THE OHIO STATE UNIVERSITY

College of Engineering

Undergraduate Education & Student Services

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Memo

To: Randy Smith, Vice Provost for Academic Programs, Office of Academic Affairs
From: Rosie Quinzon-Bonello, Assistant Dean for Curriculum and Assessment
Date: March 24, 2025

Re: Proposal for CAA review to revise the UG Embedded Certificate in Automotive Manufacturing

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On March 24, 2025, the College of Engineering Committee on Academic Affairs unanimously approved the following revisions to the UG Embedded Certificate in Automotive Manufacturing:

a) corrected current total number of credit hours from required from 15 to 12.
b) added a one-credit hours required course increasing the required credit hours from 12 to 13
c) added three courses to the *sub-area* ***Quality & Production, Digital Manufacturing*** list
d) expanded on experiential learning activities to provide more options to capstone
e) added exclusions to sub-area courses that core requirements in several majors
f) added an exception to the requirement that all courses be taken at OSU

Details can be found in the executive summary of the proposal.

Yours sincerely,

Rosario Quinzon-Bonello

Rosie Quinzon-Bonello

Proposal for an Undergraduate Embedded Certificate in Automotive Manufacturing

Proposed: July 1, 2024
Revised: March 5, 2025

Theodore Allen, Dept. of Industrial and Systems Engr
Anthony Luscher, Dept. of Mechanical and Aerospace Engr
Menachem Kimchi, Dept. of Materials Science and Engr

Proposed Changes:

a) Reduction from 15 to 13 credit hours for the certificate
b) New Course ISE/MECHENG/WELDENG 4611 (1) – *Practical Experience in Automotive Manufacturing*.
c) Expanding on experiential learning activities to provide more options to capstone.
d) New Course
   - ISE/MECHENG/WELDENG 4610 (3) - *Introduction to Automotive Manufacturing* (offered Au24 as a Group Studies 4194 and if needed, a second offering Au25)
   - Request that any engineering program not grant 4610 as a technical elective.
e) Added to the course list of the ***Sub-Area Quality & Production, Digital Manufacturing***
   - ECE 5307 *Introduction to Machine Learning for Electrical & Computer Engineers*
   - ECE/MECHENG 5643 *Introduction to Real-Time Robotics*
   - ECE 5561 *Introduction to Cybersecurity*
f) Added that courses that are core requirements in the majors below may not count the toward the certificate:
   - BME majors – MATSCEN 2010
   - CSE majors - ECE 3567
   - ENVENG majors - ENVENG 5170
   - ISE majors – ISE 2500, 3600, and 4120
   - ME majors - ISE 2500, MATSCEN 2010
   - MSE Majors – MATSCEN 2010
   - WELD majors – MATSCEN 2010, WELDENG 2001
g) Added an exception to requirement that all courses be taken at OSU, whereby the reflection class can be taken using project work taken for credit from another institution can be used in 4611.

I. Program definition

Title of program

Undergraduate Embedded Certificate in Automotive Manufacturing

Certificate Category and Justification

The continuing importance and development of automotive manufacturing in Ohio as well as the transition to hybrid and electric vehicles requires university graduates that understand the importance of this technology and can develop the skill set and technical background needed to be part of this industry.

As such, this proposed certificate is in the form of an **Undergraduate Embedded** type which will give an academic focus to the underlying knowledge needed for students to be successful in the area of automotive manufacturing. This program will emphasize modern manufacturing methods such as near net-space processes, innovative joining and fastening, automation and robotics, smart manufacturing, quality, data analytics, and digital twinning in the curriculum.

Purpose of program

The purpose of the certificate is to increase interest and build skills relating to automotive manufacturing engineering. Ohio is the #1 producer of engines, #2 producer of transmissions, and has the second largest workforce in the nation for automotive manufacturing and the concentration is likely intensifying according to JobsOhio.

Methods of delivery

The courses are primarily offered in-person currently. Certain courses may have available on-line offerings, but the overall intent is for in-person learning to the greatest extent possible.

Timing

Desired start up is Spring semester 2025.

Goals

This certificate program has the following goals:

- Understand how vehicles are made the way they are and the importance of automotive manufacturing and supply chain issues.
- Understand near net-shape manufacturing processes that are common to the auto industry.
- Understand various ways of fastening and joining via welding, adhesive, and mechanical methods.
- Understand automation and robotics in the assembly of vehicles.
- Understand the role of quality, data analytics, and smart manufacturing in the creation of vehicles.
- Understand digital modeling and simulation in an automotive manufacturing context.

Outcomes

Students receiving the certificate will:

1. Know and be able to explain the major areas manufacturing automobiles including stamping, casting, joining, assembly, and paint/coating

2. Have practical experience with the equipment and processes used in each of the areas
3. Be exposed to the application of different engineering disciplines in automotive manufacturing

Curricular Requirements

1. A minimum GPA of 2.0 in the certificate courses is required for completion. Only grades of C- or better may be counted toward the certificate.
2. The requirements below are posted and will be maintained at https://mae.osu.edu/automotivemanufacturing. Completion of the certificate requires a minimum of 13 credit hours. As shown in Table 1 below, there is a single required course followed by a selection of 3 courses (or 9 credits) from at least two different sub-areas of manufacturing processes. The final requirement is for students to complete a 1 credit reflection on an experiential learning component.
    - The single required 3-credit course 4610 - Introduction to Automotive Manufacturing cross-listed in Industrial & Systems Engineering, Mechanical Engineering, and Welding Engineering, is a detailed survey of the process and business of manufacturing automobiles. It will be delivered in a lecture format with industry guests, case studies, and field trips to manufacturers and Tier 1 suppliers.

    - The sub areas identified for selection courses are 1) Joining & Fastening, 2) Near net shape Manufacturing, 3) Quality & Production, 4) Digital Manufacturing, 5) Paint & Corrosion and 6) Battery Technology. There are more areas than credit hours available so students will be asked to choose at least 3 credits (nominally 1 course) from sub-areas 1 & 2 combined, 3 credits from sub-areas 3 & 4 combined (this area contains a few examples of <3 credit courses), and aird course (3 credits) from any area. The vast majority of courses on the selection list in the first four sub-areas already exist and are offered through a participating discipline. Further development of courses in Paint & Corrosion and Battery Technology is expected but having 2-3 courses in these areas should be sufficient to meet demand.

    - Courses that are core requirements in the major may not be counted towards the certificate. This exclusion applies to ECE 3567, ENVENG 5170, ISE 2500, ISE 3600, ISE 4120, MATSCEN 2010, and WELDENG 2001 for the relevant majors. These courses are included because they are accessible to other engineering majors beyond those hosting the certificate without pre-requisites. Further, ISE 4500 is a core requirement for Mechanical Engineers and overlaps significantly with ISE 2500 so the latter course is not available to count towards the certificate for ME students.

    - The final requirement is completion of an experiential learning component documented through a 1 credit reflection study. A new cross-listed course 4611 – Practical Experience in Automotive Manufacturing, is modeled upon existing

workshop courses in programs to capture student reflections on internship and cooperative learning experiences. For the purposes of the certificate, students will be required to have an experience in one of the following categories and follow that experience with enrollment in 4611 where they will document their reflections.

a) A capstone project related to automotive manufacturing. The capstone experience ideally will overlap with major requirements.
b) Participation for 1 academic year on a motorsports team or club.
c) Internship or cooperative work experience of at least 10 weeks duration at an automotive manufacturer or supplier.
d) Independent study or research with a faculty member for at least 2 credits on an automotive manufacturing related project.

Table 1. Certificate Requirements

Number	Title	In-Person
Required		
ISE/ME/WE 4610[1,2]	Introduction to Automotive Manufacturing	3
Sub-Area Joining & Fastening, Near-net-shape manufacturing – Take at least 3 credits		
ISE 2500[1] The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum: • Industrial & Systems Engineering • Mechanical Engineering (overlap with ISE 4500)	Introduction to Manufacturing Engineering	3
MATSCEN 2010 The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum: • Biomedical Engineering • Materials Science Engineering • Mechanical Engineering • Welding Engineering	Introduction to Engineering Materials	3
ISE 5501[3]	Fundamentals of Solid-State Processing	3
ISE 5503[3]	Manufacturing Processes and Simulation	3

ISE 5540	Polymer Processing Fundamentals	3
ISE 5555	Manufacturing Processes and Machine Tools	3
MATSCEN 5451/ ISE 5502	Molten Metal Processing	3
MECHENG 5680	Computer Aided Design and Manufacturing	4
WELDENG 2001 The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum: • Welding Engineering	Introduction to Welding Engineering	3
WELDENG 4012[1,2]	Resistance Welding Processes	4
Sub-Area Quality & Production, Digital Manufacturing – Take at least 3 credits		
ECE 3551	Introduction to Feedback Control Systems	3
ECE 3567 The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum: • Computer Engineering	Microcontroller Laboratory	1
ECE 5307	Introduction to Machine Learning for Electrical & Computer Engineers	
ECE/MECHENG 5463	Introduction to Real-Time Robotics	
ECE 5561	Introduction to Cybersecurity	
EnvEng 5170 The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum: • Environmental Engineering	Sustainability and the Circular Economy	3
ISE 3600[4] The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum:	Workplace Ergonomics	3

• Industrial & systems Engineering		
ISE 4120 The following majors will not be permitted to count this course as a certificate requirement due to its requirement in their major core curriculum: Industrial & systems Engineerin	Quality and Reliability Engineering	3
ISE 4510[3]	Manufacturing Engineering	3
ISE 5110	Design of Engineering Experiments	3
ISE 5520	Industrial Automation	1.5
ISE 5525	Industrial Robotics	1.5
ISE 5570	Manufacturing Data Processing and Analysis	3
ISE 5640	Occupational Safety: Analysis and Design of Work Environments	3
Sub-Area Paint & Corrosion – Available as 3rd course choice		
CBE 5775	Rheology of Fluids	3
MATSCEN 5951	Corrosion: Fundamentals and Experimental Methods	3
Sub-Area Battery Technology – Available as 3rd course choice		
	<future course under development>	3

[1] Course has experiential component (e.g. laboratory exercise, field trip)
[2] Course topics emphasize automotive manufacturing applications
[3] This course is offered infrequently.
[4] This course typically has greater availability in Spring semester.

Length of program compared to similar programs

Most undergraduate academic certificates in engineering are 12 credit hours. With the addition of the 4611 reflection course, this certificate will be a minimum of 13 credit hours.

Transfer Credits

All courses in the Certificate must be taken at Ohio State. If the situation arises, it will be permissible to complete the 4611 course reflecting on a project experience for credit at another institution. The credit for that experience would not necessarily need to be transferred to Ohio State.

Arranged/Individual Study Courses

It is expected that the 4611 course will have an arranged time to meet with the instructor rather than being formally scheduled.

Overlap

This certificate allows for 100% overlap with the major program although it is requested that programs not give technical elective credit in the major for 4610 – Introduction to Automotive Manufacturing. This is to ensure a small amount of content remains unique to the certificate.

II. Enrollment

Projected enrollment

The College of Engineering, its departments, and selective faculty have extensive involvement with automotive manufacturing. We have also benefited from our strategic relationship with Honda and can confirm, based on our experience, that there will be significant student interest in this program. In the near-term, Spring Semester 2025, we expect approximately 15-20 students to start this program by taking the Introduction to Automotive Manufacturing Course and other associated manufacturing courses. We anticipate that interest in this program will increase as students and industry see the benefit to this program. Longer term enrollment is projected to increase to 25-40 students.

Primary interest is expected from students in Industrial & Systems Engineering, Mechanical Engineering, and Welding Engineering. Secondary interest is expected from Electrical & Computer Engineering, Chemical Engineering, Materials Science & Engineering, Computer Science & Engineering, Environmental Engineering, and Civil Engineering. The latter programs will be approached to allow the certificate courses to count for technical electives in their program and to suggest additional courses in the sub-areas.

1. Will there be problems if too many students enroll in the certificate program?

This program can grow to fit the needs of students. Some of the manufacturing courses are under-subscribed and would benefit from additional student intertest. Furthermore, there is a large selection of courses available in this program over several departments so the students can be distributed among them and over enrollment will not be an issue.

2. Will there be problems if too few students enroll in the certificate program?

Having too few additional students enrolling will not be a concern as the manufacturing courses already exist and are currently being populated and taught. So only having only a few additional students will merely represent the current status quo. The new Introduction to Automotive Manufacturing Course will remain regardless of the number of students enrolled. The three sponsoring departments are committed to offering this course for at least 5 years as described in the attached Memorandum of Understanding.

Opportunities for graduates

Due to the large number of automotive manufacturers in the state of Ohio, certificate holders can be expected to be in high demand. Our students will have a unique blend of traditional manufacturing knowledge complemented by cutting edge technology. Our students will gain knowledge of simulation techniques, digital modeling, and other modeling tools applied to manufacturing processes. As for production, students will learn automation, robotics, and smart manufacturing. The automotive industry is in the process of a fundamental transition from ICE (Internal Combustion Engine) technology to battery-based electric vehicles. Many new vehicle platforms are being created and need to be manufactured. The goal for this new form of manufacture is a significant reduction in cost and material coupled with increased flexibility.

Even if they are not hired into automotive manufacturing, their skill set and technical knowledge is easily transferable to other types of manufacturing.

Discussions are ongoing with companies to provide access to the students enrolled in the certificate and perhaps guarantee an interview to those who complete it.

III. Sufficient resources

Adequacy and availability of facilities and staff

The majority of the courses listed above are lecture based and those that have labs currently utilize existing lab spaces supported by staff and GTAs as needed.

IV. Justifiable expenses

Additional Faculty

All courses listed above already exist and are currently being offered. We currently have enough faculty with appropriate expertise to offer this certificate.

Course additions or deletions

One more course, Introduction to Automotive Manufacturing, will be added, introducing the certificate program. No courses will be deleted. Future courses may be added to the certificate when needed, but are not currently planned.

Necessary budget adjustments

Projecting resources need forward, manufacturing and digital modeling are continuously evolving, and to maintain the relevancy of this program, updates need to be planned for. Digital control, vision systems, robotics and related equipment are always being updated to improve flexibility and efficiency and labs need to keep up. Planning will occur to anticipate those needs.

Short term, this program can be adequately managed with existing resources. An advisory board has been created to offer the introductory course and departmental advisors are being

engaged to help students in class selection. Longer term financial support is needed to hire personal and create a support infrastructure for this certificate.

Available and anticipated funding

Funds are currently being sought from industrial partners in the automotive area. Equipment grants from other companies as well as federal agencies can be sought.

V. Adequate demand

We conducted a survey of 400 undergraduate students in US universities and relevant job interests using AYTM (an contract survey company). The summary of the interest levels is given in Figure 1 with 0 relating to “not at all”, 1 relating to “a little”, 2 relating to “somewhat”, 3 relating to “interested, 4 relating to “very interested”. Overall, 91 or 23% were interested or very interested. For engineering students, the proportion of interested and very interested was much higher (23/47 or 49%). Specific subjects within the planned emphasis including augmented reality and virtual reality achieved even higher interest levels (39% overall and 51% respectively).

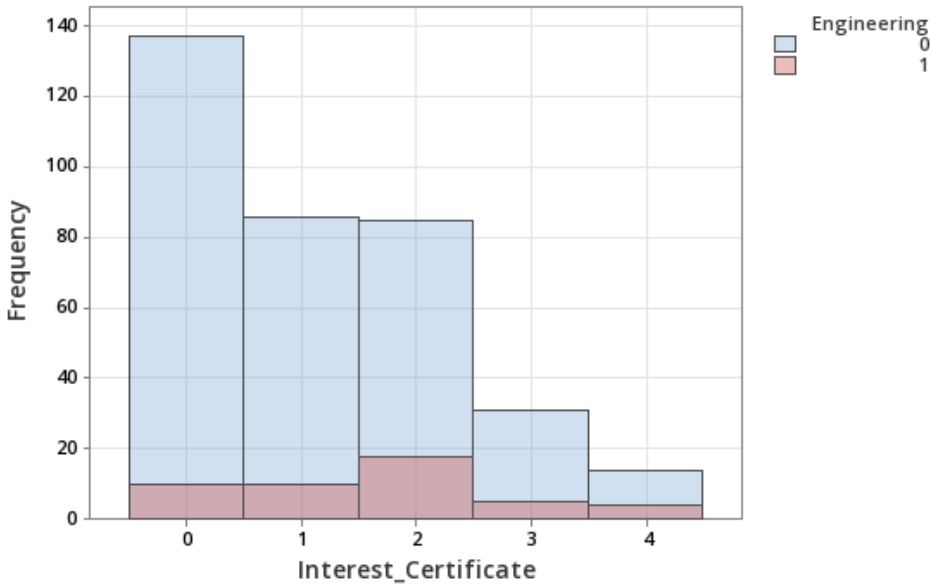

Figure 1. Frequency or count in the number of relevant students responding at different interest levels. The counts of 3 and 4 being “interested” or “very interested” respectively. The darker shaded students are engineering, and the others are students with relevant career interests outside the college of manufacturing.

Evidence of sufficient demand by students, faculty, general public, and/or business

As part of the planning for this certificate program, a thorough review of businesses who would hire manufacturing students from this program was reviewed. These included a variety of OEMs (such as GM, Ford, Honda, BMW), Tier 1 and other automotive suppliers. Surveys as well as

interviews were undertaken and showed a strong desire for graduates of this certificate. Information was also used to formulate the goals, and structure of this certificate.

The Ohio Governor's Office of Workforce Transformation (Ohio OWT) has emphasized the importance of making systematic investments in our EV workforce in pioneer battery development and assembly of new vehicles and components. Figure 2 shows projected Ohio job growth for Automotive and Advanced Mobility Industries.

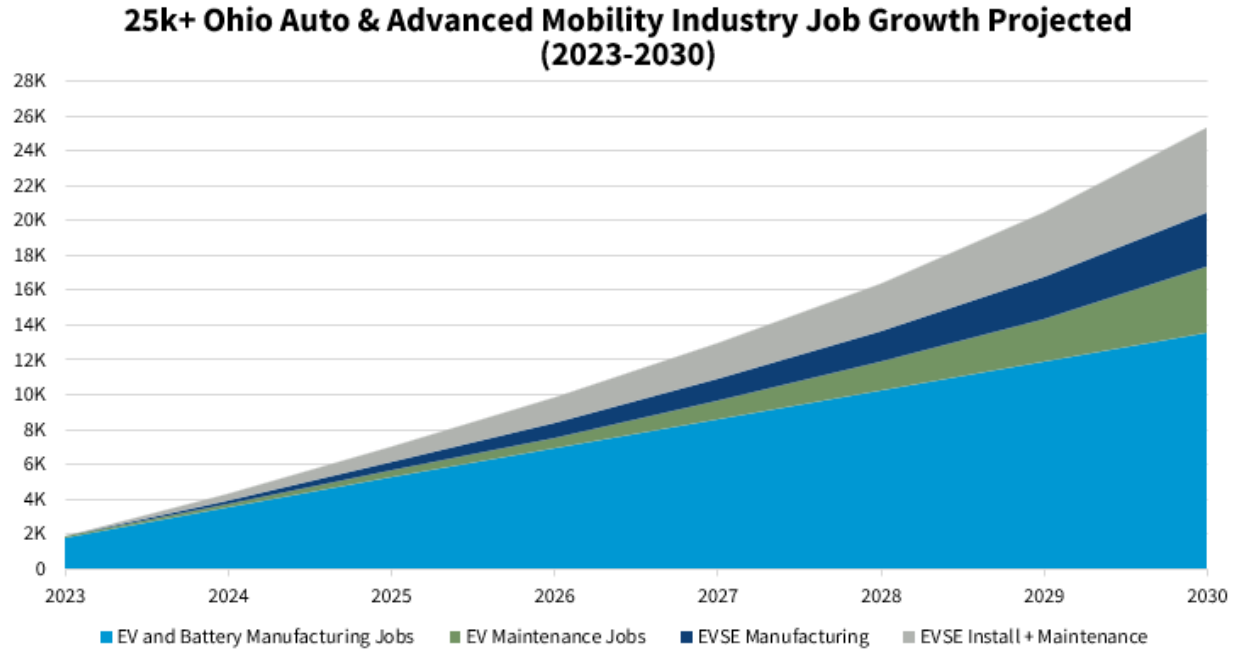

Figure 2. Projected job growth in electrical vehicle (EV) manufacturing in Ohio. From: Accelerating Ohio's Auto and Advanced Mobility Workforce, Governor's Office Workforce Transformation.

VI. Competitiveness with other institutions: limited overlap within the University

As part of the planning for this certificate program, a thorough review of manufacturing programs and facilities at other universities was conducted. Programs that were assessed and visited include Kentucky, Michigan, Purdue, and the Marion regional campuses in the OSU system. Program directors, chairs, faculty members and staff were interviewed with respect to learning goals, student assessments, and industrial needs. None of the programs were an exact match to the focus and strengths of the manufacturing program at Ohio State but seeing them provided insight into the formation of this certificate. The proposed certificate program focuses on the various manufacturing strengths within the College of Engineering.

As a single example of our exploratory visits, shown are two images from the smart manufacturing facility at Purdue. The facility is impressive in its capability and ability to

demonstrate state-of-the art automation technology. Its various features allow this one facility to support over ten manufacturing courses.

Figure xxx: Main assembly area of Smart Manufacturing facility at Purdue. There is a main conveyor system, side conveyor systems flanked by robots and associated fixturing

Figure xxx: Main assembly area of Smart Manufacturing facility at Purdue. There is a robot picking parts from bins to populate a set of fixtures for assembly.

There is a strong interest withing the College of Engineering to support this certificate. Departmental leadership in ISE, MAE, and Welding have signed a memorandum of understanding to collaboratively support this program and provide teaching resources. Therefore, there is no overlap with other programs or departments.

Longer term plans are underway to create a signature teaching laboratory on the Columbus campus with possibly a major component in Baker Systems. This is of great interest to the ISE chair as existing manufacturing undergraduate concentration withing the ISE department will be energized through the enhanced recruitment opportunities.

Also, the CSE chair is interested in participating and linking this with their own smart manufacturing activities in sensors and control. Welding Engineering is also a major participant in terms of fastening and joining. Mechanical Engineering will also play a major part in terms of smart and flexible fixturing as well as in solid modeling and digital twinning.

It is important to point out that neither this program or the proposed facility is a duplication of efforts or facilities from our regional campuses. Our regional campuses are focused on teaching manufacturing for the engineering technology degree and their programs and facilities are configured accordingly.