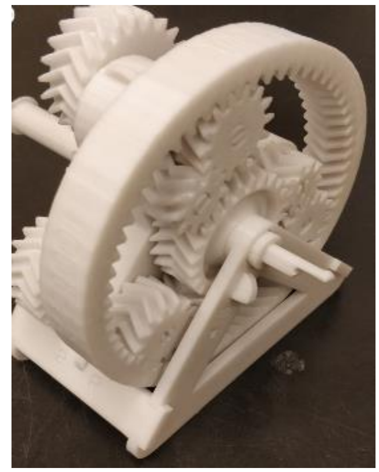
Additive Manufacturing for Practicing Engineers

WSU online class for Boeing employees

Course objective

The primary objective of this course is to help engineers understand how additive manufacturing (3D Printing) can be utilized in product design through in-class lectures and hands-on group projects.

Projects: All projects will be team based.



Project 1: Design and printing of plastic parts using fused deposition modeling (FDM) with features that cannot be processed using traditional manufacturing. This project is designed to help students appreciate inherent advantages of layer-by-layer manufacturing.

Project 2: The 2nd project will involve design and printing of multi-part system that will require assembly. This project is designed to understand what kind of dimensional variations can be allowed in AM processed parts.

Project 3: This project will involve design of simple parts where build time can be minimized without compromising mechanical strength. Built time estimation along with cost analysis will be a part of this project.

Project 4: This final project will integrate all the above project ideas where concept of topology optimization will also be introduced.

Instructor

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Amit Bandyopadhyay is working in the areas of additive manufacturing since 1995. He has written over 300 technical articles, edited 10 books and inventor of 19 issued patents. His edited book, ***Additive Manufacturing***, will be used as a text for this class, which has also been translated in Chinese.

Course outline

1. Introduction to Additive Manufacturing (AM) **Week 1**
   a. Historical perspective; Comparison between AM and conventional manufacturing (CM)
   b. Advantages and challenges of AM
   c. Different types of AM processes – Process description, advantages and disadvantages

Hands-on Project 1

2. Thermoplastic polymer-based AM **Week 2**
   a. Fused deposition modeling (FDM)
   b. Material jetting
3. Thermoset polymer-based AM **Week 3**
   a. Stereolithography (SLA)
   b. Polyjet / Multijet

Hands-on project 1 – Part building and 1 or 2 page/s technical report due at the end of Week 3.

4. Laser-based AM for polymers **Week 4**

    a. Selective laser sintering (SLS)

Hands-on Project 2

5. Other AM processes for polymers **Week 5**
    a. Binder jetting
    b. Sheet lamination
6. Design issues for additive manufacturing **Week 6**

Hands-on project 2 – Part building and 1 or 2 page/s technical report due at the end of Week 6.

7. Historical perspective for AM of metals **Week 7**
    a. Solidification behavior for pure metals and alloys
    b. Fundamentals of sintering

Hands-on Project 3

8. Powder bed-based metal additive manufacturing **Week 8 and 9**
    a. Understanding commercially available processes
    b. Advantages and challenges
    c. Examples of topology optimization using AM

Hands-on project 3 – Part building and 1 or 2 page/s technical report due at the end of Week 9.

9. Directed energy deposition of metals and alloys **Week 10**
    a. Basic processing techniques
    b. Examples, advantages and challenges

Hands-on Project 4

10. Other AM processes for metals **Week 11**
    a. Fused deposition of metals
    b. Wire feed metal printing
11. AM processes for ceramics and composites **Week 12**
    a. Basic processing techniques
    b. Examples, advantages and challenges

Hands-on project 4 – Part building and 1 or 2 page/s technical report due at the end of Week 12.

Expected learning outcomes

1. Advantages and challenges related to different commercial AM processes.
2. Design for additive – what additive manufacturing can do that is not possible in conventional manufacturing operations.
3. Metal additive manufacturing – fundamental of metal casting related to metal additive manufacturing. Also learn how to separate myths from the reality for metallic AM.
4. Topology optimization using AM
5. Multifunctional multi-materials parts via additive manufacturing – appreciate the future of AM technology in product design and materials innovation.