

**TAMALPAIS UNION HIGH SCHOOL DISTRICT
LARKSPUR, CA**

**Course of Study
PRINCIPLES OF TECHNOLOGY**

GENERAL COURSE DESCRIPTION

Principles of Technology is a project-based, introductory course designed for students with limited or no exposure to a shop or fabrication environment, and all who are interested in learning more about building and problem solving, an opportunity to do so using current technology and methodology. Principles of Technology is the first step in both the Computer Science and Engineering high school pathways. Students are introduced to, and experience, applying a variety of skills from the subject areas of Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM) fabrication using a variety of mediums (e.g., woodworking, metalworking) and computer programming. Students document work in a written format (engineering notebook) and in an online engineering portfolio. The use of an engineering notebook, and project documentation in an online portfolio, is a recursive theme throughout the engineering pathway. Students will experience working alone, in pairs, and in trios.

The master rubric, Course Objectives and Proficiency Scales (shown below), contain all course objectives. Each unit works to advance students toward proficiency in a few of the course objectives. By the end of the course, after completing all units, students will be proficient in all course objectives. The units are described in general terms, and specific example projects are detailed for each. The Example Projects provide clarity, support and ideas for teachers offering this course and are in no way requirements, expectations or boundaries. There are many ways a creative teacher could meet the unit expectations in addition to the provided examples.

Schools where the course will be taught: TUHSD Comprehensive sites

Length of course: One semester

Course Certification: UC approval pending.

Subject area and discipline: Engineering, Applied Technology

Prerequisites and/or Co-requisites: None

Grade levels: 9th or 10th; exceptions at instructor discretion

Textbooks or other supporting material: none

Course Content:

- Shop skills: safety, tool management, precision measuring/tolerances and fabrication (Ex: wood, metalworking)
- Basic Computer Aided Design CAD (Ex: Solidworks, Inventor)
- Basic Computer Aided Manufacturing CAM (ex: 3D printing, laser or plasma cutting)
- Measurement skills (Ex: calipers, tolerance)
- Basic circuits (Ex: circuits, motors, lights)
- Basic Computer programming (Ex: C++/ Arduino)

Course Objectives: *upon successful completion of the course, students will be able to:*

- Move a design idea from their head into their hands, using CAD/CAM
- Make and use precise measurements

- Wire a circuit for a given purpose
- Write and execute programming code to control electronic outputs based on system inputs
- Safely use and care for shop tools, machinery and equipment
- Fabricate accurately to a plan, i.e. practice “craftsmanship,” using various medium (ex: wood, metal)
- Work in teams toward a common goal
- Evaluate personal level of interest in the course content

Methods of evaluation:

- Success of the actual project based on project goals
- Successful achievement of the course objectives (rubric below)

| Principles of Technology: Course Objectives and Proficiency Scale | | | | |
|---|--|--|--|---|
| Course Objectives (Upon completion of the course, the student will be able to...) | 1 (emerging) | 2 (developing) | 3 (Meets expectations) | 4 (exceeds expectations) |
| Safely use and care for shop tools, machinery and equipment while developing craftsmanship skills using various medium (ex: wood, metal) | Student understands shop responsibilities. Student can identify tools and understands tool functions. Student understands the benefits of having a plan. | Student cleans and takes care of the shop when prompted. Student can use tools safely for their intended purpose. Student can create a plan of what to fabricate, and can follow a given plan. | Student takes ownership of shop condition and tool usage. Student can independently select a tool for a given need. Student can successfully create a plan, fabricate something and have it come out like the plan ("craftsmanship") | Student self-identifies improvements in the way the shop operates. Student independently uses understandings of tool functionality to make project planning decisions. Fabrication results are exact to the plan. |
| Get a design idea from their head, into their hands, using precision measurement and CAD/CAM | With help, student can create a CAD model of a given part and understands the principles behind CAM methods | Student can independently create a dimensionally accurate CAD model of a given part and can fabricate a part when guided through CAM | Student can independently create a CAD model of a given design challenge with established critical measurements and fabricate it using CAM | Student can identify critical measurements and precisely measure them. Student uses extensive CAD skills and understandings of CAM limitations to independently design and fabricate something highly dimensionally dependent |
| Wire a circuit, then write and execute programming code to control electronic outputs based on system inputs | Student understands the principles behind programmable controllers, computer code, outputs and inputs. Student understands the necessary components of a complete circuit. | With help, student can write and execute code to control an output. Student can write and execute code to monitor a system input. With guidance, student can properly connect components into a complete circuit | Student can independently create a described circuit and then write/execute code to control electronic outputs based on system inputs. | Student can select outputs and inputs necessary to accomplish a project goal. Student can design and fabricate a circuit necessary to accomplish the project goal. Students can independently write /execute code controlling outputs and inputs to accomplish a project goal |

| <p>COURSE OBJECTIVES (Upon completion of the course, the student will be able to...) <i>Continued</i></p> | <p>1 (emerging)</p> | <p>2 (developing)</p> | <p>3 (Meets expectations)</p> | <p>4 (exceeds expectations)</p> |
|--|--|--|--|--|
| <p>Successfully work in teams toward a common goal</p> | <p>Student understands the common goal of the team</p> | <p>When prompted with specific tasks, student contributes to the common goal of the team</p> | <p>Student can independently identify tasks that valuably contribute to the team's progress towards the common goal. The results from this student are valuable contributions.</p> | <p>Student can identify tasks necessary to achieve the team's common goal. Student and the team can work independently to delegate tasks, execute the tasks and achieve the common goal.</p> |
| <p>Evaluate personal level of interest in the course content</p> | <p>Student understands course content</p> | <p>Student experiences the content of the course and understands that the content is the beginning of possible further study</p> | <p>Student understands career and further study opportunities in the areas of the course content</p> | <p>Student understands lifestyle of individuals working in the industry related to the course content and understands pathways to obtain such a career</p> |

UNIT BY UNIT DESCRIPTION

Unit 1: Introduction to Fabrication

Students learn safety and functionality of tools associated with cutting and finishing material (ex: band saw, miter saw, belt sander, drill press). Students learn safety and functionality of common hand tools and various fasteners (ex: hand drill and bits, screws, nuts and bolts). Students learn to make a plan and build to the plan. The unit should be structured so that collaboration between students and student groups is necessary for project success.

Example project: Marble Maze

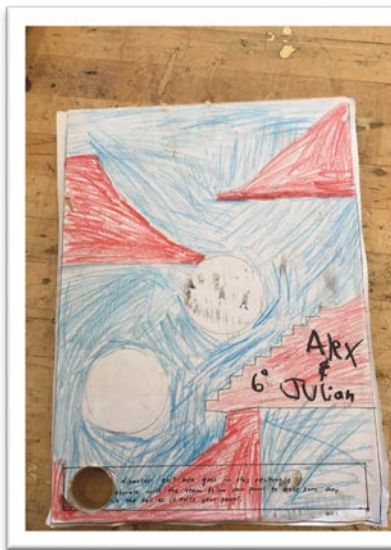
Students must collaborate with a partner to plan and build one panel of a five-panel wooden marble maze (ten total students build one, five-panel maze). Success of the project depends on how many balls make it from the top of the five-panel maze to the bottom without getting stuck or falling off the maze. An extension challenge for individuals finished early is to design a ball release mechanism that holds up to five balls, but releases them one at a time in response to some sort of human input (push, twist, pull something, etc.)

Target Course Objectives for the marble maze

- Safely use and care for shop tools, machinery and equipment while developing craftsmanship skills
- Develop basic woodworking skills (wood fabrication)
- Successfully work in teams (and coordinate teams) toward a common goal
- Practice precision measuring
- Evaluate personal level of interest in the course content

[Unit content and Depth of of progression towards course objectives for the marble maze project](#)

Images, l to r: Student plan, student cutting parts, completed panel, completed maze





Example project: The Steel Floating cube.

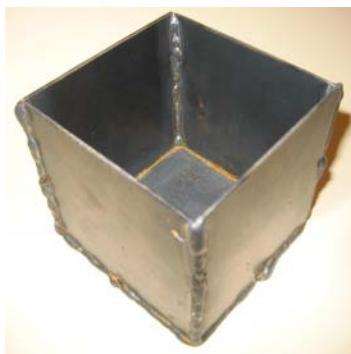
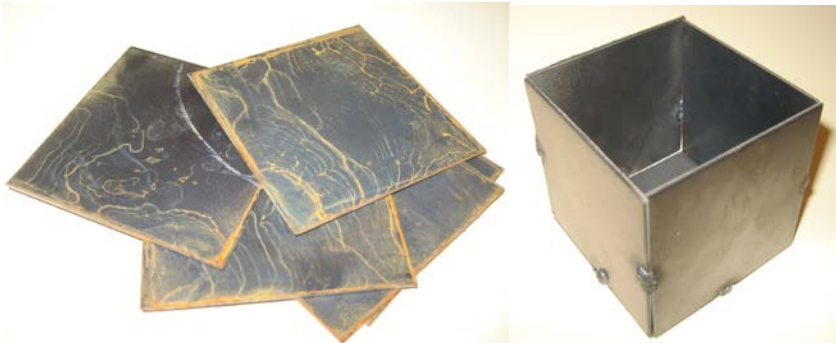
Students observe a CNC plasma cutter cutting out five square pieces (3"x3" of 16 GA steel). Working with an instructor individually, students learn to tack weld and are then tasked to tack the five metal squares into the shape of a cube (one side missing). They then learn to complete their welds to create a watertight box. The box is put into water, open side up. Success is a floating cube with a dry interior. Excessively large welds, or incomplete welds sink the cube.

Target Course Objectives for the Steel Floating Cube.

- Safely use and care for shop tools, machinery and equipment while developing craftsmanship skills (welding/steel fabrication)
- Evaluate personal level of interest in the course content

[Unit content and depth of progression towards course objectives for the floating cube project](#)

Images (l to r): Provided supplies, Tack welded box, fully welded box



Example project: Weld a Letter

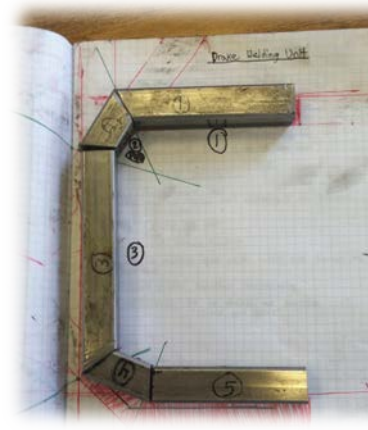
Students work individually on this project. Students plan in their notebook, draw precise cutlines, then cut, tack and weld steel tube-stock into the shape of a letter. Students then learn to drill and fasten the letter to a piece of wood. Students have accountability to the class to submit individual work in order to complete the spelled word or statement. Individual letter size and style is coordinated by students through structured collaboration.

Target Course Objectives for the Weld a Letter Project

- Safely use and care for shop tools, machinery and equipment while developing craftsmanship skills (welding/steel fabrication)
- Move a 3D design idea from their head into their hands, using precision measurement and CAD/CAM
- Successfully coordinate with other students towards a common goal
- Evaluate personal level of interest in the course content

Unit content and depth of progression towards course objectives for the floating cube project

Images (Top l to Bottom r): Plan in student notebook, Cut lines being drawn, Cutting, Parts weld ready, Welded letter, Class result



Unit 2: Introduction to Measurement and CAD/CAM

Students learn introductory level Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) skills. Students are introduced to precision measurement and translating measurements into the CAD tool. Students learn to model in an XYZ coordinate environment and discover how these coordinates enable us to “See” 3D objects on a 2D screen. Students learn and understand capabilities and limitations of CAM devices and how these capabilities and limitations inform design decisions.

Example Project: The notebook clip

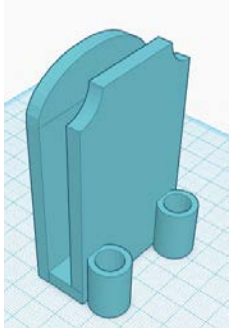
Students are guided through the CAD/CAM process, designing and then 3D printing a keychain that does not have critical measurements. They are then taught to take precision measurements with calipers. Students are then challenged to independently design and 3D print a part that will attach two different writing utensils to their engineering notebook. The clip needs to be sketched in the notebook. Critical measurements (ex: writing utensil and notebook dimensions) then must be taken and the part is designed using 3D design software. Once the design is approved, students learn 3D printing and print their piece. Students are provided one opportunity to make design revisions.

Target Course Objectives for the notebook clip project

- Move a 3D design idea from their head into their hands, using precision measurement and CAD/CAM
- Evaluate personal level of interest in the course content

[Unit content and depth of progression towards course objectives for the notebook clip project](#)

Images: Keychain model, Keychain print, two example notebook clip designs



Unit 3: Introduction to programming and basic circuits

Students are exposed to and work with common electronic components. Students learn to fabricate a safe and effective electrical circuit. Students learn basics related to writing computer code, uploading code to a controller and running code that interacts with humans using both inputs and outputs.

Example project: The Stoplight

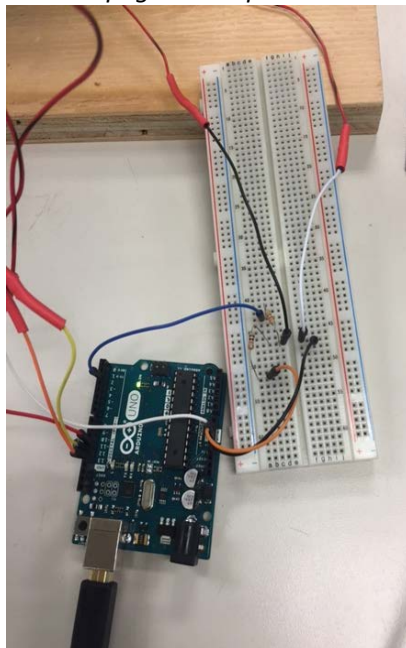
Students construct an LED model of a stoplight. Students wire stoplight to a microcontroller and program it to control the lights, correctly reacting to a simulated pedestrian pressing the cross-request button. Extension activity: Model the walk/don't walk lights and correctly implement them into the programmed light routine.

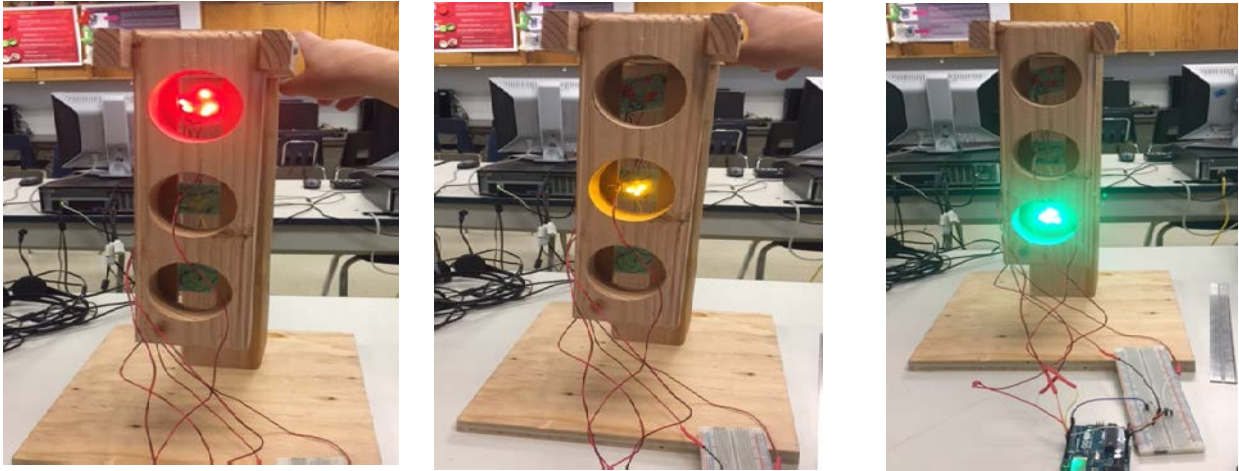
Target Course Objectives for the stoplight project

- Safely use and care for shop tools, machinery and equipment while developing craftsmanship skills
- Wire a circuit, then write and execute programming code to control electronic outputs based on system inputs
- Evaluate personal level of interest in the course content

[Unit content and depth of progression towards course objectives for the Stoplight](#)

Images (Top l to Bottom r): Completed stoplight examples and wiring; stoplight through light cycle.





Unit 4: Culminating project

Students apply the content from the three previous units in a group project. Project requires individual documentation. Project provides opportunity to exceed expectations of course objectives.

Example project: Mini-Golf course

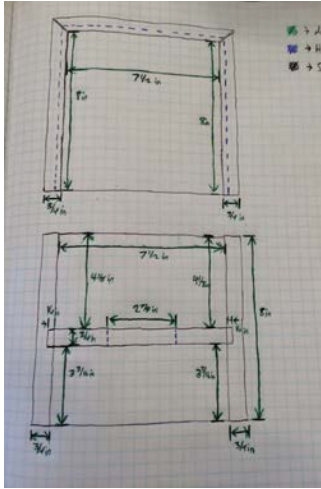
Students work in groups of three. The project task list is provided, but students must delegate tasks themselves. Project tasks: Construct a wooden box with a hole to act as a golf hole target. Design, model and 3D print a golf ball catcher that, after catching a golf ball, triggers a provided switch. Upon detecting the switch closure, a student-programmed microcontroller should activate outputs (lights, sound, motion, etc.) to perform a “hole made” celebration. When these three tasks are complete, the team then works together to create the fairway of the hole out of a provided 4'x8' sheet of cardboard.

Target Course Objectives for the Mini-Golf course

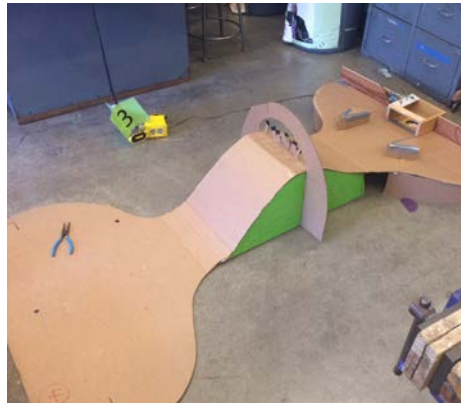
- Safely use and care for shop tools, machinery and equipment while developing craftsmanship skills
- Move a 3D design idea from their head into their hands, using precision measurement and CAD/CAM
- Wire a circuit and then write and execute programming code to control electronic outputs based on system inputs
- Successfully work in teams toward a common goal

Unit content and depth of progression towards course objectives for the Mini-Golf course

Images (l to r): Student notebook plan of golf hole, golf hole, 3D designed and printed ball activated switch



Images: Example golf holes



UC(g) Approved 7/29/16

BOT Approved
Revised 5/24/16