MET-2191: ADDITIVE MANUFACTURING PROJECT CAPSTONE

Cuyahoga Community College

Viewing: MET-2191 : Additive Manufacturing Project Capstone

Board of Trustees:
2017-06-29

Academic Term:
Fall 2018

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
2191

Title:
Additive Manufacturing Project Capstone

Catalog Description:
Examines the key elements of product development from the concept through design to production. Application technologies learned in the Additive Manufacturing curricula to complete individual and team projects involving product development and production.

Credit Hour(s):
2

Lecture Hour(s):
1

Lab Hour(s):
3

Requisites

Prerequisite and Corequisite
MET-2151 3D Digital Design & Printing.

Outcomes

Course Outcome(s):
Design a solution to address a given problem by following the key elements of product development from concept through design to production.

Essential Learning Outcome Mapping:
Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.
Oral Communication: Demonstrate effective verbal and nonverbal communication for an intended audience that is clear, organized, and delivered effectively following the standard conventions of that language.
Written Communication: Demonstrate effective written communication for an intended audience that follows genre/disciplinary conventions that reflect clarity, organization, and editing skills.

Objective(s):
1. Investigate and identify relevant manufacturing problems requiring engineered solution.
2. Design a production process applying quality control, cost analysis components, and marketability considerations.
3. Write standard technical reports.
4. Apply the appropriate knowledge and skills to resolve manufacturing problems.
5. Apply other relevant research to solve engineering and manufacturing problems.
6. Evaluate proposed solutions in terms of current skills and knowledge.
7. Determine the requisite knowledge and skills for the resolution of pending problems.
8. Apply the tools of project management to ensure timely project completion.
9. Design a new solution or build on past work to resolve designs or process problems.
10. Evaluate actual solution performance against expected outcome.
11. Experiment and re-design for proper operation.

Methods of Evaluation:

1. Participation
2. Assignments
3. Projects
4. Reports
5. Oral Presentation

Course Content Outline:

1. Introduction and basic principles
    a. What is Additive Manufacturing?
    b. What are AM parts used for?
    c. Generic AM Process
        i. CAD
        ii. Conversion to STL
        iii. Transfer to AM Machine and STL file manipulation
        iv. Machine Setup
        v. Build
        vi. Removal
        vii. Post Processing
        viii. Application
2. Development of Additive Manufacturing Technology
    a. Computers
    b. Computer-Aided Design Technology
    c. Lasers
    d. Printing Technology
    e. Programmable Logic Controllers
    f. Materials
3. Generalized Additive Manufacturing Process Chain
    a. Eight steps in AM
    b. Variations in AM Machines
    c. Metal Systems
    d. Maintenance of equipment
    e. Material handling issues
    f. Design for AM
4. Photo-p
5. olymerization Processes
    a. Photo-polymerization materials
    b. Reaction rate
    c. Vector scan SL
    d. SL Resin curing process
    e. SL Scan pattern
    f. Vector scan micro-stereo-lithography
    g. Mask Projection Photo-polymerization
6. Powder Bed Fusion Processes
    a. SLS Process description
    b. Power fusion mechanism
    c. Powder handling
    d. Approaches to metal and ceramic part creation
    e. Variants of powder bed fusion processes
7. Extrusion-Based Systems
    a. Basic principles
        i. Material loading
        ii. Liquification
        iii. Extrusion
        iv. Solidification

        v. Positional control
        vi. Bonding
        vii. Support generation
    b. Plotting and path control
    c. Fused deposition modeling from Stratasys
    d. Materials
    e. Limitations of FDM
    f. Bioextrusion
8. Printing Processes
    a. Evolution of printing as an Additive Manufacturing process
    b. Research achievements in printing deposition
    c. Technical challenges of printing
    d. Printing process modeling
    e. Materials modification methods
    f. 3 Dimensional printing
    g. Advantages of binder printing
9. Sheet Lamination Processes
    a. Gluing or adhesive bonding
    b. Thermal bonding
    c. Process based on sheet-metal clamping
10. Beam Deposition Processes
    a. Description of beam deposition process
    b. Material delivery
    c. BD system
    d. Process parameters
    e. Typical materials and microstructure
11. Direct Write Technologies
    a. Ink based DW
    b. Laser Transfer DW
    c. Thermal spray DW
    d. Beam deposition DW
    e. Liquid phase direct deposition
    f. Hybrid technology
    g. Application of DW technologies
12. Design for Additive Manufacturing
    a. Motivation
    b. Design for Manufacturing and Assembly
    c. Core DFAM concepts and objectives
    d. AM unique capabilities
    e. Design tools for AM
13. Guidelines for Process Selection
    a. Selection methods for a part
    b. Challenges of selection
    c. Production planning and control
14. Software Issues for Additive Manufacturing
    a. Preparation of CAD models
    b. STL file format, Binary/ASCH
    c. STL files manipulation
15. Direct Digital Manufacturing
    a. Align technology
    b. Siemens and Phonaks
    c. DDM drivers
    d. Manufacturing vs. prototyping
    e. Cost estimation
    f. Life cycle costing
16. Medical Applications for Additive Manufacturing
    a. Use of AM to support medical applications
    b. Software support for medical applications

   c. Limitation of AM for medical applications
   d. Materials
17. Post-Processing
   a. Support materials removal
   b. Surface texture improvements
   c. Accuracy improvements
   d. Aesthetic improvements
   e. Preparation for use as patterns
   f. Property enhancements using non-thermal techniques
   g. Properties enhancements using thermal techniques
18. The use of Multiple Materials in Additive Manufacturing
   a. Multiple materials approaches
   b. Discrete multiple materials processes
   c. Porous multiple materials processes
   d. Blended multiple materials processes
19. Business Opportunities and Future Directions
   a. New types of products and employment
   b. Digiproneurship
20. Economics of Additive Manufacturing
   a. Rational decision process
   b. Time value of money
   c. Rate of return analysis
   d. Accounting for depreciation

Resources

Chan S. Park. *Fundamentals of Engineering Economics.* 3ed. Auburn University, Prentice Hall, 2012.

Besterfield, Dale H. *Quality Control.* 8th Ed. Upper Saddle River, NJ, 2011.

Foston, Arthur; Smith, Carolena; Au, Tony. *Fundamentals of Computer Integrated Manufacturing.* Upper Saddle River, NJ, 1991.

Wright, Kenneth. *21st Century Manufacturing.* Upper Saddle River, NJ, 2001.

Heldman, K. *PMP: Project management professional study-guide.* (5th ed.). Hoboken, NJ: Wiley Publishing, 2009.

Resources Other

1. Handouts/materials as specified by instructor.

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