	Additional space is needed to support the development of the curriculum in robotics, automation and systems. The Manufacturing Cell on the 1st floor has potential to be better utilized.	An operational Learning Factory that is being used in one or more classes in the curriculum and that supports faculty R&D.	
3	Recruit and hire faculty with specialization in Robotics, Automation and Systems Integration		FS, D, R	New faculty is needed to support curriculum changes that will expanding and introduce new courses in Robotics, Automation and Systems.	Successful hire of a new faculty with expertise to support this specialization.	
4	Develop strategic plan for growth of the MFGE program over the next decade and get buy-in from the Industrial Advisory Committee.		C, R	Growth of the program is essential to support the need for engineers in Washington State and the creation of a specialization in RAS.	Minutes from IAC Meeting documenting discussion and support of proposal.	
5	Begin conversion of rubrics and performance indicators from current a-k SLOs to new 1-7 SLOs and develop schedule for deployment. Start with SLOs 3 and 4 for assessment in 2018-19.		A	Change to new 1-7 outcomes has been mandated by ABET and will be in effect at next accrediation visit in 2022.	Data collected and feedback on the effectiveness of the measurement tool will be presented and discussed at the program and department levels to	

					determine if assessment is complete and effective.	
6	Type key: C - Curricular, FS - Faculty Support, D - Faculty Development, P - Pedagogy, SS - Student Support, R - Resources, A - Assessment Methodology					

Appendix F
Advising Tools

2021-2022 Academic Year

Manufacturing Engineering, BS

WESTERN WASHINGTON UNIVERSITY
ENGINEERING AND DESIGN

ABET accredited
Course offerings subject to change
Major Credits: 151-155 (GURs not included)

Admissions information - https://engineeringdesign.wwu.edu/
Academic advising available - see contact information below
Pre-major coursework in grey areas

	Fall	Winter	Spring
First year	**MATH 124 (5) Calculus I,** FWS	**MATH 125 (5) Calculus II,** FWS	**MATH 224 (5) Multiv. Calc and Geom.,** FWS
	PHYS 161 (5) Physics w/ Calculus I, FW	**PHYS 162 (5) Physics w/ Calculus II,** WS	PHYS 163 (5) Physics w/ Calculus III, FS
	ENGR 101 (2)Eng., Design, & Society, FW	**ENGR 115 (4) Innovationin Design,** WS	**CHEM 161 (5) Gen. Chemistry I,** FWS

Pre-major courses in BOLD are required for major admissions.

	Fall	Winter	Spring
Second Year	**MATH 204 (4) Elem. Linear Algebra,** FWS	**APPLY TO MAJOR**	**MAJOR COURSES BEGIN**
	ENGR 170 (4) Intro Material Science, FW	MATH 331 (4) Differential Equations,FWS	MFGE 231 (4) Intro to Manuf. Processes, FS
	ENGR 214 (4) Statics, FW	ENGR 225(4) Mechanics of Materials, FWS	MFGE 261 (4) Intro to CAD, S
		MATH 345 (4) Engineering Statistics, FWS	MFGE 250 (4) Intro to Automation, S
Third Year	PCE 371 (5) Intro to Plastics, FS	MFGE 341 (4) Quality Assurance , FW	PCE 342 (4) Design of Experiment, WS
	EECE 351 (4) Electronics for Engineers, FS	MFGE 333 (4) Design for Manufacture, W	MFGE 381 (4) Manufacturing Process Plan, S
	MFGE 332 (4) Intro to CAM & CNC, FW	MFGE 340 (4) Numerical Methods, W	EECE 352 (4) Intro Automation & Control, S
		MFGE 365 (4) Machine Design, WS	
Fourth Year	MFGE 491 (3) Project Research (WP), F	MFGE 492 (3) Project Proposal (WP), W	MFGE 493 (4) Project Implementation, S
	MFGE 463 (4) Design of Tooling, F	*MFGE 434 (4) Advanced CAM and CNC*, W*	*MFGE 462 (4) CAD Using Surfaces*, W S*
	MFGE 453 (4) Industrial Robotics, F	*MFGE 454 (4) Systems Integration*, W*	PCE 372 Intro to Composites (5), WS
	Tech Elective	Tech Elective	

Engineering & Design
516 High Street, Bellingham, WA 98229
ENGD@wwu.edu | 360.650.3380
http://engineeringdesign.wwu.edu

Pre-major Advisor:
Lisa Ochs lisa.ochs@wwu.edu

Notes and Excetions

Students must complete General University Requirements in addtion to major courses
Students not enrolled in MATH 124 and PHYS 161 fall quarter, may not finish in four years
Math 341 may be substituted for MATH 345
*Students must complete one of MFGE 434, 454, or 462. If more than one , then count as tech elective
Students must complete at minimum 6 credits of technical electives

Manufacturing Engineering, BS

WESTERN WASHINGTON UNIVERSITY
ENGINEERING AND DESIGN

Major Admissions

Students must first be accepted by the university. **The program accepts major applications during winter quarter.** Accepted students start major coursework spring quarter. Transfer students may apply at the same time if pre-requisite coursework is completed or in progress.

Required coursework to apply

MATH 124	Calculus I
MATH 125	Calculus II
MATH 224	Multivariable Calculus & Geometry I
MATH 204	Linear Algebra
CHEM 161	General Chemistry I
PHYS 161	Physics w/ Calculus I
PHYS 162	Physics w/ Calculus II
ENGR 101*	Engineering, Design, and Society
ENGR 115	Engineering, Innovation, & Design
ENGR 170	Intro to Materials Science & Engineering
ENGR 214	Statics

* waived for transfer students

Students may be enrolled in no more than 4 of the required courses at time of application.

Recommended but not required to apply

ENGR 225	Mechanics of Materials
MATH 331	Differential Equations
MATH 345	Engineering Statistics
PHYS 163	Physics w/ Calculus III

Required essaay

The program requires applicants to submit a 500 words max essay explaining why they want to pursue a degree in Manufacturing Engineering.

Applications due: Winter Quarter

Applications due the first Friday in February every year. Accepted students start major coursework spring quarter. Applicants are notified of decisions before spring quarter registration begins.

Transfer students

Transfer students are encouraged to contact the pre-major advisor to discuss course equivlancies and recommended time to transfer.

Admissions statistics

38-45 applicants

average 3.1 pre-major GPA (not a cut off)

24 accepted

Technical Electives

Students are required to complete 6-10 credits of technical electives. See website for approved list of courses. Faculty advisors must approve courses not on this list.

Faculty Contact Information

Associate Professor David Gill, gilld2@wwu.edu
Associate Professor Sura Alqudah, alqudas@wwu.edu
Professor Jeff Newcomer, newcomj@wwu.edu
Associate Professor Tarek Algeddawy, algeddt@wwu.edu
Professor Derek Yip-Hoi, yiphoid@wwu.edu

updated: April 2021

Manufacturing Engineering Major Evaluation

Catalog Year: 2020-21

Name: ______________________________ **Student Number:** ____________________

Completed 180 Credits? YES____ NO____ **Catalog Year Declared:** 2020-21

 # Credits Remaining: ______________ 0

Anticipated Qtr of Completion: Spring 23

Program Advisor: **Advisor Signature:** **Date:**

Department Chair: Jeff Newcomer **Chair Signature:** **Date:**

Bachelor of Science in Manufacturing Engineering (WB-34)

* All courses on this form must be successfully completed with a **C- or better** and with a minimum cumulative GPA of 2.0

Manufacturing Engineering Core (96 credits)						
Course #	**Course Title**	**Credits**	**Completed***	**In-Progress/Remaining (Qtr)**	**Alternate/Transfer Course/School**	
EE 351	Electronics for Engineering	4		F21		
EE 352	Intro to Automation & Control	4		S22		
ENGR 104	Intro to Engineering and Design	3	?			
ENGR 170	Intro to Mat'ls Science and Engineering	4	?			
ENGR 214	Statics	4	?			
ENGR 225	Mechanics of Materials	5	?			
MFGE 231	Intro to Metal Manufacturing Processes	4		S21		
MFGE 261	Introduction to CAD	4		S21		
MFGE 332	Intro to CAM and CNC	4		F21		
MFGE 333	Design for Manufacturing	4		W22		
MFGE 340	Numerical Methods for Engineers	4		W22		
MFGE 341	Quality and Contin Imprv	4		W22		
MFGE 342	Data Analysis and Design of Exper.	4		S22		
MFGE 350	Intro to Manufacturing Automation	4		S21		
MFGE 362	CAD and Analysis using Surfaces	4		S23		
MFGE 381	Manufacturing Process Planning	4		S22		
MFGE 434	Advanced CAM & CNC--*(OR MFGE 453)*	4		S23		
MFGE 453	Industrial Robotics--*(OR MFGE 434)*			F22		
MFGE 463	Design of Tooling	4		F22		
MFGE 465	Machine Design	4		W22 or S22		
MFGE 491	Project Research, Planning, and Ethics	4		F22		
MFGE 492	Manufacturing Project Proposal	2		W23		
MFGE 493	Manufacturing Project Implemen.	4		S23		
PCE 371	Intro to Polymer Mat'ls and Processing	5		F21		
PCE 372	Intro to Composites Mat'ls and Process.	5		S23		
Technical Electives (6-10 credits):						
MFGE ???	**???**					
MFGE ???	???					

Supporting Courses (51 credits)						
Course #	**Course Title**	**Credits**	**Completed***	**In-Progress/Remaining (Qtr)**	**Alternate/Transfer Course/School**	
CHEM 161	General Chemistry I	5	?			
MATH 124	Calculus & Analytic Geometry I	5	?			
MATH 125	Calculus & Analytic Geometry II	5	?			
MATH 204	Linear Algebra	4	?			
MATH 224	Multivariable Calc. & Geometry I	5	?			
MATH 331	Differential Equations	4	?			
MATH 345	Engineering Statistics	4	?			
PHYS 161	Physics w/ Calculus I	5	?			
PHYS 162	Physics w/ Calculus II	5	?			
PHYS 163	Physics w/ Calculus III	5	?			

TOTAL MAJOR CREDITS: 149-153