Enhancing Teacher Knowledge and Skills in Manufacturing

Research Experiences for Techers

Texas A&M University

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Harlingen High School

Harlingen Consolidated ISD

Computer Integrated Manufacturing

11-12 Grade

Product Design and Fabrication Activity

8 days (12 hours)

Hands-on Activity: **Design, Drill, Tap, Engrave.**

Summary

Students will work in teams to design and fabricate a Bolt Thread Gauge from Aluminum plate. Teams are given open-ended specifications and use the engineering design process to determine the most efficient product shape and arrangement of ten various size tapped holes. Traditional manufacturing skills will be used to cut the Aluminum to the desired shape, layout holes, drill and cut internal threads. Tread designations will then be engraved around/above each hole using a Computer Numerical Control (CNC) milling machine. Team logo will also be engraved on the top surface.

Engineering Connection

Design engineers design products to meet customers needs that function and performs as intended. Manufacturing engineers design the processes to efficiently produce products of high quality with low production cost. Understanding the life cycle of a product and the manufacturing process that are used to produce them are important skill for engineers.

Learning Objectives

After this activity, students should be able to:

- Explain the design process and how it is used to select the best solution to the problem.
- Communicate technical information about a product.
- Use measuring tools to layout shape and location geometry on a part.
- Develop a manufacturing sequence production plan.
- Explain how machines are used to produce metal products.

Pre-Req Knowledge

Before this activity, students should be able to:

- Understand basic algebra and geometry.
- Proficiently use Computer Aides Design (CAD) and Computer Aided Manufacturing (CAM) software.
- Metric and standard measurement.

Educational Standards

This project will meet the learning objectives from Texas Essential Knowledge and Skills (TEKS) from Chapter 130, Subchapter M, Manufacturing, 130.359 Precision Metal Manufacturing, 130.359 (c)6 A-I, 130,359 (c)7 A-D, 130.359 (c)8 A-I, 9 A-L. This project will partially prepare students for the Project Lead The Way (PLTW) Computer Integrated Manufacturing (CIM) nationally administered End Of Course Exam .

Consumable supplies used by students

- 1/2 inch 6011 Aluminum plate, 6 square inches or less.
- Cutting fluid.
- Layout fluid.

Equipment required for activity

- Computer with internet and CAD/CAM software.
- Measuring tools; Combination square, digital caliper.
- Layout tools; Granite surface plate, scribe, scribing block.
- Bandsaw.
- Drill press.
- Center drill.
- Standard tap drill set.
- Standard tap and die set.
- Vises; bench and drill press.
- CNC mill with tooling and coolant system.

Introduction/Motivation

Holding up a large threaded fastener. What size is this bolt? (expect answers based on the estimated length) What do I need to know about this bolt to select the correct nut to fit it? Conduct a discussion on the size of the bolt being metric or standard and differences in thread pitch. Distribute an assortment of large nuts and bolts and have students attempt to determine the size and thread designation for two or more of the fasteners. What size cylinder is an external thread cut on? What size hole is an internal Thread cut into?

Discuss the usefulness of a tool that can quickly identify a bolt size and thread designation.

Procedure

Before the Activity

- Divide students into design team of two.
- All students will have passed a general lab safety test and are dressed appropriately for the activity.
- Demonstrate the safe use of the bandsaw, drillpress and CNC machine.
- Hand out Design Brief on Bolt Thread Gauge that includes constraints and deliverables.
- The constraints will include a Maximum square inches of material allowed, the number and size of the Threaded holes and engraving requirements (note that no specific shape or arrangement of the holes is specified).

Students will:

Part 1

1. Design a Bolt Thread Gauge using the engineering design process. This will include sketching, modeling, creating technical drawings and possibly 3D printing.
2. Produce a step by step production plan for fabrication of the design.

Students will:

Part 2

1. Transfer the Bolt Thread Gauge shape to a 1/2 inch Aluminum plate and use the Bandsaw to cut it out. Deburr and dress the edges of the shape.
2. Layout hole pattern on shape using layout dye and scribes.
3. Drill the ten holes using the drillpress and the appropriate size tap drill.
4. Chamfer the top edges of the holes.
5. Tape the holes with a manually fed tap and tap wrench.

Part 3

1. Develop tool paths in CAM software to engrave team logo and thread designations around/above each threaded hole.
2. Engrave Bolt Thread Gauge using CNC milling machine.

Part 4

1. Produce a presentation promoting the benefits of their design, describing defects and how to correct them , problems with equipment and procedures and how to improve them.
2. Submit Bolt Thread Gauge for grading.

Assessments

Pre-Activity Assessment

1. General safety tests and machine specific safety test that include part identification, maintenance, inherent dangers, procedures in the event of an accident.
2. Vocabulary associated with the project.

During Activity Assessment

1. Participation grades based on observation and progress.
2. Daily engineering notebook entries.

Post-Activity Assessment

1. Student presentation about the product and the processes.
2. Comparison of finished product and technical drawing the team submitted in part 1 of the activity.
3. A rubric will be used to award grades in the following categories: Efficient use of material, product finish, meeting all deliverables specified, efficient use of time.
4. Teams will critique the Bolt Thread Gauges produced by other groups.

RET Specific Topics

Materials and equipment required and how it will be acquired and maintained.

1. Activity materials and supplies will be funded will annual consumable supplies budget, however and increase in the amount will have to be justified with documentation and support from administration and department head.

- 1/2 inch 6011 Aluminum plate (4 square feet)
- Layout dye
- Cutting fluids

2. Tools required for the activity will have to be purchased with Career and Technical Education (CTE) department funds or borrowed from other programs.

- Tapping Drillbit set
- Center drills (6)
- Scribes (6)
- Tap and Die set
- Engraving tips (6)
- Layout surface and block
- Vises (6)
- Drill press vise.
- Files or Deburring tools (6)
- Shop Vac

3. Capital outlay equipment ($5000 or more) will require a grant. We have applied for a Texas Workforce Commission JET grant (not yet awarded).

- Bandsaw
- Drillpress
- CNC Milling Machine, tooling, clamping, coolant system.

Support from RET team and Industry

1. Student tour of the new A&M McAllen campus.
2. Student tours of local manufacturing facilities.
3. Guest speakers from local companies that employ engineers.
4. Monetary support for the purchase of capital outlay equipment.

Student outcomes

1. This activity will provide the Opportunity for students to apply skills developed in prerequisite engineering classes, including: application of the engineering design process, presentation, measurement, modeling and technical communication.
2. Students will have experience using layout procedures, production planning, drilling, tapping, creation of toolpaths in CAM software and CNC milling operations.

In conclusion

The Research Experiences for Teachers (RET), Enhancing Teacher Knowledge and Skills in Manufacturing at Texas A&M University has enlightening and motivating. It has made me realize that the academic level of engineering students is expected to be much higher than we are graduating from Harlingen Schools. The knowledge gap in high school graduates and freshman engineering students appears to be with the level of math taught at high school and the students understanding of the level of subject complexity taught at the university level. I will be increasing the math expectations for my students and will work with the math department to recruit students to take AP calculus. According to a Harlingen community survey, Science Technology Engineering and Math (STEM) is the number one path parents want to provide in our schools. As a Harlingen CISD STEM design team member, the information I have learned and observed while at Texas A&M this summer will help me to make informed decisions about the direction our engineering program proceed.