Gabriella Ortega

PSJA Southwest Early College High school – Pharr San Juan Alamo ISD

Robotics 9-12

30 Instructional Days

Table of contents

Overview and purpose:

The RET program allows for teachers of different districts to come together at the ATM college station campus, under the guidance of Dr. Hung, and gain some hands-on experience in

the manufacturing industry. Participants undergo 6 weeks of experiences to explore the fields of traditional manufacturing, additive manufacturing, material-manufacturing relationships and surface engineering and quality. During their experiences, teachers are encouraged to relate their experiences to their curriculum for areas of improvement and incorporation. Teacher participants are also encouraged to network with RET professors, exhibitors , and amongst themselves to expand their network. After participating in the RET program, a common theme that can be incorporated and help improve my curriculum is metrology, which is the scientific study of measurement.

The importance of measurement is a lost skill among students. Many students do not know how to take measurements using a ruler, how to make a specific measurement such as width, length, height or depth and they do not know the scope of tools outside of a ruler and tape measure. These concepts are a necessity not just in the engineering field but in the manufacturing field and any STEM field as well. Many students on my campus believe rulers are primarily used in math problems they will never encounter in the real world. Completing the RET program has allowed me to identify a common theme of metrology between all of the projects. During each project, we were required to complete measurements ranging from traditional width, length and height to more sophisticated measurements such as surface roughness and porosity density. The RET program has allowed me to gather hands-on experience with a variety of tools that I would otherwise not be able to draw on experiences for curriculum development.

Education standards:

Metrology can be incorporated in several stages of the design process, as I observed through the RET project Material-Manufacturing Relationships. Metrology can be used in several units of the robotics course, however these are the state requirements (TEKS) that directly correlate with metrology for the robotics course:

130.408.10: The student learns the function and application of the tools, equipment and materials used in robotic and automated systems through specific project-based assessments. The student is expected to:

(A) use tools and laboratory equipment in a safe manner to construct and repair systems;
(B) use precision measuring instruments to analyze systems and prototypes;

There are several TEKS in this course that require a foundation of metrology in order to execute these TEKS to a technical level. Using metrology as a foundational skill will help students increase their knowledge, understanding and interest.The following TEKS require metrology to execute at a technical level:

130.408.5: The student practices safe and proper work habits. The student is expected to:

(F) perform maintenance on selected tools, equipment and machines;
(G) handles and store tools and materials correctly; and
(H) describe the results of improper maintenance of material, tools and equipment.

130.408.9: The student uses engineering design methodologies. The student is expected to:

(B) think critically, identify the system constraints, and make fact-based decisions;
(C) apply testing and reiteration strategies to develop or improve a product;
(E) identify quality- control issues in engineering design and production;
(G) Use an engineer notebook to document the project design process as a legal document;
(H) interpret industry standard system schematics.

130.408.11: The student produces a product using the appropriate tools, materials and techniques. The student is expected to:

(B) identify and describe the steps needed to produce a prototype;
(C) construct a robotic or automated system to perform specified operations using the design process;
(D) test and evaluate the design in relation to pre-established requirements such as criteria and constraints;
(E) refine the design of a robotic or automated system to ensure quality, efficiency and manufacturability of the final product;

Class objectives:

Meteorology is a versatile topic that can help cover several classroom objectives. For this proposed unit, several classroom objectives are as follows:

1) Students will be able to demonstrate their knowledge of the division of an inch through the use of a ruler and measured lines by the end of the unit.
2) Students will be able to demonstrate their knowledge of precise measurement tools and their use by creating technical drawings with accurate dimensions by the end of the unit.
3) Students will be able to demonstrate their knowledge of technical drawings by correctly naming the sections of a technical drawing and demonstrating the correct view and dimensions according to ANSI standards.
4) Students will be able to understand how the manufacturing process connects to robotics by verbally describing how the two fields overlap.

Lesson/ unit:

(A) Outline of activities:

To introduce students to metrology and guide their learning, several activities will have to be done. I've broken down the activities to two major components: lecture and practice. The lecture section will consist of four lectures that introduce students to the necessary concepts and may also include small foldables that help with understanding. The lectures for this unit will be as follows: How to read a ruler, different types of measuring tools, which tool and when, and how to create technical drawings with dimensions. The practice component is a combination of group and individual activities that allow the students to become hands-on with these tools to reinforce their knowledge of them.

(B) Student activities:

To help students of different learning styles understand and connect to material, several hands-on activities have been designed. Once students have an understanding of the divisions of an inch and centimeter and have gone through the how to read a ruler they will complete the measurements scavenger hunt to reinforce their knowledge of the ruler. Students will be given a selection of measurements for which they will need to find an object in the room that matches that measurement, and objects for which they need to identify that measurement.

After completing the different types of measuring tools lecture, students will use rulers, calipers and micrometers, students will gather the precise measurements of several small objects and label them accordingly on their worksheet. This can be done in pairs, with one person taking a primary measurement and the second taking a secondary measurement.

After completing the which tool and when lecture, students will be tasked with creating powerpoints that highlight the purpose of different measuring tools, what measurements can be taken with those tools, and then a demonstration that teaches how to use that tool.
After students complete the how to create technical drawings with dimensions lesson, students will be tasked to use ruler, calipers and micrometers to create a technical drawing of a Lego assembly.

Once students have demonstrated mastery of these tools, they will be challenged to create a robotic structure that features at least one 3D printed part. Students will first need to design their structure, prototype it using the available metal pieces, use the appropriate measuring tools to identify necessary dimensions, create a CAD file with technical drawing, 3D print the piece and test with their system. Once this has been completed students will go back and make adjusts to their dimensions (as needed) or design, before 3D printing again and ensuring the dimensions and design are correct, before creating the final technical drawing that will be sent to the manufacturing lab to be made.

(C) Methods to use:

Students will be involved through the design process from start to finished in their final project for this unit. Students will be tasked with creating a basic structure, and identifying a piece that will benefit their design but can not be made with the metal currently available to

them. This will allow the student to be involved with problem identification and allow them to begin problem solving with criteria and constraints. Students will then proceed to prototyping and redesign which will enable the student identify strengths and weakness of their design as well as verify dimension.

(D) Support:

To complete this project support will be needed from my school administration, my CTE department, and the RET program. I will need the support from my school administration to allow for a field trip to tour the manufacturing lab and give students an inside view of the manufacturing process. I will need the support from my CTE department to help with the acquiring of the tools required for this unit, as well assistance in facilitating a tour of the manufacturing lab. I will need the support of the RET program to help in the acquisition of the necessary tools to complete this unit, possibly with manufacturing parts if the district manufacturing lab is unavailable, and with the outside perspective to improve these lessons.

(E) Materials and equipment:

Materials that will be required to complete this unit is currently unavailable. I will be seeking funding from my CTE department, donations from the RET program or industry in terms of equipment.

Precision contact tools:

- Class set of dial calipers
- Class set of micrometers
- One height gage
- One dial indicator

Manufacturing Machines:

- Formslab 2 printer
- Tabletop mill
- Tabletop drill press
- Tabletop CNC machine
- Manufacturing misters

Lean Manufacturing aids from ToolingU:

- Introduction to lean tooling
- Toast Kaizen
- Learning lean through simulation

(F) Other resources:

Other resources to complete this unit include the following:
Access to computers
World Wide Web

Robotics kits
Printer
Pencils

Summary:

Metrology is foundational topic that is continually needed throughout the robotics course. Students currents do not have the skills required to understand and demonstrate measurement with rulers, and lack knowledge of measuring tools outside of rulers and tape measures. Students in the robotics class will be taught how to read a ruler, understand the variety and measuring tools available and demonstrate their knowledge of these tools and measurements. Students will begin with demonstrating knowledge of a ruler through lecture and hands-on practice before continuing to calipers and micrometers. Students will learn how to use several measurement tools to create technical drawings before designing a functional 3D piece on a CAD software, printing and improving their design.

Pre- and Post tests:

Students will demonstrate knowledge gain through pre- and post tests. They will take a pre test that checks their knowledge of measurement. During the pre-test students will be asked to use a ruler to identify the measurements of lines, identify measuring tools by name and their accuracy, create a small technical drawing with dimensions, and identify how metrology can be using in the engineering design process. .Students will be given a similar post test to compare knowledge before and after instruction.

Reflection:

Reflection will help in determining the success of this unit. To reflect, I will analyze the scores of the pre- and post tests. If more than 40% of students do not show improvement of more than 5 -10 points on their post test as compared to their pre-test, then I will know mastery has not been achieved. Students will get to reflect by completing exit tickets prior to them leaving the class. These exit tickets will ask 1- 2 questions on the concepts covered that day, and we will go over them as a class so students can check their level of understanding. Additional resources will be posted to the online classroom so students who want to increase their level of understanding, can access additional practice without fear of ridicule.

Supplemental information:

The information gained in the RET program has allowed me to expand my curriculum and identify areas of growth in my curriculum. The RET program has provided me with hands-on experience in the area of manufacturing. RET professors have provided us lessons in the tooling and terminology before allowing us to become hands-on in the lessons. RET participants have gained experience in the areas of metrology, traditional manufacturing, additive manufacturing, surface finishes, defects and limitations of 3D printing processes, and the impact of helix and point angles in drilling. In the appendix, is a collection of photographs from various projects conducted during the 6 weeks.

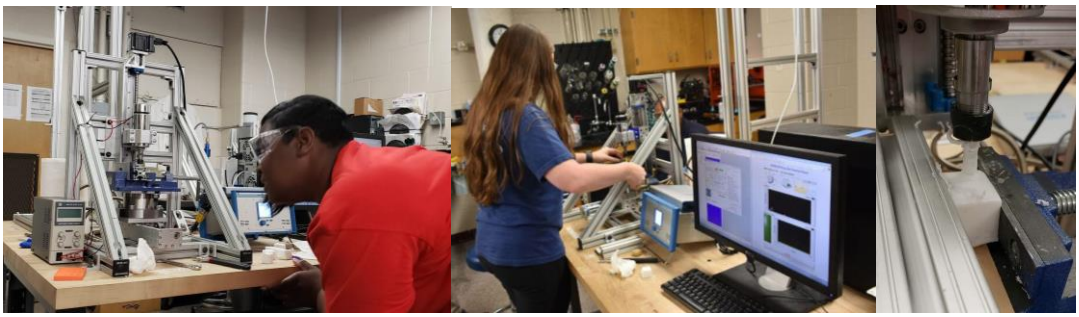
Closing:

The RET program allowed me to gather hands-on experience and gain some industry knowledge of the manufacturing industry. This program benefited me because I will now be able to identify places in my robotics curriculum to incorporate knowledge of the manufacturing industry to help students make connections between the two. I would recommend this experience to engineer, manufacturing, robotics and math teachers who have not had industry experience, would like to some of the processes used in manufacturing and/or that would like to explore manufacturing for real-world connections to incorporate into their curriculum to enhance student interest and learning.

I plan to use my experiences from the RET program to enhance student learning by incorporating some of the contact tools that were used during the program and relating to the industry,showing them videos and pictures that were taken during my time at the RET program to help them connect to material, and talking to students that may be interested in a career in manufacturing or engineering technology about the resources that are available. I will be giving a testimonial and encouraging teachers to participate in this RET when applications open for the following years.

APPENDIX:

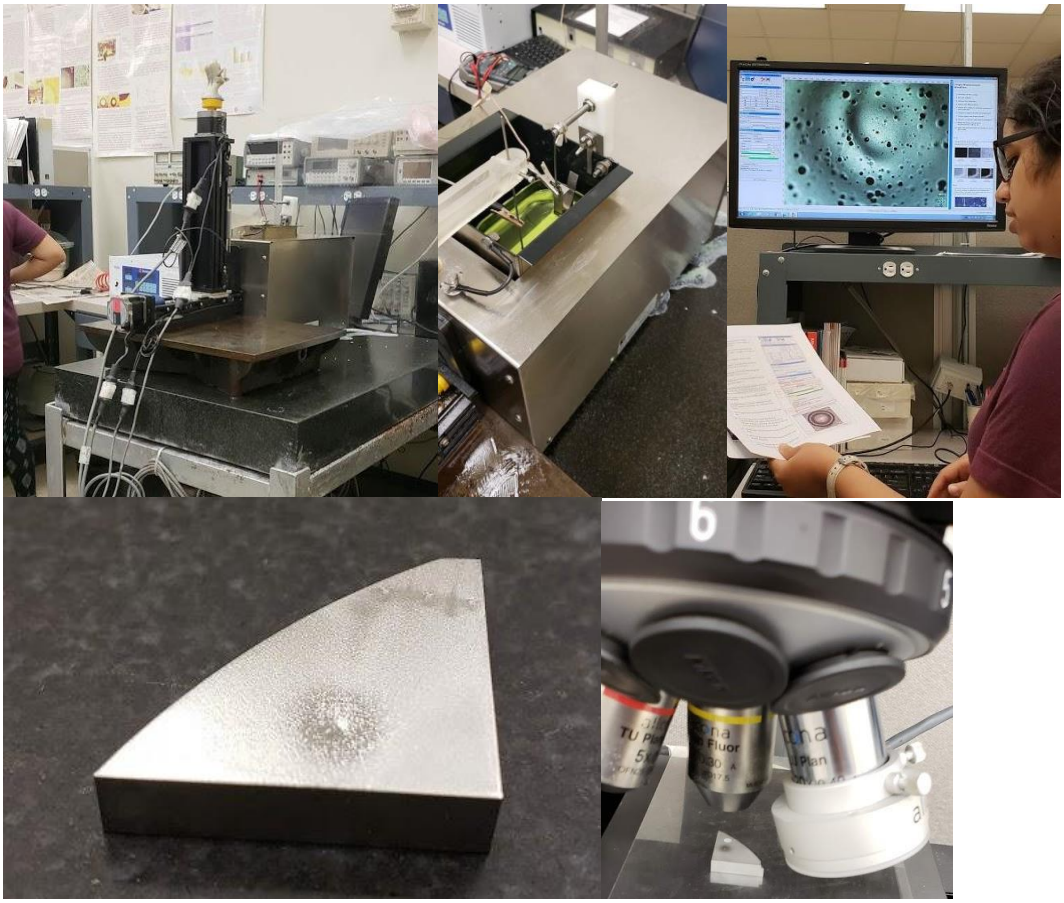
RET participants using various contact tools to gather measurements of assorted Lego blocks.



RET participants create drill bits with different helix and point angles and test the force and torque that occured.

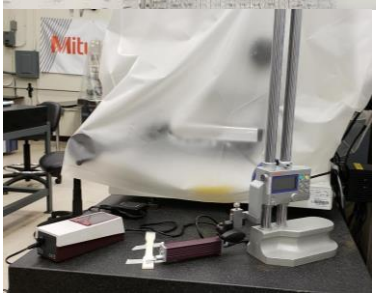
RET participants using aluminum stock to create a finished pen base and pen holder on sawing machines, horizontal mill, vertical mill, drill press, lathe, and taps.

RET Participants learning Fusion 360 to create an engraving and tooling path for the CNC machine.



RET participants conducting electrochemical polishing and then analyzing the smoothness and pore composition of the inconel samples.





RET participants using profilometer to analyze surface finish of ABS samples that have been buffed.