

FOLSOM CORDOVA UNIFIED SCHOOL DISTRICT



Honors Manufacturing & Product Design

Board Approval Date: November 18, 2021	Course Length: 2 Semesters
Grading: A-F	Credits: 5 Credits per Semester
Proposed Grade Level(s): 11, 12	Subject Area: Elective Elective Area (if applicable): Career Technical Education
Prerequisite(s): Advanced Innovation & Product Design Grade B or better or Manufacturing & Product Design with teacher approval.	Corequisite(s):
CTE Sector/Pathway: Manufacturing and Product Development/Product Innovation and Design	
Intent to Pursue 'A-G' College Prep Status: Yes	
A-G Course Identifier: (g) College-preparatory elective	
Graduation Requirement: No	
Course Intent: Site Specific Program (if applicable): CTE	
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COURSE DESCRIPTION:

This course is an advanced third year course for students in a three-year Manufacturing and Product Design CTE Pathway. This course will be offered to students who have completed the previous two classes (Manufacturing Product Design and/or Advanced Manufacturing & Product Design) This course also has online summer assignments, additional machining projects, and research papers. Students are introduced to an in-depth analysis of the manufacturing process. Students gain technical

proficiency in the setup, programming, and operation of computer numerically controlled (CNC) manufacturing equipment, with an emphasis on the Haas control system. Students learn foundational skills necessary for manufacturing majors and careers such as Machine Shop Safety, Applied Mathematics, Production Economics, Precision Measurements, Calculation of feeds and speeds, and advanced Print reading. Students then setup and operate the machine to produce the finished part from raw material, using the program code they developed. During second-semester, students use advanced Computer-Aided Manufacturing (CAM) software to program 2.5D and 3D high-speed machining toolpath strategies using solid model geometry. Students run 3D simulations of the machining process to check for proper machining technique and to verify proper part outcomes. Students then optimize the cutting strategies for efficiency in production and produce tangible products from raw materials. The final project includes machining parts from "Titans of CNC Academy".

Students participate in individual and group assignments and projects using demonstrations, research, presentations, and written expositions. In addition to regular reading and writing assignments using the textbook and manuals, students read *To Engineer is Human* and *Invention by Design*. Students write APA formatted research papers, including one on a chosen manufacturing process. Students participate in a variety of college and career readiness learning activities. They also maintain a Product Development Notebook, technical binder as well as a portfolio of their work which document their growth in knowledge and skills as well as their reflections on learning.

DETAILED UNITS OF INSTRUCTION:

Unit Number/Title	Unit Essential Questions	Examples of Formative Assessments	Examples of Summative Assessment
1. Foundational Mathematics	How do students apply mathematical formulas and concepts in a manufacturing application?	*Quizzes involving how to calculate angles, radius' and various geometric features of an item	*Student created formula sheet.
2. Machine Shop Safety	How do students operate safely in an industrial environment?	*Demonstration of safe practices including wearing of PPE.	*Year-long demonstration of safe behavior and protocols in the Lab spaces
3. Precision Measurements	How do students use precision measuring tools to measure items within .001 of an inch?	*Identification of measuring tools (Dial calipers, micrometer, dial indicator, gauge blocks)	*Practical test of measuring given items within .001" to place on order from smallest to largest
4. Orthographic Drawing Interpretation	How do students create a 3d model when given an Orthographic drawing of an engineered part?	*Identify parts of an orthographic drawing	*Using an orthographic drawing, students will create a 3D model using AutoCAD software

5. CNC Tooling	How do students select proper tooling based on industry standards?	*Identification of types of machine tooling based on speeds, feeds, tool material	*Project: Students will set-up a CNC machining job with tool selection and proper setting of speed and feed rates
6. Economics of Manufacturing	How do students predict the appropriate volume of parts to be made based on inputs of customer, demand, time and material?	*Compare the cost of manufacturing manual parts to CNC machining parts	*Project: Estimate demand of a designed part, perform cost benefit analysis, establish price point and find break even point
7. 3-Axis CNC milling Machine Setup	When given a 3-axis project, can a student properly set up a machine to make parts within a .005 inch tolerance?	*Demonstration of proper tool and work offsets in the Haas Controller	*Project: students will set up a machine to produce duplicated parts within .005 inch tolerance
8. 3-Axis CNC Milling Machine Programming	How do students manually program a CNC Machine at the controller?	*Demonstration of how to edit a program using the Haas Controller	*Project: Students will manually write a program using G and M code at the controller
9. 2.5D Tool Path Strategies	How do students program a CNC mill to make parts with complicated features such as pockets with different depths?	*Demonstration of ability to set work offset for features of various Z-Axis heights	*Project: Using CAD/CAM software, program CNC mill to make duplicated parts with various Z-Height features within .005 Inch tolerance
10. 5th Axis programming	How do students program a CNC mill to machine on 5 sides of a part in one operation?	*Demonstration of A and C axis operation by Hand Jogging CNC Mill	*Project: Design part and write program for CNC Mill to machine on 5 axis
11. Welding Automation	How do students program and operate Robotic Welder to make duplicated parts?	*Demonstrate how to load a program into Robotic Welder	*Project: Program robotic welder to repeatedly weld finished parts
12. Final Project	How do students create an assembly using multiple machined parts?	*Design and machine one piece to a multiple piece assembly	*Project: Build a working steam engine from a given design

ESSENTIAL STANDARDS:

D1.0 Understand the basic product design and development process as it relates to the design of a product, line of products, system design, or services.

D1.1 Identify the variations in the product design and development process as it relates to the designing of a product, product line, system design, or service.

D1.2 Apply and identify the various phases of the product design development process to an existing product, product line, system design, or service.

D2.0 Understand and apply research methodologies as a means to identify a need, problem, or opportunity for a new product, product line, system design, or service.

D2.1 Employ research methodologies, using primary research and electronic reference materials, to gather information relevant to the topic or area of opportunity.

D2.2 Organize information to identify and define an area of opportunity, need, or problem that can be resolved through design.

D2.3 Identify potential design areas (e.g., product, product line, system design, or service) that would address the need, problem, or opportunity.

D2.4 Research and identify the user demographic for the product, product line, system design, or service (local, national, global market).

D3.0 Understand and apply various ideation techniques to develop ideas and concepts.

D3.1 Apply ideation techniques to explore and produce multiple concepts.

D3.2 Edit concepts and identify key idea(s) that solve the problem, fulfill a need, or address an opportunity.

D3.3 Assess the environmental impact of the design solution and other sustainability issues and product life cycle considerations.

D3.4 Synthesize information and experiment with nontraditional possibilities for innovative design solutions

D4.0 Apply various two-dimensional (2-D) graphic and/or three-dimensional (3-D) modeling techniques to develop concepts.

D4.1 Create a preliminary design of a product concept utilizing drawing, computer software (graphic or CAD), and/or conceptual model fabrication techniques.

D4.2 Identify materials, mechanisms, technologies, and other requirements (e.g., safety, manufacturing, sustainability) the concept may require.

D4.3 Analyze and assess the strengths and weaknesses in the design, function, ergonomics, features, and benefits and identify possible resolutions for improvement.

D5.0 Develop the concept into a well-defined product for prototyping.

D5.1 Produce technical drawings and other specifications required for the prototyping or manufacturing of the product.

D5.2 Recognize the safety issues related to the reliability, functionality, and use of the product.

D5.3 Communicate and collaborate with fabricators, manufacturers, engineers, technologists, or other industry experts to review requirements and specifications and to validate the design.

D6.0 Produce a prototype of a product.

D6.1 Build a looks-like, works-like prototype of the model using the appropriate fabrication, manufacturing, or reproduction techniques or technologies.

D6.2 Assess the outcome of the prototype product and analyze any issues that need redesigning or refining related to function, construction, or other factors.

D6.3 Resolve and/or redesign issues with a prototype.

D7.0 Evaluate the prototype to determine if it meets the requirements and objectives.

D7.1 Create a performance criteria and a quality standard to measure and evaluate a prototype.

D7.2 Test the functionality and other features of the prototype against the performance criteria and quality standard and evaluate the results.

D7.3 Identify any redesigning or additional corrections required to improve the overall quality, look, and performance of the prototype model.

D8.0 Understand and apply basic business and entrepreneurial principles and identify potential markets and/or other business opportunities for distribution of the product.

D8.1 Apply research methodologies to identify potential investors or business opportunities to market the product.

D10.0 Produce a presentation of the product, product line, system design, or service.

D10.1 Create a presentation of the design solution (e.g., product, product line, system design, or service) that effectively communicates its features and benefits.

RELEVANT STANDARDS AND FRAMEWORKS, CONTENT/PROGRAM SPECIFIC STANDARDS:

Link to Common Core Standards (if applicable):

Educational standards describe what students should know and be able to do in each subject in each grade. In California, the State Board of Education decides on the standards for all students, from kindergarten through high school.

<https://www.cde.ca.gov/be/st/ss/documents/finaelaccsstandards.pdf>

Link to Framework (if applicable):

Curriculum frameworks provide guidance for implementing the content standards adopted by the State Board of Education (SBE). Frameworks are developed by the Instructional Quality Commission, formerly known as the Curriculum Development and Supplemental Materials Commission, which also reviews and recommends textbooks and other instructional materials to be adopted by the SBE.

Link to Subject Area Content Standards (if applicable):

Content standards were designed to encourage the highest achievement of every student, by defining the knowledge, concepts, and skills that students should acquire at each grade level.

<https://www.cde.ca.gov/ci/ct/sf/documents/ctescrpflyer.pdf>

<https://www.cde.ca.gov/ci/ct/sf/documents/manproddev.pdf>

Link to Program Content Area Standards (if applicable):

Program Content Area Standards apply to programs such as International Baccalaureate, Advanced Placement, Career and Technical Education, etc.

<https://www.cde.ca.gov/ci/ct/sf/documents/manproddev.pdf>

TEXTBOOKS AND RESOURCE MATERIALS:

Textbooks

Board Approved	Pilot Completion Date (If applicable)	Textbook Title	Author(s)	Publisher	Edition	Date
		<i>N/A</i>				

Other Resource Materials

Autodesk: Fundamentals of CNC Machining(Class Reference material), Invention By Design: by Henry Petroski (Summer Reading) , Machinery's Handbook: Industrial Press (Class reference Material), CNC Programming Manual: Haas Automation (Class Reference Material).

Supplemental Materials

Board approved supplemental materials (Including but not limited to: Film Clips, Digital Resources, Supplemental texts, DVDs, Programs (Pebble Creek, DBQ, etc.):

Haas Automation- YouTube Haas Tip of the Day, Machining Cloud (Application), Miller Automation Training Materials.