La Cañada High School

Proposed Course Outline – Integrated Computer Manufacturing - Project Lead the Way 3

I. Course Title – Integrated Computer Manufacturing - Project Lead the Way 3

II. Grade Level(s) – Grades 9-12

III. Length/Credit – 1 Year - 10.0 units - Elective Credit

IV. Preparations – No prerequisite. Completion of PLTW 2 P with grade of C or better is recommended.

V. Course Description

Computer Integrated Manufacturing is one of the specialization courses in the PLTW Engineering program. The course deepens the skills and knowledge of an engineering student within the context of efficiently creating the products all around us. Students build upon their Computer Aided Design (CAD) experience through the use of Computer Aided Manufacturing (CAM) software. CAM transforms a digital design into a program that a Computer Numerical Controlled (CNC) mill uses to transform a block of raw material into a product designed by a student. Students learn and apply concepts related to integrating robotic systems such as Automated Guided Vehicles (AGV) and robotic arms into manufacturing systems. Throughout the course students learn about manufacturing processes and systems. This course culminates with a capstone project where students design, build, program, and present a manufacturing system model capable of creating a product.

VI. Standards/ESLRs Addressed

Engineering and Architecture Pathways Standards - Career and Technical Ed. (CTE)
Introduction: Students will be engaged in an instructional program that integrates academic and technical preparation and focuses on career awareness, career exploration, and career preparation in a three course pathway that emphasize real-world, occupationally relevant experiences of significant scope and depth. To prepare students for continued training, advanced educational opportunities, and direct entry to a career, the Engineering courses pathway offers the following components: classroom, laboratory, and hands-on contextual learning; project- and work-based instruction; and leadership and interpersonal skills development. There are three Career and Technical Education standard domains that address this course proposal: the Engineering and Architecture Knowledge and Performance Anchor Standards (domain A), the Engineering and Architecture Pathway Standards related to the Engineering Technology Pathway (domain B), and the Engineering and Architecture Pathway Standards related to the Engineering Design Pathway (domain C).

I. Engineering and Architecture Knowledge and Performance Anchor Standards - Domain A

- 1.0 Academics - Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Engineering and Architecture academic alignment matrix for identification of standards.
- 2.0 Communications - Acquire and accurately use Engineering and Architecture sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.
- 3.0 Career Planning and Management - Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.
- 4.0 Technology - Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Engineering and Architecture sector workplace environment.
- 5.0 Problem Solving and Critical Thinking - Conduct short, as well as more sustained, research projects to create alternative solutions to answer a question or solve a problem unique to the Engineering and Architecture sector using critical and creative thinking; logical reasoning, analysis, inquiry, and problem-solving techniques.
- 6.0 Health and Safety - Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Engineering and Architecture sector workplace environment.
- 7.0 Responsibility and Flexibility - Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Engineering and Architecture sector workplace environment and community settings.
- 8.0 Ethics and Legal Responsibilities - Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.
- 9.0 Leadership and Teamwork - Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organization.
- 10.0 Technical Knowledge and Skills- Apply essential technical knowledge and skills common to all pathways in the Engineering and Architecture sector, following procedures when carrying out experiments or performing technical tasks.
- 11.0 Demonstration and Application - Demonstrate and apply the knowledge and skills contained in the Engineering and Architecture anchor standards, pathway standards, and performance indicators in classroom, laboratory and workplace settings, and through the formation of a career technical student organization.

II. Engineering Technology Pathway Standards - Domain B

- B1.0 Communicate and interpret information clearly in industry-standard visual and written formats.
- B2.0 Demonstrate the sketching process used in concept development.
- B6.0 Employ the design process to solve analysis and design problems.
- B7.0 Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.
- B8.0 Understand fundamental control system design and develop systems that complete pre-programmed tasks.
- B9.0 Understand the fundamentals of systems and market influences on products as they are developed and released to production.
- B10.0 Design and construct a culminating project effectively using engineering technology.
- B11.0 Understand the methods of creating both written and digital portfolios.

III. Engineering Design Pathway Standards - Domain C

- C1.0 Understand historical and current events related to engineering design and their effects on society.
- C2.0 Understand the effective use of engineering design equipment.
- C3.0 Understand the sketching process used in concept development.
- C4.0 Understand measurement systems as they apply to engineering design.
- C5.0 Use proper projection techniques to develop orthographic drawings.
- C6.0 Understand the applications and functions of sectional views.
- C7.0 Understand the applications and functions of auxiliary views.
- C8.0 Understand and apply proper dimensioning standards to drawings.
- C9.0 Understand the tolerance relationships between mating parts.
- C10.0 Understand the methods of applying text to a drawing.
- C11.0 Understand the methods of creating both written and digital portfolios.

VII. Brief Course Outline

Unit 1: Principles of Manufacturing

Manufacturing has a long history of innovation and continuous improvement. While improvement once focused on refining individual manufacturing processes, more recently manufacturing has been considered a system. Sustainable manufacturing organizations focus on safety while improving material, financial, and time efficiency. The integration of hardware and software solutions is transforming worldwide manufacturing into predominantly computer integrated manufacturing. In this unit students will explore the history of manufacturing and understand how manufacturing components are interconnected within a system. Students will learn to use input and output devices as a foundation to

model manufacturing processes. The design of a model is refined through the introduction of financial consideration.

Principles of Manufacturing Lesson Summary Lesson

1.1 History of Manufacturing Lesson
1.2 Control Systems Lesson
1.3 Cost of Manufacturing

Lesson 1.1 History of Manufacturing

The goal of this lesson is to provide context for manufacturing as an evolution of processes and systems. Students are given the opportunity to explore a manufacturing topic in greater depth and share this knowledge with their peers while developing presentation skills. Students are introduced to a model for how manufacturing components interact to more efficiently manufacture products.

Lesson 1.2 Control Systems

The goal of this lesson is for students to learn the use of input and output devices. Students will acquire efficient program creation techniques and apply them as they develop manufacturing system models.

Lesson 1.3 Cost of Manufacturing

The goal of this lesson is to integrate financial consideration into manufacturing design. Students collaborate on a project as they financially optimize a manufacturing system.

Unit 2: Manufacturing Processes

The goal of unit 2 is to introduce students to manufacturing processes as discrete steps within a manufacturing system. Students analyze a product to consider design improvements, perform calculations to make manufacturing decisions, and recommend processes. Students explore manufacturing machines while learning to develop machine language called G&M code. Students create G&M code manually to understand how machine code controls a CNC device. Students then practice workflow as they design a part using CAD software, use powerful CAM software to create G&M code, and run that G&M code on a CNC mill to manufacture a part. Ultimately students operate a CNC mill and create a physical part with their G&M code

Manufacturing Processes Lesson Summary

Lesson 2.1 Designing for Manufacturability
Lesson 2.2 How We Make Things
Lesson 2.3 Product Development

Lesson 2.1 Designing for Manufacturability

The goal of this lesson is consider how an effective product could be efficiently manufactured. In this lesson students analyze bad designs and discuss ways in which these could be improved. Students develop and apply formulas related to manufacturing scenarios while considering safety and ethics.

Lesson 2.2 How We Make Things

The goal of this lesson is to build a foundation of manufacturing process knowledge. Students are shown processes and the associated machines as these are applied to product manufacturing. Students apply this knowledge as they analyze products and recommend effective manufacturing processes.

Lesson 2.3 Product Development

The goal of this lesson is for students to execute a workflow from product concept through product creation using a CNC mill. A CNC mill uses a machine language called G&M code to move a cutting tool to remove raw material, resulting in a final product. Students create G&M code manually to understand how machine code controls a CNC device. As students prepare to operate a CNC mill, they learn how to calculate appropriate mill settings to produce products safely and efficiently. Students then practice workflow as they design a part with CAD software and convert the CAD model into G&M code using powerful CAM software. Ultimately students program and operate a CNC mill to create a physical part with their G&M code.

Unit 3: Elements of Automation

The goal of this unit is to introduce students to robotic automation within a manufacturing system. Robots as a form of automation have improved manufacturing by performing tasks that may be too mundane, impossible, unsafe, or inefficient for humans to perform. Robot effectiveness is impacted by factors such as robot geometry, controlling program, and robot power sources. In this unit students create programs for a robot to move material similarly to pick and place operations typically used in an automated manufacturing setting. Students integrate a robot arm into a more complex environment through integration with other devices. used in an automated manufacturing setting. Students integrate a robot arm into a more complex environment through integration with other devices.

Elements of Automation Lesson Summary

Lesson 3.1 Introduction to Robotic Automation
Lesson 3.2 Introduction to Automation Power
Lesson 3.3 Robotic Programming and Usage

Lesson 3.1 Introduction to Robotic Automation

The goal of this lesson is to develop a deeper understanding of the application of robotic automation within manufacturing. In this lesson students are provided a historical frame of reference for robotic automation development. Students create automated sequences that instruct a robot to complete a task in a simulated environment.

Lesson 3.2 2 Introduction to Automation Power

The goal of this lesson is for students to apply power concepts related to robotic automation. Students apply power formulas to solve theoretical engineering problems. Students design, build, and develop a program to model the use of fluid power to complete a task.

Lesson 3.3 Robotic Programming and Usage

The goal of this lesson is to apply concepts learned in the previous lessons to a physical robot. Students create programs to control a robot arm. Ultimately students will integrate the robot into complex systems through communication with other control systems.

Unit 4: Integration of Manufacturing

The goal of this unit is to apply the course concepts to a capstone problem. This opportunity will allow students to develop teamwork and presentation skills. The unit also explores career opportunities available in the manufacturing industry.

Integration of Manufacturing Elements Lesson Summary

Lesson 4.1 CIM Systems
Lesson 4.2 Integration of Manufacturing

Lesson 4.1 CIM Systems

Students will connect the concepts learned in this course to manufacturing in a real-world setting though a visit to a manufacturing facility. This lesson will also introduce manufacturing career opportunities.

Lesson 4.2 Integration of Manufacturing

The goal of this lesson is to provide students the opportunity to apply the knowledge and skills learned in this and previous engineering courses to a capstone problem. Student teams choose a product to manufacture. Students will break down the processes from simulated raw material to finished product. Students design, build, and program a flexible manufacturing system model with the same prototyping system used earlier in the course.

VIII. Methods of Assessment

The evaluation of projects will be on going and cumulative with the use of performance, portfolio, test, and self-report assessments. These assessments are check marks of how the students are meeting the standards set in the course and help direct the accomplishment of the project itself.

Project Assessments may include but are not limited to:

1. Presentation
2. Written/Oral Report
    - Daily Journal
    - Engineering Notebook
    - Multimedia
3. Graphic Representation
    - Orthographic representation
    - Pictorial representations

- Schematics
- Sketches
- Photos
- Diagrams
- Video Clips
- Graphs and Charts
- Statistical Analysis

4. Final Product

- Constructed Models
- Computer Models
- Computer Simulations
- New system
- New Products

5. Performance skills

- Computer Applications (i.e., Word Processing, Spreadsheet, PowerPoint, CAD)
- Use of CNC machine
- Measurement
- Construction
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Grades and Class Participation:

All work will be assessed and the students will receive points. Overall grades in the class will be by total percentage: **A=90+ B=80-89 C=70-79 D=60-69**

Grades will be based on daily class assignments, homework, notebook checks, projects, quizzes and tests. Class participation is essential to the learning process; therefore, I encourage students to attend daily.

Grades for this class will derive from the following sources:

Projects	**50 %**
Homework, Sketches, Worksheets, Engineering Notebook, Portfolio	**25 %**
Tests & Quizzes	**20 %**
Employability Skills & Work Ethic: includes participation, attendance, effort, behavior, & professional attitude	**5 %**

Employability Skills & Work Ethic Grade:

This portion of the student grade is based upon excellent daily attendance, active participation in class, no tardies, no truancies, and an excellent and positive attitude. It is also based on how well you

complete your daily assignments and tasks, bring all required materials to class daily and complete assignments on time. In addition, when the teacher is talking, students are expected to stop, look, listen, and follow directions, and take notes if needed. To guide your excellent work in this area, act and behave in such a way as you believe would be most highly desirable to a prospective employer.

Attendance Policy: Attendance in this course will be treated the same way as it would be treated at a place of employment. If a student is absent, it is the student's responsibility to see the instructor to get "make-up" or "missed" information. Also, if a student is behind, he/she can set up appointment to use the computer lab before or after school, or during STEP, as is mutually agreeable to teacher and student.

Academic Honesty:

Students are expected to demonstrate honesty and integrity at all times. Each student is responsible for his or her own work, which includes test taking, homework, class assignments, individual contributions to group products, and the original creation of digital art, web pages, essays, compositions, and research papers. All work submitted by a student should be a true reflection of that student's knowledge, experience, effort and ability. It is unacceptable academic behavior to submit work that is not one's own. Refer to "Academic Honesty & Integrity" section in your student handbook. The consequences laid out in this section will be strictly adhered to in all incidents of cheating or plagiarism.

IX. Materials/Textbook(s)

Project Lead the Way - Computer Integrated Manufacturing course materials, embedded, 2016

X. Seeking "a-f" Approval – Yes/No – Yes, this course will be submitted to the University of California for approval for the 2016-17 academic year in the subject domain "G" for college-preparatory elective credit.

XI. Seeking AP Class Approval – Yes/No – This course does NOT seek AP approval.

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