Lab Framework

Text:CORD Classic
Unit number and title:11 Using Signed Number and Vectors; also addresses Units 1 Problem Solving; 3 Measuring English and Metric Units; 4 Using graphs, charts, and tables; 6 Working with Lines and Angles; 8 Working with Shapes in two dimensions; 10 Working with scale drawings; 13 Precision, Accuracy and Tolerance.

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Date:6-26-2007

Lab Title

Engraving: Using Three axis Vectors on a CNC Machine

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Short Description: Using graph paper students will lay out a three-axis plan for engraving (initials, name, etc,) utilizing a CNC machine (milling or Plasma Cutter).

LAB PLAN

TEACHER: Teacher Prep/ Lesson Plan

- **Lab Objective**
  Students will be able to: use positive and negative vectors to complete an engraving plan; understand scale with graphing; mearure numeric value of vectors; allow for appropriate allowance (tolerance); ability to find and correct correct their own mistakes; introduction to G-codes and CNC software.
- **Statement of pre-requisite skills needed** (i.e., vocabulary, measurement techniques, formulas, etc.)
  Vocabulary, knowledge of measurement using decimals and fractions, know how to identify a two-axis grid with scale, ability to label two-axis coordinates, ability to compare and contrast, addition and subtraction of decimals and fractions with positive and negative integers.
- **New Vocabulary**
  Computer Numeric Control, axis, allowances and tolerances upper and lower limit (postive and negative), tolerance interval, magnitude and direction, accuracy, precision, coordinates. milling, engraving, scale drawing, quadrant.
- **Materials List**
  Graph paper and pencil for initial layout/design.
  To complete engraving: CNC milling, engraving, or cutting machine; a few computers with Word Pad and NC macchines program installed with simulation.
- **GLEs addressed**
  Math: GLE EALR 1 Understand and applies concepts and procedures of math, GLE 1.1 Understand and apply concepts and procedures from number sence. GLE 1.17 Applies strategies and uses tools to complete tasks involving computation of real numbers.
  Reading: GLE 2.1 Demonstrate evidence of reading comprehension. 2.2 Understand and apply knowledge of text components to comprehend text. 3.1 Read to learn new information. 3.2 Read too perform task.(Reading)
  Writing: GLE 2.21 Demonstrate understanding of different purposes for writing. GLE 2.4 Writes for career application.
- **Leadership Skills**

Active Skills USA Metals Club

- **SCAN Skills**

  Basic Skills: C. Identifies relevant details, facts, and specifications. Writing: B. Records information completely and accurately. Arithmetic: A. Perform basic computation, D. Uses graphs and charts to convey quantities. Math: B. Uses quantitative data to construct logical explanations for real world situations. Listening: B. To comprehend, D. To critically evaluate, Thinking Skills: Problem solving. Personal qualities: Self management.

- **Set-up information**

  Provide graph paper. Explain problem and grid/scale, allowance of machine. Make sure the CNC machine and computers are working and the software is loaded and in working order. Copies of Basic g-codes with simple examples

- **Lab organization**(-Grouping/leadership opportunities/cooperative learning expectations; -**Timeline required)**

  Use of cooperative learning using sharing and peer tutoring. Advanced students helping others and overseeing of machine use. This lesson could be used with fractions or decimals. Timeline can vary depending on how complicated the engraving is - First engraving with explanations generally takes five 50 minute class periods: first engraving should include 24 coordinates and should take one 50 minute class period - mistakes and regraphing usually takes a second day- third day for labeling and typing out the g-codes and an additional day for actual engraving and set-up. While one engraving is being cut others can revise or complete a second more difficult engraving.

  Alternate assignments with metric and english units as well as decimals and fractions for the grid graph.

- **Teacher Assessment of student learning** (scoring guide, rubric)

  Students completion of engraving, typed g-code, graphed design plan with labeled coordinates are all student assessments and can be graded as individual assignments for those that don't complete the entire project. Students will self assess with a written statement explaining the math concepts used to complete engraving and critique their own work.

- **Summary of learning** (to be finished after student completes lab)

  -discuss real world application of learning from lab

  -opportunity for students to share/present learning

  Students will have learned to properly measure vectors, be able to graph coordinates, assign positive and negative numeric values, understand and use allowances and tolerances, convert coordinate to vectors using g-codes, understand and use decimals and decimal fractions. Explain how robotics use CNC and g-codes with math coordinates are used in manufacturing in almost every industry today including building computer chips, cutting granite rock counter tops, cabinets, welding, auto manufacturing, etc.

- **Optional activities**

  First engraving should be simple with about 24 coordinates, then next engraving can be more complicated adding more coordinates.

  Alternate between English and metric units of measure.

  Alternate between decimal and fraction grid.

  Alternate size (diameter) of bits to change allowances and tolerances.

  After mastering use of basic x,z coordinates use j,k for arcs and circles.

  Use quadrant I (+,+) for first engraving or two; then alternate to quadrant IiI (-,-); then quadrant II (-,+);then quadrant IV (+,-).

- **Career Applications**

Modern indusrty and manufacturing use CNC robotics and g-codes with math coordinates in almost every application today including building computer chips, cutting granite rock counter tops, cabinets, welding, metal cutting, auto manufacturing, etc. .

LAB TITLE: Engraving: Using Three axis Vectors on a CNC Machine
STUDENT INSTRUCTIONS:

- **Statement of problem addressed by lab**
  Design an engraving using graph paper to be to the Pro-lite 1000 CNC Milling machine using basic G-codes and Wordpad on the computer in order for the machine to cut out your design..

- **Grouping instructions and roles**
  Individual work with help allowed from fellow students.

- **Procedures** – steps to follow/instructions
  1. Draw a rectangle on your paper that is 5" wide (x-axis) by 3 " tall (y-axis).
  2. Assign a 0.1" grid to your 25 squares per square inch grid paper.
  3. Keeping your lines 0.2" apart, draw your initials using lines that start and stop on grid intersections - use between 20-24 grid intersection points (coordinates).
  4. Check to make sure that your lines are both 0.2" from the outside edges of your drawn box and each other - revise as necessary.
  5. Label each grid intersection (coordinate) a letter (A-Z).
  6. Label your box as an x,y quadrant with (0,0) as the lower left hand corner, the horizontal (5") side is the x axis and the vertical (3") side is the y-axis.
  7. Make a chart with the letter designation of your coordinates and then using the 0.1"=one square grid label each coordinate as (x,y).
  8. On the computer using Wordpad type in the G-codes using the coordinates of each point in order of cutting procedure. Follow each line of code with a semi-colon followed by written direction for each vector (see example).
  9. Label and copy the file and transfer it (open) into ProLite 1000 computer program.
  10. Set up the size of your block in the setup menu and then using the simulation menu simulate the G-code program.
  11. Analyze the results as to your drawn expectations on the graph paper.
  12. Find your mistakes by locating the line of code where each mistake occurs and then go back into Wordpad and correct each error then resave and reevaluate by simulation.
  13. When simulation is correct transfer your file to the computer that operates the CNC machine and resimulate for one more evaluation.
  14. When 2nd simulation is correct set up your machine and engrave the wood.
  15. Evaluate the product - does it look like the drawing?
  16. Write a written evaluation of the engraving and include numeric data including coordinates and positive and negative vectors.

- **Outcome instructions**
  Evaluate the product - does it look like the drawing?
  . Write a written evaluation of the engraving and include numeric data including coordinates and positive and negative vectors.

- **Assessment instructions** (peer-teacher)
  Teacher observation of: proper use of measurement; completed graph with labeled x-axis and y-axis and column labeling all coordinates; typed G-codes on

Wordpad; simulation of cutting; written analysis of self-evaluation; and actual engraved part.

Students self analysis: check work through simulation and inspection of engraving correcting errors prior to cutting.

Safety procedures while using machine are followed.

Work area is clean.

Lab Data Collection

Student: _____ **Date:** _____

Unit: CLASSIC CORD UNIT 11 _____

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Criteria: Write the problem/objective in statement form

Data Collection: Record the collected/given data

Calculations: Complete the given calculations to solve for an answer(s)

Summary Statement:

Include an analysis of your engraving in a written statement verifying your assessment as to whether your engraving has met your expected outcome. Explain using numbers and vectors an allowances.

Other Assessment(s)

Students self analysis: check work through simulation and inspection of engraving correcting errors prior to cutting.

Finished engrving.