ADDITIVE MANUFACTURING FOR INNOVATIVE DESIGN AND PRODUCTION
INTRODUCTION

The implications of additive manufacturing (AM), also known as 3D printing, span the entire product lifecycle and compel us to reimagine how products are designed, produced, and delivered to customers around the globe. Emerging industrial AM processes can be used with polymers, metals, composites, and other advanced materials. More than half of all parts made by 3D printing are already for end-use applications. Combined with advanced digital design tools, AM is poised for industrial deployment.

It is imperative that engineers, designers, and executives take the steps now to understand how and when to leverage AM in their roles and organizations. In this online course, you will study the technical fundamentals, industrial applications, and business implications of AM, and acquire the knowledge and confidence to create innovative solutions using AM across a vast opportunity space.
IN THIS COURSE

In the MIT xPRO course, Additive Manufacturing for Innovative Design and Production, learners will join leading MIT and industry experts in an 11-week exploration of the fundamentals, applications, and implications AM, and will walk away with the confidence to deploy AM to create value in their roles and organizations.

The course incorporates advanced digital design, modeling, and visualization tools, and concludes with an in-depth case study, where learners solve a real-world design or strategy problem using their knowledge of AM.

What You’ll Acquire

• The vocabulary necessary to navigate the complex, multivariate landscape of additive manufacturing processes, materials, and applications.

• For each mainstream AM process, an understanding of its materials compatibility, fundamental mechanism of operation, performance metrics, and design limitations.

• The ability to identify how, when, and where additive manufacturing can create value across the entire product lifecycle, from design conception to end-of-life.

• The skills necessary to design parts for AM that combine engineering intuition with computationally-driven design and process-specific constraints.

• The ability to quantitatively assess the value of an additively manufactured part based on its production cost and performance.

• A cutting-edge perspective on digital transformation and the factory of the future.
Who You’ll Meet

• MIT faculty from mechanical engineering, materials science, computer science, & management.
• Experts in the nuts-and-bolts of designing parts for AM, & implementing AM in aerospace, automotive, medical, consumer products, & other industries.
• Leaders who are driving industrialization.

What You’ll See

• An in-depth series of video lectures, with high-quality graphics & detailed descriptions.
• 24+ recorded interviews with academic & industry experts, capturing cutting-edge perspectives.
• High-detail examinations of industrial parts produced using each mainstream AM process.
• A portfolio of AM applications including prototyping, rapid product development, tooling, mass production, customization, repair & maintenance.
• The use of generative design, process planning, & build simulation software for AM.
• A comprehensive assessment of the performance of AM processes, & the resultant properties of AM materials & components.

What You’ll Use

• The interactive, browser-based edX platform that includes multimedia content presentations, three-dimensional part data, & interactive quantitative tools.
• Cloud-based CAD & generative design software.
• A curated online discussion platform for communicating with course peers & exchanging insights.
• An interactive online Knowledge Base that offers extensive supplemental content on AM processes, materials, & properties to enhance your in-depth understanding of AM.
• Spreadsheet-based cost models that enable you to evaluate the economics of AM-based production.
UNIQUE COURSE FEATURES

Advanced Digital Tools
Experience interactive 3D visualizations of the processes and parts discussed in the course, including advanced topology optimization and build preparation software. Utilize quantitative tools for cost modeling of AM parts, and cloud-driven digital design tools for CAD and generative design.

3DMIT Design Kit
The MIT course team has designed and fabricated a library of components that illustrate key AM design principles. These components feature overhangs, lattice structures, and other features which are described in relation to the capabilities and limitations of each AM process. One such artifact is a modular assembly of MIT’s iconic central dome building, and is shown via 4K video, high-resolution microscope images; 3D models of the parts are available for download and manipulation.

High-Quality Video
Exceptional production value on all lectures and demonstrations including special attention to detail on all machinery and parts.
WEEKLY COURSE STRUCTURE

1. STATUS + IMPLICATIONS OF AM
   - The vocabulary and status of AM and its implications.
   - A description of the AM workflow and digital thread.
   - Perspectives from industry leaders and academic experts.

2. AM PROCESSES
   - An overview of all major AM processes and comparison of their performance.
   - Modules on the fundamentals, materials, and design guidelines for each process.
   - Video walkthroughs of process-specific workflows.

3. APPLICATIONS OF AM
   - A structured presentation of AM across the product lifecycle.
   - AM application examples from aerospace, automotive, medical, and more.
   - A methodology for selecting and classifying potential applications of AM.

4, 5, 6. DESIGN FOR AM
   - Engineering approaches to design for AM, spanning processes and materials.
   - Design methods for novel geometries, lattices, and mill patterns.
   - Software for build preparation, generative design, and part/process simulation.
   - Process and materials selection; assessment of performance, quality, and cost tradeoffs.

7. COST AND VALUE ANALYSIS
   - Understand how to quantitatively capture the value of AM versus conventional manufacturing.
   - A framework and online tool for AM cost modeling, applied to example scenarios.
   - Implications of AM on supply chain operations.

8, 9. CASE STUDIES
   - In the capstone experience of the course, synthesize your new knowledge of AM to solve a real-world problem.
   - Connect with peers to evaluate and receive feedback.

10. FUTURE OF PRODUCTION
    - Assess critical technologies that will complement AM in the factory of the future, including robotics, advanced materials, and computation.
    - Identify near, medium- and long-term challenges and opportunities for AM.
    - Build a perspective on product, process, and business model innovations catalyzed by AM.

11. CHOICE OF CASE STUDIES

   DESIGN
   - Redesign an existing functional part for AM to achieve higher performance, reduce weight, or simplify assembly.
   - Use cloud-based computer-aided-design and generative design programs to produce your design, and then discuss process selection and additional considerations to produce the final part at scale.

   STRATEGY
   - Evaluate a proposed deployment of additive manufacturing in a production environment.
   - Perform detailed cost modeling given an AM-oriented design and other product requirements, select an AM process, and recommend a comprehensive deployment.

12. ONE HOLIDAY WEEK
    - The week of Thanksgiving falls between Week 7 and Week 8. There will be no assignments or new course materials this week.
COURSE INSTRUCTORS

John Hart
John Hart is Associate Professor of Mechanical Engineering, Director of the Laboratory for Manufacturing and Productivity, and Director of the Center for Additive and Digital Production Technologies (http://adapt.mit.edu) at MIT. John’s research group (http://mechanosynthesis.mit.edu) focuses on additive manufacturing, nanostructured materials, and the integration of computation and automation in process discovery. He is co-inventor on >50 patents, many of which are licensed commercially, and is co-founder of three advanced manufacturing startup companies including Desktop Metal. John also authored the world’s first massive open online course on manufacturing processes, MIT 2.008x on edX. He received the MIT Ruth and Joel Spira Award for Distinguished Teaching in 2017.

Cem Tasan
Cem Tasan is the Thomas B. King Career Development Professor of Metallurgy in the Department of Materials Science and Engineering at MIT. His research group (http://tasan.mit.edu) seeks to understand the deformation, transformation, and damage mechanisms in metals, and to enable the design of game-changing new alloys for industrial use including via additive manufacturing. Prior to joining MIT in 2016 he was Group leader in Adaptive Structural Materials at the Max-Planck-Institut für Eisenforschung.

Ely Sachs
Emanuel “Ely” Sachs is a Professor of Mechanical Engineering at MIT. He began working on 3D printing in the late 1980’s and co-invented the binder jetting process which has widespread commercial uses. Ely’s career spans academia and industry; he has cofounded or otherwise been involved in seven start-up companies based on his inventions, including three that went public, one that was acquired by a public company, and three that are still private. In 2016 he was elected to the National Academy of Engineering for his contributions to 3D printing and photovoltaics.

Stefanie Mueller
Stefanie Mueller is an Assistant Professor of Electrical Engineering and Computer Science at MIT, where she leads the HCI Engineering Group (http://hcie.csail.mit.edu). Her research focuses on novel hardware and software systems that enable rapid, interactive design and fabrication, including fast 3D printing, real-time material shaping, and modularization using standard and custom components. She is also the co-founder of the ACM Symposium on Computational Fabrication.

Steve Graves
Stephen Graves is the Abraham J. Siegel Professor of Management and a Professor of Operations Management at MIT. He teaches courses in supply chain planning and design, and in mathematical modeling and analysis, as applied to manufacturing, supply chains, and distribution systems. Steve’s research addresses operational issues arising in supply chain optimization, online retailing, and strategic inventory positioning, as well as production and capacity planning for various contexts. He holds a joint appointment in Mechanical Engineering and previously served as the Chair of the MIT Faculty and co-director of the MIT Leaders for Manufacturing Program.
READY TO LEARN?

Explore the fundamentals, applications, and implications of AM with MIT’s online course:

**Additive Manufacturing for Innovative Design and Production**

This course starts October 1, 2018 and enrollment is now open. To enroll, [click here](#).