Computer Integrated Manufacturing Unit 2: CNC Mill & Rapid Prototyping

Unit Focus

Computer-integrated manufacturing (CIM) is an introduction to the use of computer techniques to integrate manufacturing activities. These activities encompass all functions necessary to translate customer needs into a final product. CIM usually starts with the development of a product concept then product design and specification with the final step revolving around automating the manufacturing process.

The content and skills learned throughout the course will be taught in 3 separate modules (units) followed by an all encompassing PBA. For each module, students will work collaboratively, at their own pace, following a guided instructional tutorial. The first three days of the trimester will be used for review of computer aided mechanical drawing and 3D printing skills.

In this module, students will learn how to manufacture items through subtractive prototyping. This will be done through a hands-on approach in designing a part, setup and execution of a Computer Numerical Control (CNC) Mill to construct a part. A PBA will have students conceptualize and create a wax crayon mold prototype that will be used in the final unit.

Stage 1: Desired Results - Key Understandings

Standard(s)

Connecticut Goals and Standards

Computer Aided Drafting and Design: 12

- Express a design of an object as a 3D model.*(A5) *CADD.02.07*

Manufacturing: 12

- Select materials based on properties required by the project *MAN.02.03*
- Apply a variety of manufacturing techniques and processes to create a usable product *MAN.03.03*

Pre-Engineering Technology: 12

- Measure with precision measurement tools and instruments. *ENG.03.03*
- Use all tools and equipment safely *ENG.06.03*
- Describe and demonstrate the process for using CAD in a design solution. *ENG.07.04*

Wood Technology: 12

- Follow laboratory safety rules and procedures. *WM.03.15*

ITEEA - Standards for Technological Literacy

Technological Literacy: K-12

- Students will develop an understanding of the characteristics and scope of technology. *1*
- Students will develop an understanding of the core concepts of technology. *2*

Transfer

Students will be able to independently use their learning to...

T1 Develop a product/solution that adheres to key parameters (e.g., cost, timeline, restrictions, available resources and audience).

T2 Explore and hone techniques, skills, methods, and processes to create and innovate

Meaning

Understanding(s)

Students will understand that...

U1 Prototyping is a major step in the design cycle of manufactured goods and has been greatly advanced with the advent and use of rapid prototyping processes.

U2 Subtractive prototyping yields a higher structural integrity which is critical if the prototype part is to be used in product testing. Product testing with a part made through subtractive prototyping allows for an accurate analysis of the part's viability and even durability since it is made from the same material that will be used to manufacture production parts.

U3 Design thinking offers a structured framework for understanding and pursuing innovation in ways that contribute to growth and add real value to customers.

Essential Question(s)

Students will keep considering...

Q1 How do you manufacture a part once it has been designed?

Q2 How do you determine how a part should be manufactured?

Q3 How can rapid prototyping help in meeting the needs of my client?

Stage 1: Desired Results - Key Understandings

- Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study. *3*
- Students will develop an understanding of the attributes of design. *8*
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. *10*
- Students will develop the abilities to apply the design process. *11*
- Students will develop the abilities to use and maintain technological products and systems. *12*
- Students will develop an understanding of and be able to select and use manufacturing technologies. *19*

NGSS/NSTA Science & Engineering Practices

NGSS Science & Engineering Practices: 9-12

- Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations. *SE.9-12.1.8*
- Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. *SE.9-12.2.1*
- Develop a complex model that allows for manipulation and testing of a proposed process or system. *SE.9-12.2.5*
- Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. *SE.9-12.2.6*
- Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success. *SE.9-12.4.6*
- Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system. *SE.9-12.5.2*
- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. *SE.9-12.6.5*

Madison Public Schools Profile of a Graduate

- Design: Engaging in a process to refine a product for an intended audience and purpose. (POG.2.2)
- Product Creation: Effectively use a medium to communicate important information. (POG.3.2)

Acquisition of Knowledge and Skill

Knowledge

Students will know...

K1 Vocabulary: Computer Numerical Control, XYZ Coordinate Axis System, CNC Milling machine, Collet, Flat End Mill, Ball End Mill, Toolpath, Addative Prototyping, Subtractive Prototyping, Foundry, Casting, Sand Casting, Permanent Mold Gravity Casting, Die Casting, Lost Foam Casting, Casting pattern, Cope, Drag, Gating system and Draft (positive or negative).

K2 "Design Thinking" is an iterative process in which we seek to understand the user, challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might not be instantly apparent with our initial level of understanding.

K3 Additive prototyping versus subtractive prototyping

Skill(s)

Students will be skilled at...

S1 Setup and orient a CNC mill for machining an object.

S2 Manipulate the criteria within a CNC Milling software to yield to best print results with a Mill.

S3 Create a functional prototype using a CNC Mill.

S4 Empathize with a client in using the "Design Thinking" process to create a solution.