Proposal for a new program:
Master of Science in Product Development

Sherman Center for Engineering Entrepreneurship Education

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Contents

Executive Summary

The technology sector has continued to be the furnace powering the world economy through COVID and leading in addressing problems such as climate change through technology development. Ranging from smart devices, to the internet of things, to software as a service product development is key to the success of businesses. The US tech industry has an estimated market size of $1.6 trillion in 2021[1]. The tech industry is expected to grow by 6% and the possibility of up to a quarter million new jobs by the end of 2022. Leaders in many companies are product managers and engineers. These positions guide product innovation and lead in crafting products for users. A look at any careers page for any technology firm currently hiring shows many positions open for individuals that have a mix of technical and product development knowledge.

The Sherman Center for Engineering Entrepreneurship Education in the College of Engineering proposes a new graduate program, the Masters of Science in Product Development, to allow students to meet the current and projected demand for skilled product engineers and managers. This program builds off a core of entrepreneurial engineering and product development while allowing students to choose a path in alignment with their chosen industry through their diverse elective course selections across four colleges. The program utilizes currently offered courses and infrastructure meaning that it would require minimal additional cost and effort to launch with a large potential upside in enrollment.

This degree program seeks to educate students who want to persue employment in many technology industries. The educational objectives of the program are to establish the foundation for the systems approach needed to conceive, create, launch, and support products and platforms. The program considers new product development in a larger framework: how a venture's strategy, vision, and core capabilities coupled with the voice of the customer combine to determine product strategy and create best-in-class product portfolios. From the engineering viewpoint, product development can be seen as a process from invention, design, planning and production, to service phases.

The total degree program will require 32 semester hours. The program will consists of a common core of 16 semester hours in product development and then three options: (1) 16 additional semester hours of elective coursework, (2) 12 semester hours of elective courses and a 4 semester hour project, and (3) 8 semester hours of elective coursework and 8 semester hours of thesis. There are over forty elective courses available to students come from many departments within the College of Engineering as well as course from the D'More-McKim School of Business, the College of Art, Media and Design, and the Bouvé College of Health Sciences.

Program Description

The MS in Product Develop with position students to be in demand across many technology industries and be the engine of innovation. The Sherman Center for Entrepreneurial Engineering Education is uniquely positioned to offer students a combination of product process and technical skills. The mission of the center is to enable interdisciplinary student entrepreneurship in the broadest sense by providing education about tools, concepts, and resources to foster creativity and the ability to develop commercially viable ideas.

Products ranging from smart devices to the internet of things, to software as a service all require people with product development skills. These positions guide product innovation and lead in crafting products for users. A look at any careers page for any technology firm currently hiring shows many positions open for individuals that have a mix of technical and product development knowledge. This program addresses these skills through a through, interdisciplinary, and dynamic set of over 40 elective courses ranging in topics from robotics to visual cognition, to platform innovation, to connected devices, to intelligent manufacturing, to measurements and analysis.

The MS in Product Development program contains a core of courses that span the product development cycle and then allows students to customize the rest of their degree to fit their chosen industry or path. The core courses cover topics such as customer acquisition, technical market analysis, product life cycle, intellectual property, prototyping, iterative development, product design, user testing, and manufacturing. Students will be able to follow an idea all the way through the process using the core courses to do so.

The program will take advantage of various co-op opportunities within the Sherman Center Co-op model. This unique program challenges students to develop milestones to be accomplished at the end of each month. Be at the Sherman Center during daytime business hours, 9:00AM-5:00PM. Submit a 1-page report at the end of each week detailing progress on milestones. Give a formal presentation on progress toward milestones at the end of each month

Contribution to the University Mission

This program in Product Development offers significant contributions to Northeastern’s mission. This program produces professionals that can empower the Northeastern network. The program not only can attract graduate students from many countries it can also provide another attractive option for Northeastern's BS students to pursue for their Plus One. This MS program opens additional avenues for university-industry collaborative projects and new opportunities for graduate co-op positions. The core of the program is technology platform agnostic allowing students a customized experience through disciplinary electives to craft the best degree for them. We also envision this program expanding to other campus nodes, such as San Francisco and Seattle.

Program Market Analysis

The Bureau of Labor Statistics does not track Product Managers specifically but states that the expectation for job growth is like Managing occupations with a growth of 8% between 2019-2029. Growth for related engineering disciplines is similar. Product Managers are the 4th highest in demand job in Silicon Valley[2].

Competition from other Programs

There are other programs in the US that are like the proposed program. They have been complied into the following table.

TABLE 1: OTHER US GRADUATE PROGRAMS IN PRODUCT DEVELOPMENT

University	Program	Description
Rochester Institute of Technology	MS in Product Development	https://www.rit.edu/study/product-development-ms
Northwestern	MPD[2] in Product Design and Development	https://design.northwestern.edu/product-design-development-management/
University of Southern California Online	MS in Product Development Engineering	https://online.usc.edu/programs/product-development-ms/
Carnegie Mellon University	MS in Product Development	https://ms-product-management.cmu.edu/
Boston University	MS in Product Design and Manufacture	https://www.bu.edu/eng/programs/master-of-science-in-product-design-and-manufacture/
Milwaukee School of Engineering	MS in New Product Management	https://www.msoe.edu/academics/graduate-degrees/business/new-product-management/
University of Pennsylvania	M:IPD in Integrated Product Design	https://ipd.me.upenn.edu/ipd-programs/m-ipd-degree/
University of Pennsylvania	MSE:IPD in Integrated Product Design	https://ipd.me.upenn.edu/ipd-programs/mse-ipd-degree/
University of Southern California Irvine	MS in Product Innovation	https://iovine-young.usc.edu/learn/graduate/ms-product-innovation
University of Detroit Mercy	MPD in Product Development	https://eng-sci.udmercy.edu/academics/engineering/mpd

[2] https://www.techrepublic.com/article/state-of-tech-in-silicon-valley-top-10-in-demand-jobs-and-employment-trends/

The programs that are most like what is being proposed here is the MS in Product Design and Manufacture at BU and the MS in New Product Management from Milwaukee School of Engineering. The advantages our program has over these programs are the strength of our faculty and the integration with the other departments in the college. Additionally, our experiential focus is clear differentiator (e.g., Experiential Masters Project).

A SWOT analysis was performed for this program and the results are below.

TABLE 2: SWOT ANALYSIS OF THE PROPOSED PROGRAM

Strengths	**Weaknesses**
The Sherman Center is a unique part of Northeastern and is positioned to see this program be a success	While the core courses of this program are not new many of them are taught by adjunct faculty.
Opportunities	**Threats**
There are options for new courses as well as the possibility to role this program out campuses beyond Boston.	Many of the competing offerings are available as online degrees. Students with technical undergrads have many options for graduate programs.

Impact on existing programs at Northeastern

The largest potential impact of this program would be on the Minor in Entrepreneurial Engineering. If students have the availability of a Plus One with this degree it would be a compelling option. There are also potentially impacts on other MS programs in COE as students in the proposed program will take elective courses in other COE departments. Outside of COE there are potential impacts on DMSB graduate programs from students with a technical background similar to Engineering Management.

Program Requirements

The following includes all the information about the requirements of the programs.

Admission criteria and process

To be eligible for admission to MS in Product Development program, a prospective student must hold a Bachelor of Science degree in engineering or an equivalent field. Applications will be processed by the Graduate School of Engineering. The program director will review the applications and offer admission to applicants that meet the admission standards defined in terms of GPA, GRE and TOEFL scores, recommendation letters, and related work experience. The Program Director will communicate his or her decision to the Graduate School of Engineering for a final review and follow through the admission process. The admissions requirements of the program will be defined within the framework of policies and guidelines set forth by the College of Engineering and the University Graduate Council.

Educational objectives

To develop a knowledge base of the total life cycle product development system, integrating management and (systems) engineering elements. To establish the foundation for the systems approach needed to conceive, create, launch, and support products and platforms. The program considers new product development in a larger framework: how a venture's strategy, vision, and core capabilities coupled with the voice of the customer combine to determine product strategy and create best-in-class product portfolios. From the engineering viewpoint, product development can be seen as a process from invention, design, planning and production, to service phases.

Three types of knowledge are needed to go through these phases:

1. knowledge to generate new product ideas
2. knowledge to evaluate these ideas
3. knowledge to structure and manage the development process

Degree requirements

The following includes requirements information for the proposed degree. For course descriptions see the attached appendix.

Credit hour requirements

Successful completion of the program will include 32SH. Of those courses, 16SH are core courses and the other 16SH are electives. Students must take 24SH of course work and then have three options for the remaining 8SH:

1. 8SH of MS Thesis
2. 4SH of MS Project and 4SH of additional course work
3. 8SH of additional course work

Core course requirements

This program includes 4 core existing courses totaling 16SH:

- GE 5010 Custom Driven Technical Innovation
- GE 5020 Engineering Product Design Methodology
- GE 5030 Iterative Product Prototyping for Engineers
- GE 5100 Product Development for Engineers

These courses are designed to give students a foundation in program development and engineering entrepreneurship. They are currently the core courses in the undergraduate minor in Entrepreneurial Engineering

Elective course requirements

Students will choose either 8SH from the existing courses listed below or 16SH if they chose option 3 above to complete 8SH of additional courses instead of a project or thesis.

ME

ME 5245 Mechatronic Systems
ME 5250 Robot Mechanics and Control
ME 5645 Environmental Issues in Manufacturing and Project Use
ME 5650 Advanced Mechanics of Materials
ME 5659 Control Systems Engineering

IE

IE 5617 Lean Concepts and Applications
IE 6200 Engineering Probability and Statistics
IE 7200 Supply Chain Engineering
IE 7270 Intelligent Manufacturing
IE 5630 Biosensor and Human Behavior Measurement
IE 6500 Human Performance in Sociotechnical Systems

BIOE

BIOE 5250 Design, Manufacture, and Evaluation of Medical Devices
BIOE 5810 Design of Biomedical Instrumentation4
BIOE 5850 Design of Implants, as a project class
BIOE 5510 Product Technology Commercialization

CSYE

CSYE 6510 Fundamentals of Internet of Things
CSYE 6530 Connected Devices
CSYE 6200 Concepts of Object-Oriented Design
CSYE 6205 Concepts of Object-Oriented Design in C++
CSYE 7280 User Experience Design and Testing

INFO

INFO 6660 Business Ethics and Intellectual Property for Engineers

EECE

EECE 5155 Wireless Sensor Networks and the Internet of Things
EECE 7258 Human Sensing and Recognition
EECE 5550 Mobile Robotics
EECE 5552 Assistive Robotics
EECE 5580 Classical Control Systems
EECE 5639 Computer Vision
EECE 5666 Digital Signal Processing

D'More-McKim School of Business courses

TECE

TECE 6222 Emerging and Disruptive Technologies

TECE 6250 Lean Design and Development

MKTG

MKTG 6200 Creating and Sustaining Customer Markets.

ENTR

ENTR 6230 Platform Innovation

ENTR 6320 Innovation, Entrepreneurship and Dynamic Competition

College of Art, Media, and Design courses

GSND

GSND 5110 Game Design & Analysis

GSND 6320 Psychology of Play

ARTG

ARTG 5120 Research Methods for Design

ARTG 5310 Visual Cognition

ARTG 5610 Design Systems

ARTG 5640 Prototyping for Experience Design

ARTG 6310 Design for Behavior and Experience

Bouvé College of Health Sciences

PT

PT 5321 Applications of Biomechanics in Human Function and Movement

PT 7010 Measurement and Analysis

Experiential masters project

In place of an elective course, students can undertake a 4-credit hour project under the supervision of a faculty member from the above colleges. The project should address a product development. The project could be either sponsored by industry or defined by a faculty advisor.

Masters Thesis

In lieu of elective courses, students can undertake an 8-credit MS thesis under the supervision of a faculty member from the colleges. The thesis topic should cover one or more of the areas from the above. The thesis should train students for research in human factors and/or prepare them for a doctoral program related to product development.

Minimum academic standards

There are no academic standards required in addition to the university requirements.

Requirements as applicable

All students who receive financial support from the university in the form of a research, teaching, or tuition assistantship must complete an 8-semester-hour thesis. Students who complete the thesis option must make a presentation at a thesis defense before approval by the departments and colleges. All students in the program must complete a minimum of 32 semester hours (exclusive of any preparatory courses) with a minimum GPA of 3.000.

Additional experiential components

Students in this program will be able to apply to the Sherman Center coop. This entrepreneurial opportunity allows students to work on a venture for their coop with the following requirements:

- Develop milestones to be accomplished at the end of each month.
- Be at the Sherman Center during daytime business hours, 9:00AM-5:00PM.
- Submit a 1-page report at the end of each week detailing progress on milestones.
- Give a formal presentation on progress toward milestones at the end of each month

Program assessment

The program director and Sherman Academic Board will develop a rubric of metrics for key performance indicators of the course and program objectives. Using this rubric, the program director and the advisory committee will assess course and program activities and experiences.

Once the students are admitted into the program, core outcomes of each course will be assessed through direct and indirect assessment methods. The program director will develop survey instruments to get anonymous student feedback on courses they take. These surveys will be conducted for all core courses and for a random sample of elective courses. In addition, the outcomes for the courses will be assessed through TRACE evaluations. The survey results will be summarized in an outcome rubric for each course to assess the core outcomes of the course. This assessment will be conducted each year until the program reaches maturity and stability, expectedly by the end of the fifth year of the program.

The overall program outcomes will be assessed through many standard graduate program metrics such as application volume, acceptance rate, yield, graduate rate, placement statistics, and competency match between curriculum and industry needs. The program will also monitor the students' co-op positions and co-op employers' feedback to gauge the program outcomes. Furthermore, the program will conduct surveys for graduating students and the employed alumni in the field to get their feedback on the program performance. This feedback from the graduating students and employed alumni will be translated into recommendations for the program improvement. This assessment will be conducted annually to address curricular issues and co-op and employment issues. A comprehensive program review will be conducted at the end of the fifth year of the program.

The program director and Sherman Academic Board will conduct comprehensive curriculum assessment at the end of the fifth year of the program. By reviewing formative course evaluations and program evaluations, program director and advisory committee will identify and address issues related to knowledge and skill gaps,

course prerequisites, course sequences, and other barriers to student learning. The assessment methods and schedule are summarized in the table below.

TABLE 3: PROGRAM ASSESSMENT SCHEDULE

Assessment Method	**Year 1 (AY 22/23) Formative Assessment**	**Year 2 (AY 23/24) Formative Assessment**	**Year 3 (AY 24/25) Formative Assessment**	**Year 4 (AY 25/26) Formative Assessment**	**Year 5 (AY 26/27) Summative Assessment**
Admission Data Review	Spring	Spring	Spring	Spring	Spring
Student Feedback on Courses	Summer	Summer	Summer	Summer	Summer
TRACE Evaluations	Summer	Summer	Summer	Summer	Summer
Co-Op Student Survey	Fall	Fall	Fall	Fall	Fall
Co-Op Employer Survey	Fall	Fall	Fall	Fall	Fall
Graduate Student Exit Survey	Spring	Spring	Spring	Spring	Spring
Employed Alumni Survey	Fall	Fall	Fall	Fall	Fall
Curriculum assessment	Summer	Summer	Summer	Summer	Summer
Overall Program Performance Evaluation	Summer	Summer	Summer	Summer	Summer

Resources

As this program grows it will need more faculty as most of the current courses are taught by adjunct faculty. The Sherman Center Maker Space is used for teaching currently and as the program grows more classroom space will be needed. There are sufficient library resources for this program.

The current affiliated faculty with this program:

- Jackie Isaacs, MIE
- Mona Minkara, Bio
- Tucker Marion, DMSB
- Aileen Huang-Saad, Bio
- Mark Sivak, CAMD and Sherman Center

Appendix: Course Descriptions

GE 5010. Customer-Driven Technical Innovation for Engineers. (4 Hours)

Studies the role of engineering innovation in addressing customer needs in early start-ups and the need to conceive successful innovative engineering design as part of a commercialization strategy. Emphasizes understanding how engineering innovation can meet real technical market needs and how to gather the necessary, relevant technical information early in the innovation process to produce a successful engineering design. Uses a series of practical engineering design projects to demonstrate how students can assess the technical capabilities of the start-up in producing an innovative design, how to communicate with customers in an iterative engineering design process, and how to correspondingly design and innovate to meet customer technical requirements.

GE 5020. Engineering Product Design Methodology. (4 Hours)

Explores the iterative product development process, with a focus on user-centered design techniques. Employs generative and evaluative user research methods to set product requirements and end-user technical specifications and inform the product development decision-making process. Expects students to develop a simple product, device, or tool in a team-based workshop environment, through a project spanning opportunity recognition, concept generation, prototyping and testing, concept selection, and engineering design, all informed by the needs of the intended user population. Includes discussions of industrial design, sketching, design thinking, prototyping and manufacturing processes, and product development consulting.

GE 5030. Iterative Product Prototyping for Engineers. (4 Hours)

Seeks to develop in-depth knowledge and experience in prototyping by focusing on engineering processes and instrumentation that are used in different industries. Studies the prototyping cycle, from initial process flow and sketching to prototype development to testing and analysis, with an emphasis on iteration. Analyzes how different kinds of engineering prototypes can address design and user-interface needs vs. functional needs, such as looks-like and works-like prototypes. Offers students an opportunity to obtain operating knowledge of methods including 3D printing, SolidWorks, off-the-shelf hardware-software interfaces, simulation, embedded systems, product testing, prototype analysis, and prototype iteration.

GE 5100. Product Development for Engineers. (4 Hours)

Focuses on the main processes needed to develop a complex, high-technology product. Emphasizes the most important techniques and approaches used in a startup environment. Seeks to benefit students of all engineering disciplines including computer science and biomedical, industrial, electrical, mechanical, computer, and chemical engineering. Includes a running practical project in which a new product is designed and executed through a series of small projects for each phase of the product development process. Topics include the product life cycle, new product development processes, project planning and management, new product idea generation, the systems approach to product development, design for manufacturing, market testing and launch, and escalation to manufacturing.

Appendix: Competing Program Curriculums

Rochester Institute of Technology

1. **First Year**
    - Accounting for Decision Makers
    - Operations and Supply Chain Management
    - Decision and Risk Benefit Analysis
    - Engineering of Systems 1
    - Engineering of Systems 2
    - Excellence in New Product Development
    - Product Development Capstone 2
    - Marketing Concepts and Commercialization
2. **Choose one of the Following**
    - Project Management
    - Agile Project Management
    - Systems and Project Management
    - Engineering or Business Elective
3. An elective course offers students the opportunity to better meet personal and organizational needs. Students may select from a long list of courses. Recommended electives include such offerings as Managing Research and Innovation, Lean Six Sigma Fundamentals, Advanced or International Project Management, Breakthrough Thinking and Creativity, Customer Centricity, and others.
4. Students complete a project during the final academic year of the program, based on a real problem often identified in the companies where they work. The corporate-oriented capstone project encompasses the broad integrative aspects of new product development – it synthesizes, increases, and demonstrates the student's understanding of previous program material and underscores the behaviors essential to product development leadership. The capstone project generates immediate benefits to sponsoring organizations. View our list of capstone projects for examples of projects past students have completed as part of the program.

Northwestern

Each course is 5 weeks long and all MPD2 students take the same classes in sequence

Requires 3+ Years experience in a Product Development Field

1. Fall 1

    - Intro. to Product Design and Development
    - Effective Communication
    - Materials Selection- Managing Choices
    - Team Building and Organizational Behavior

2. Winter 1

    - Accounting Issues for Product Development
    - Understanding through Design
    - Financial Issues for Product Development
    - Negotiation/Conflict Resolution

3. Spring 1

    - Leading with Data Visualization and Analytics
    - Global Product Design and Supply Chains
    - Project Management

4. Fall 2

    - Human Factors
    - Customer Driven Opportunities
    - Intellectual Capital Strategy

5. Winter 2

    - Management of Product Innovation
    - Creativity and Innovation
    - Agile Management of Software Product Design and Development
    - Essentials of Design

6. Spring 2

    - Principles of Marketing
    - Lean Design
    - Global Leadership in a Smart and Connected World
    - Business Model Design

University of Southern California

Joint offered by Aerospace and Mechanical as well as Industrial and Systems Engineering Department.

Need **27 Units** (credit hours) for degree

1. **Core Courses (6 Units)**

    - ISE 501 Innovative Conceptual Design for New Product Development Units: 3
    - ISE 545 Technology Development and Implementation Units: 3

2. **Product Development Systems Specialization (13-14 Units)**

    - ISE 515 Engineering Project Management Units: 3
    - ISE 544 Leading and Managing Engineering Teams Units: 3
    - Select Two
        - BAEP 557 Technology Commercialization Units: 3
        - CE 576 Invention and Technology Development Units: 3
        - DSCI 552 Machine Learning for Data Science Units: 4
        - ISE 510 Advanced Computational Design and Manufacturing Units: 3
        - ISE 511L Mechatronic Systems Engineering Units: 3

- ISE 514 Advanced Production Planning and Scheduling Units: 3
- ISE 525 Design of Experiments Units: 3
- ISE 527 Quality Management for Engineers Units: 3
- ISE 561 Economic Analysis of Engineering Projects Units: 3
- ISE 562 Decision Analysis Units: 3
- ISE 567 Collaborative Engineering Principles and Practice Units: 3
- ISE 580 Performance Analysis with Simulation Units: 3
- ISE 583 Enterprise Wide Information Systems Units: 3
- ISE 585 Strategic Management of Technology Units: 3
- ISE 610 Advance Design of Experiments and Quality Engineering Units: 3
- SAE 541 Systems Engineering Theory and Practice Units: 3
- SAE 549 Systems Architecting Units: 3

3. **Product Development Technology Specialization (13-14 Units)**

    - AME 503 Advanced Mechanical Design Units: 3
    - AME 525 Engineering Analysis Units: 4
    - Select Two
        - AME 408 Computer-Aided Design of Mechanical Systems Units: 3
        - AME 410 Engineering Design Theory and Methodology Units: 3
        - AME 502 Modern Topics in Aerospace Design Units: 3
        - AME 505 Engineering Information Modeling Units: 3
        - AME 527 Elements of Vehicle and Energy Systems Design Units: 3
        - AME 544 Computer Control of Mechanical Systems Units: 3
        - AME 546 Design for Manufacturing Assembly Units: 4
        - AME 547 Foundations for Manufacturing Automation Units: 4
        - AME 578 Modern Alternative Energy Conversion Devices Units: 3
        - ASTE 523 Design of Low Cost Space Missions Units: 3
        - CE 576 Invention and Technology Development Units: 3
        - ISE 510 Advanced Computational Design and Manufacturing Units: 3
        - ISE 567 Collaborative Engineering Principles and Practice Units: 3
        - ISE 576 Industrial Ecology: Technology-Environment Interaction Units: 3
        - MASC 551 Mechanical Behavior of Engineering Materials Units: 4
        - MASC 583 Materials Selection Units: 4
        - SAE 549 Systems Architecting Units: 3

4. **General Electives (9 Units)**

Adviser-approved electives must be upper-division 400- or 500-level courses. Up to 4 units can be transferred from other institutions.

Carnegie Mellon University

3 Semester, 12 Month Program. Geared towards product management and team leading with light bias towards Computer Science/Software Products

1. Spring Semester
    - Business Fundamentals for High Tech PM (12 units, Tepper)
    - Digital Service Innovation (12 units, HCII) OR Service Design for Product Management (12 units) OR Design of Artificial Intelligence Products (12 units)
    - Principles of Product Management (6 units, Tepper)
    - Business Communications (6 units, Tepper)
    - Managing People and Teams (6 units, Tepper)
    - Product Marketing (6 units, Tepper)
    - Data Science for Product Managers (6 units, HCII)
    - HCI for Product Managers (6 units, HCII)
2. Summer Semester
    - During the summer, you'll complete an approved internship in product management and take part in a weekly class that meets via video. The summer internship course gives you an opportunity to reflect on the relationship between the theories and techniques you've been taught and your experience on the job, and allows you to work with the instructor and other students to address challenges you're facing at your internship. Participating in the course will also help build a professional network of colleagues working in the field.
3. Fall Semester
    - In your final semester, you'll return to the Pittsburgh campus, where you'll complete a capstone experience and dive deeply into advanced technical courses and business electives.
        - Capstone Project (12 units, HCII)
        - Digital Service Innovation (12 units, HCII) OR Service Design for Product Management (12 units)
        - Technical Depth Elective (12 units, SCS)
        - Principles of Product Management II (6 units)
        - One Tepper Elective (6 units, Tepper)
        - Tepper or SCS Elective - Optional (6 units)
        - 111 Units required for graduation
    - Throughout the entire program, you'll work with expert coaches in the Tepper School's Accelerate Leadership Center to hone your communication and interpersonal skills.

Boston University

Core Requirements (20 credits)

- All students are required to take and pass ENG ME510, ENG ME537, ENG ME584, ENG ME691, and ENG ME692 in order to receive their Master's degree. These courses cover the fundamentals of the product design and manufacture program.
    - ME 510- Production Systems Analysis
    - ME 537- Product Realization
    - ME 584- Manufacturing & Supply Chain Strategy
    - ME 691- Advanced Product Design
    - ME 692- Advanced Product Design

2. **Design and Manufacture Electives (8 credits)**

- Each student must complete at least two of the 500-level or above courses in Design and Manufacturing listed below to fulfill the Design and Manufacture Requirement.

- ME517 Product Development
- ME555 MEMs: Fabrication and Materials
- ME557 Additive Manufacturing
- ME560 Precision Machine Design
- ME579 Nano/Microelectronic Device Manufacturing*
- ME538 Introduction to Finite Element Methods and Analysis
- ME507 Process Modeling and Control*
- ME518 Product Quality
- ME526 Simulation of Physical Processes*
- ME535 Green Manufacturing (not offered every year)
- ME606 Industrial Practicum

3. **Engineering and Physical Science Requirement (4 credits)**

    - Each student must complete one graduate-level course in engineering and/or physical sciences to fulfill the Elective Requirement.2 This course may be taken in any department or division of the College of Engineering or in the College of Arts and Sciences. The advisor's approval must be obtained to count this course towards the Elective Requirement.

Milwaukee School of Engineering

1. **Must complete 45 management course credits including a capstone project**

(required courses)

- MB 6000 - Management Principles **4 credits**
- MB 6110 - Fundamental Statistics and Analytics **4 credits**
- MB 6200 - Finance and Accounting **4 credits**
- MB 6310 - Professional Seminar I **1 credit**
- MB 6320 - Professional Seminar II **1 credit**
- MB 6630 - Applied Organizational Behavior **4 credits**
- MB 6900 - Project Management **4 credits**
- MB 7460 - Technology Strategy **4 credits**
- MB 7500 - Operations and Systems Management **4 credits**
- MB 7700 - Marketing **4 credits**
- MB 7770 - New Product Management **4 credits**
- MB 7900 - Strategy **4 credits**
- MB 8110 - Capstone Phase I **1 credit**
- MB 8120 - Capstone Phase II **1 credit**
- MB 8130 - Capstone Phase III **1 credit**

2. **Second Master's Degree**

A student who has earned an MBA, MSCBM, MSEM, MSNP, MSXM, MSE, MSN, MSCVE, MSP, MSAE or MSST degree within the last 7 years will be awarded 21 credits towards the pursuit of a second degree, either MBA, MSEM, or MSNP. ****

(see "Awarding Two Master's Degree" in the catalog for more information)

3. **Capstone**

Each student must complete a capstone project. This aims to: 1) provide a learning experience in which the student has the opportunity to discover something about a business topic that is not readily accessible, that is not conventional wisdom, and is not found in any book or other common source; and 2) allows the student to demonstrate his or her depth and breadth of learning from the MSNP program. Alumni cite this opportunity as one of the most valuable components of the program in their career advancement.

UC Irvine

1. A 2-year master's degree OR a 5-year progressive degree for undergraduates.

2. MSPRIN graduate students must complete a minimum of **64 units**, including **52 units in the Core** and a minimum of **12 units of Electives.**

    1. Core

- PRIN 501 The Creator's Mindset (2 units)
- PRIN 502 History and Theory of Product Innovation (2)
- PRIN 503 Principles of Human-Centered Design (2)
- PRIN 504 Aesthetics of Form I (4)
- PRIN 504 Aesthetics of Form II (4)
- PRIN 510 Foundation Studio (4)
- PRIN 515 Maker Foundation I (4)
- PRIN 516 Maker Foundation II (2)
- PRIN 520 Creator's Studio (4)
- PRIN 525 Physical Maker Lab (Making and Fabrication of Physical Products) (2)
- PRIN 526 Virtual Maker (Web Frontend Production) (2)
- PRIN 530 Business Essentials for Product Innovators (4)
- PRIN 531 Product Venture Design and Foresight (4)
- PRIN 532 Lading Product Enterprises (4)
- PRIN 535 Entrepreneur Lab (Finance for Disruptive Innovation) (2)
- PRIN 550 Industry Lab (2)
- PRIN 575A The Garage Experience (2)
- PRIN 575B The Garage Experience (2)

    2. Electives

- PRIN 525 Physical Maker Lab (2 units)

- PRIN 526 Virtual Maker Lab (2)
- PRIN 535 Entrepreneur Lab (2)
- PRIN 550 Industry Lab (2)
- PRIN 590 Directed Research (Vary)

Penn

1. 6 core courses and 4 additional courses, one in design, one in business and two in engineering. Since the program is cross-disciplinary, students who do not have the requisite background in the design arts and marketing/finance, may be required to enroll in additional foundational courses in these areas.

2. Required Courses

    - IPD 551: Design Process (1st Semester) (1 CU)
    - IPD 552: Problem Framing (2nd Semester) (1 CU)
    - IPD 799: Final Project (3rd Semester) (1 CU)
    - IPD 799: Final Project (4th Semester) (1 CU)
    - MEAM 514: Design for Manufacturability (1 CU)
    - MEAM 510: Design of Mechatronic Systems (1 CU)

1. 5 core courses and 5 additional courses, one each in design, business and engineering and two additional courses in any of the disciplines. Since the program is cross-disciplinary, students who do not have the requisite background in the three areas, engineering, design arts, and marketing/finance, may be required to enroll in additional foundational courses in these areas.
2. Required Courses

- IPD 551: Design Process (1st Semester) (1 CU)
- IPD 552: Problem Framing (2nd Semester) (1 CU)
- IPD 515: Product Design or IPD 514: Design For Manufacturability (1st year) (1 CU)
- IPD 799: Final Project (3rd Semester) (1 CU)
- IPD 799: Final Project (4th Semester) (1 CU)