1. ES470 Desktop Manufacturing and Product Design

2. 4 credit hours, 2 recitation hours, 4 laboratory hours

3. Course Coordinator: Professor Bradley E. Bishop

4. Textbook: Universal Principles of Design by Lidwell, Holden and Butler, 2010.

   Materials and Design (3rd edition) by Ashby and Johnson, 2014.

5. Specific course information

   a. This course focuses on the fundamental principles of commercial product design and prototyping using tools from desktop manufacturing, including 3-D printers, laser cutters, 3D scanners, vacuum formers, and printed circuit board (PCB) manufacturing capabilities. Students are introduced to a wide array of tools, including CAD principles for desktop manufacturing, professional graphics software for documentation and promotion, and product design concepts ranging from usability to aesthetics. The course culminates in the generation of a novel product design including a fully functional prototype generated using the tools from the course.

   b. Prerequisite: ES202, and ESE or ESEH major

   c. Elective course

6. Specific goals for the course

   a. At the conclusion of the course, students will be able to:

      - Describe the concept and reality of low-cost desktop manufacturing
      - Properly choose and utilize existing tools for:
        - Additive manufacturing and 3D printing
        - 3D scanning
        - Laser cutting and engraving
        - Printed Circuit Board Layout and Production
        - CAD and digital art tools for 3D modeling
      - Understand the primary principles of product design
      - Demonstrate the skills needed to carry a product from concept through prototype
      - Demonstrate design principles in preparation of presentations and digital media
      - Understand the implications of the desktop manufacturing revolution

b. This course focuses on growth of engineering skills through hands-on, project-based learning associated with product design and development as well as experience with modern rapid prototyping techniques, engineering graphics, and design principles. As such, it addresses the following outcomes:

- (a) an ability to apply knowledge of mathematics, science, and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function on multidisciplinary teams
- (e) an ability to identify, formulate, and solve engineering problems
- (g) an ability to communicate effectively
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Topics covered:

- Principles of design, including usability, aesthetics, affordances, propositional density, and material properties.
- Rapid prototyping techniques, including 3D printing (FDM, SLA, and polyjet), laser cutting, vacuum forming and molding, 3D scanning and reverse engineering.
- Engineering skills, including graphic design (using Adobe Illustrator), CAD (using Autodesk Inventor), 3D sculpting (using freeware such as Meshmixer and Sculptris), product cost estimation and pricing.
- Creativity, through multiple challenges using the various tools of the course as well as the semester project.
- Full product design through functional prototype, on both a wearable project and a fully student-developed prototype product.