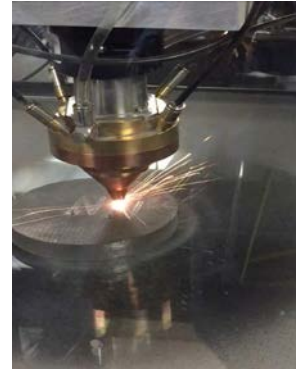


## MS specializing in Advanced Manufacturing

Advanced manufacturing is an integration platform that requires knowledge from various disciplines and becomes an enabler for innovations. At Northwestern, we address advanced manufacturing from our known academic strengths and our collaborative nature, e.g., innovative manufacturing processes, data-driven design and optimization, digital manufacturing enriched by sensors and simulations, artificial intelligence, human-machine interaction, and life cycle analysis.



### Features

Students also may have an opportunity to enrich their educational experiences through an internship either at Argonne National Laboratory or at an industrial partner affiliated with the Northwestern Initiative for Manufacturing Science and Innovation (NIMSI, <https://nimsi.northwestern.edu/>). Upon completion of MSME and Advanced Manufacturing specialization certificate will be awarded.

### Requirements

This 12-unit specialization will include seven courses as described below, two additional graduate level courses at-large, and three independent individual projects under ME 499 or a thesis comprising of three research units under ME 590. Students in this course will carry out projects at Northwestern under a faculty affiliated with NIMSI. Furthermore, the projects can also include experiences at Argonne National Laboratory's Midwest Transformative Energy Manufacturing (MTEM) Research and Development facility and the Materials Engineering Research Facility (MERF). At these facilities, students will be able to explore new manufacturing approaches (including additive manufacturing) that integrate smart sensors, simulations and materials data.

Note: Student must have 5 ME courses and 5 courses at the 400 level. All courses need to be from McCormick and at the Graduate level. Any exceptions should be pre-approved with the MS Program Director, Professor Manohar Kulkarni, PhD, PE (Manohar.kulkarni@northwestern.edu).

The students will choose courses in the following 5 categories:

#### *Manufacturing Processes and Equipment (minimum 2 required from the list below)*

- ME 340-1:** Computer Integrated Manufacturing I: Manufacturing Processes
- ME 340-2:** Computer Integrated Manufacturing II: CAD/CAM
- ME 340-3:** Computer Integrated Manufacturing III: Manufacturing Automation
- ME 415:** Mechanics of Manufacturing Processes
- ME 439:** Computer Control in Manufacturing
- ME 443:** Metal Cutting
- ME 445:** Micromanufacturing
- ME 446:** Advanced Tribology

***Materials and Sensors in Manufacturing (minimum 2 required from the list below)***

**ME 414-1:** Mechanics of Composite Materials I  
**ME 417:** Multiscale Modeling and Simulation in Solid Mechanics  
**ME 426-1:** Advanced Finite Element Methods I  
**ME 426-2:** Advanced Finite Element Methods II  
**ME 495:** Metamaterials  
**ME 495:** Nanoscale Thermal Transport  
**ME 495:** Theory of Heterogeneous Materials  
**CEE 424:** Stability of Structures  
**CEE 455:** Plasticity and Limit Analysis  
**EE 495:** Introduction to Nanophotonics and Plasmonics Science and Technology  
**MSE 406:** Symmetry and Mechanical Properties of Materials  
**MSE 435:** High Temperature materials  
**MSE 445:** High Polymer Science  
**MSE 465:** Advanced Electron Microscopy & Diffraction

***Design and Optimization in Manufacturing (minimum 1 required from the list below)***

**ME 341:** Computational Methods for Engineering Design  
**ME 441:** Engineering Optimization for Product Design and Manufacturing  
**IEMS 307:** Quality Improvement by Experimental Design

***Sustainable Manufacturing and Life Cycle Analysis (1 required from the list below)***

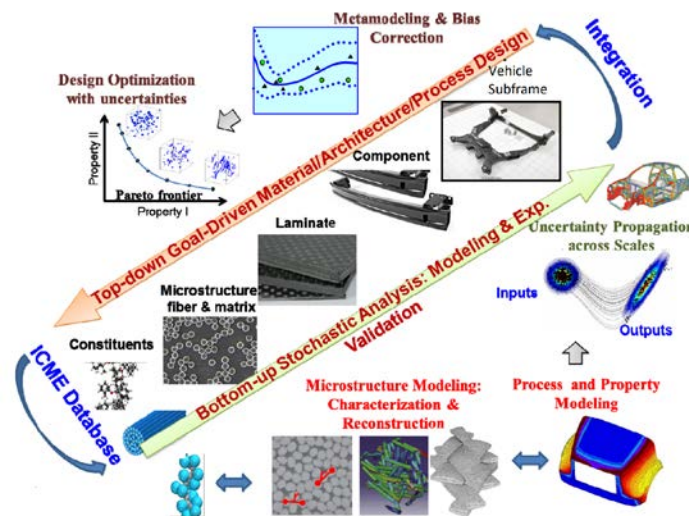
**ME 367:** Quantitative Methods in Life Cycle Analysis  
**ME 380/ISEN 390:** Thermal Energy Systems Design  
**ME 467/ISEN 495:** Industrial Energy Management and Utilization  
**POLI\_SCI 441:** International Political Economy  
**SOCIOL 437-0:** Economic Sociology

***Digital Manufacturing and Cybersecurity (1 required from the list below)***

**ME 395:** Industry 4.0 Manufacturing  
**ME 495:** Sensing, Navigation and Machine Learning for Robotics  
**IEMS 381:** Supply-chain Modeling and Analysis  
**IEMS 382:** Production Planning and Scheduling  
**IEMS 383:** Service Operations Management  
**COMP-SCI 340:** Introduction to Computer Networking  
**COMP\_SCI 450:** Internet Security  
**COMP\_ENG 395, 495:** Internet-of-Things Sensors, Systems and Applications  
**COMP\_ENG 495:** Introduction to Database Systems and Data Warehousing

## Internship

To enrich their educational experiences, we will work with students to seek a summer internship opportunity provided by a national lab/institute or industrial partner affiliated with the Northwestern Initiative for Manufacturing Science and Innovation (NIMSI, <https://nimsi.northwestern.edu/>). Interested students should apply to them according to their hiring timetables. Generally, the recruiting period extends from October 1<sup>st</sup> through the end of February.



Recent intern Erkin Oto said about his experience, “My summer internship experience at Argonne National Laboratory was a truly transformative experience and in fact the experience of a lifetime. Needless to say, Argonne National Laboratory is one of the most influential research enterprises in the history of science and technology, and it was an incredible source of inspiration and honor being a part of the cutting-edge Advanced Manufacturing research. Argonne National Laboratory is at the forefront of metal additive manufacturing research that has the enormous potential to transform manufacturing.

*The Advanced Manufacturing research experience I gained at Northwestern prepared me for this life-changing and eye-opening experience at Argonne. My research in Advanced Manufacturing Processes Laboratory under the supervision of Professor Jian Cao and my research work at Argonne have synergistically augmented each other. With its reputable faculty and rigorously designed courses, Northwestern University is known as the Mecca for applied research and teaching in Additive Manufacturing. I firmly believe it deserves this reputation to the fullest extent.”*

## Contact

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