# Lesson Plan

**Course Title:** Engineering Design and Presentation

**Session Title:** Solid Modeling

**Performance Objective:**
After completing this assignment, the student will be able to construct a solid modeling drawing using system software (CAD) that can draw in three dimensions (width, height, and depth) to match the example given in the storyboard slide presentation.

**Specific Objectives:**
Students will be able to:
- Define terms associated with lesson
- Define CAD terms - solids terms and 2-D associative terms
- Identify solid modeling tools
- Identify views and 2-D associative parametric parts and where to find the missing 3-D part
- Identify and use shapes to add a third dimension to make a solid associative of the parametric object
- Follow storyboard to complete solid modeling drawings

## Preparation

**TEKS Correlations:**
This lesson, as published, correlates to the following TEKS. Any changes/alterations to the activities may result in the elimination of any or all of the TEKS listed.

**Engineering Design and Presentation:**

  - distinguish the differences between an engineering technician, engineering technologist, and engineer;
  - identify employment and career opportunities;
  - investigate and work toward industry certifications;
  - demonstrate the principles of teamwork related to engineering and technology;
  - identify and use appropriate work habits;
  - demonstrate knowledge related to governmental regulations, including health and safety;
  - discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;
  - demonstrate respect for diversity in the workplace;
  - demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and equality;
  - demonstrate effective oral and written communication skills using a variety of software applications and media;
  - explore career preparation learning experiences, including, but not limited to, job shadowing, mentoring, and apprenticeship training.
130.365 (c)(2)(A)(B)(C)
...understand and discuss how teams function;
...use teamwork to solve problems;
...serve as a team leader and a team member and demonstrate appropriate attitudes while participating in team projects.

130.365 (c)(3)(A)(B)(C)(D)
...use time-management techniques to develop and maintain work schedules and meet deadlines;
...complete work according to established criteria;
...participate in the organization and operation of a real or simulated engineering project;
...develop a plan for production of an individual product.

130.365 (c)(4)(E)(F)(G)
...perform maintenance on selected tools, equipment, and machines;
...handle and store tools and materials correctly;
...describe the results of negligent or improper maintenance.

...sketch single- and multi-view projections;
...prepare orthographic and pictorial views;
...project points and construct lines to build geometric forms;
...construct true length of lines and true size of planes by the revolution method;
...draw developments using radial line, parallel line, and triangulation methods;
...construct piercing points and intersection of planes using edge-view and cutting plane methods;
...prepare and revise annotated multi-dimensional production drawings in computer-aided drafting and design to industry standards;
...demonstrate knowledge of effective file structure and management.

...understand and discuss principles of ideation;
...think critically, identify the system constraints, and make fact-based decisions;
...use rational thinking to develop or improve a product;
...apply decision-making strategies when developing solutions;
...use an engineering notebook to record prototypes, corrections, and/or mistakes in the design process;
...use an engineering notebook to record the final design, construction, and manipulation of finished projects.

130.365 (c)(7)(A)(C)(D)
...use a variety of technologies to design components;
...research applications of different types of computer-aided drafting and design software;
...use multiple software applications for concept presentations.

130.365 (c)(8)(A)(B)(C)(D)(E)
...interpret engineering drawings;
...identify areas where quality, reliability, and safety can be designed into a product;
...improve a product design to meet a specified need;
...produce engineering drawings to industry standards;
...describe potential patents and the patenting process.

- **130.365 (c)(9)(A)(B)(C)**
  ...identify and describe the steps needed to produce a prototype;
  ...identify and use appropriate tools, equipment, machines, and materials to produce the prototype;
  ...present the prototype using a variety of media.

### Interdisciplinary Correlations:

**English:**

- **110.42(6)(A)(B)**
  ...expand vocabulary through wide reading, listening, and discussing;
  ...rely on context to determine meanings of words and phrases such as figurative language, idioms, multiple meaning words, and technical vocabulary;

- **110.42(7)(A)(I)(J)**
  ...establish a purpose for reading such as to discover, interpret, and enjoy;
  ...use study strategies such as skimming and scanning, note taking, outlining, and using study-guide questions to better understand texts;
  ...read silently with comprehension for a sustained period of time;

### Teacher Preparation:

The teacher should practice with four, three-view drawings, projecting all points around to show alignment of one object. Three-view objects show all the sides of the same object and how to assemble the object a side at a time. With solid modeling, select a given part, add the missing dimension and stack, and align it to form the full object.

### Reference:


### Instructional Aids:

1. PowerPoint presentation - *See note below
2. Storyboard

*By clicking on PPT slides of CAD drawings, you will be taken into AutoCAD software loaded on your computer. From there, you can manipulate the drawings, such as increase the size, change colors, etc.

### Materials Needed:

1. CAD system software that can draw in three dimensions with features such as,
   A) command - for geometry
   B) generators - functions to control the viewing of drawing geometry
C) modifiers - for changing the drawing  
D) editor – for editing feature and variations.

CAD system software has features that are becoming more user-friendly and subject to the way drafting was first derived.

Equipment Needed:
1. Computer with CAD system software  
2. Computer projection unit if available  
3. Printer and/or plotter

Learner Preparation:  
Students need to understand that construction of a solid drawing is based upon system software (CAD) that can draw in three dimensions (width, height, and depth). Solid modeling is unlike two dimensional drawing that draws a series of two drawings to show all its features.

Introduction

Introduction (LSI Quadrant I):  
SAY: Today we are going to construct a solid modeling drawing using CAD software that can draw in three dimensions (width, height, and depth). Solid modeling is unlike two dimensional drawing that draws a series of two drawings to show all its features. You will refer to the storyboard for steps in constructing your solid modeling drawing.  
SAY: Start with these four, three-view drawings. Project all points around to show alignment, of one object. Extrude front view (.75) inches to finish.  
ASK: Why front view?  
SAY: Because it shows the most of the object in solid form and all I had to do was to add depth onto the object. The width and height already exist.  
SHOW: Part 2 of the slide presentation.  
SAY: From the top choose this part and with a polyline, extrude it (1.5) inches by placing the height onto the depth. Move it, align it to midpoint, and union it to form one part. The object has only one process to turn into a solid.  
SHOW: Part 3 of the slide presentation.  
ASK: What view would you pick to turn this drawing into a parametric solid? (Hint, place the height onto the width)  
SAY: Front view.  
SHOW: Part 4 of the slide presentation.  
ASK: What part best describes this object?  
SAY: 1 of right side view. The command you would use is extrude.  
ASK: What second part would you pick?  
SAY: 2 of right side view. Then also extrude. Now move to midpoint and union.

Outline

Outline (LSI Quadrant II):  
Instructors can use the PowerPoint presentation, slides, handouts, and note pages in conjunction with the following outline.
<table>
<thead>
<tr>
<th>MI</th>
<th>Outline</th>
<th>Notes to Instructor</th>
</tr>
</thead>
</table>
| | I. Define terms associated with lesson  
A. Solid modeling – combining two or more parts by adding the third dimension  
B. Parametric solid – the finished object  
D. Extrude – putting in third dimension  
E. Polyline - a connected sequence of segments created as a single planar object. You can create straight line segments, arc segments, or a combination of the two.  
F. Midpoint – center of line or object  
G. Union – join one part to the next part  
H. Alignment – putting something in place  
I. Subtract – Removing one shape out of another shape | Teacher will distribute “Terms Used With Solid Modeling” handout.  
Teacher will begin PowerPoint slide presentation. |
| | II. Define CAD terms  
A. Solids terms – functions that take 2-D terms into 3-D shapes  
B. 2-D associative terms – associate line terms into 3-D shapes  
a. line – creates line segments  
b. polygon - creates an equilateral closed polyline  
c. rectangle - creates a rectangular polyline  
d. center, radius - creates a circle using a specified radius  
e. 3-point - creates an arc using three points | Teacher will discuss and review terms associated with the lesson. |
| | III. Use solid modeling tools by completing drawings 4 and 5 of the slide presentation | Teacher will show solid modeling tools and discuss their use. |
| | IV. Identify views and 2-D associative parametric parts and where to find the missing 3-D part  
A. Front view  
B. Top view  
C. Right side view | Teacher will show views and associative parametric parts and discuss. |
| | V. Follow storyboard to complete solid modeling drawing using CAD software | Teacher will instruct students how to use storyboard to |
A. Identify and use shapes to add a third dimension to make a solid associative of the parametric object
B. Select a part in a pectoral view that best describes its attributes and give it a parametric third dimension then move it to its given location

VI. Students will be evaluated on criteria in the solid modeling rubric provided with this lesson

Teacher will provide solid modeling rubric at the beginning of this lesson.

Copy and paste Multiple Intelligences Graphic in appropriate place in left column.

<table>
<thead>
<tr>
<th>Verbal Linguistic</th>
<th>Logical Mathematical</th>
<th>Visual Spatial</th>
<th>Musical Rhythmic</th>
<th>Bodily Kinesthetic</th>
<th>Intra-personal</th>
<th>Inter-personal</th>
<th>Naturalist</th>
<th>Existentialist</th>
</tr>
</thead>
</table>

Application

Guided Practice (LSI Quadrant III): The Teacher will instruct the students on how to use the storyboard to complete the solid modeling drawings. Students will be monitored as they work and the teacher will provide questions to stimulate their thinking.

Question: Why use front view?
Answer: Because it shows the most of the object in solid format and all I had to do was to add depth onto the object. (The width and height already exist.)

Question: What view would you pick to turn this drawing into a parametric solid?
Answer: Front view.

Question: What 2 parts best describes this object?
Answer: Part1 of front view and part 2 of top view.

Independent Practice (LSI Quadrant III): Students will work independently through the steps outlined in the storyboard to complete the solid modeling drawing using their CAD system software.

Summary

Review (LSI Quadrants I and IV):
The students will review by answering questions posed by the teacher as they work through the storyboard and will review the terms associated with the lesson in the handout provided. The key learning point is to ask the students to find the hidden dimension and this is emphasized over and over again in the review.
### Evaluation

**Informal Assessment (LSI Quadrant III):** The teacher will monitor the students’ progression through the storyboard and will informally assess their progress.

**Formal Assessment (LSI Quadrant III, IV):**
The students will be assessed based on the criteria of the rubric provided with this lesson.

### Extension

**Extension/Enrichment (LSI Quadrant IV):**
- A. Students may complete drawings 2-5 from slide presentation.
- B. Students may apply parametric modeling to a drawing of their choice.
Terms Used With Solid Modeling

A. Solid modeling – combining two or more parts by adding the 3rd dimension

B. Parametric solid – the finished object

C. Extrude – putting in 3rd dimension

D. Polyline - a connected sequence of segments created as a single planar object. You can create straight line segments, arc segments, or a combination of the two.

E. Midpoint – center of line or object

F. Union – join one part to the next part

G. Alignment – putting something in place

H. Subtract – removing one shape out of another shape

I. Line – creates line segments

J. Polygon - creates an equilateral closed polyline

K. Rectangle - creates a rectangular polyline

L. Center, radius - creates a circle using a specified radius

M. 3-point - creates an arc using three points
## Solid Modeling Rubric

**Task Statement:** Construct a solid modeling drawing.

**Task Assignment:** Construct a solid modeling drawing by using system software (CAD) that can draw in three dimensions (width, height, and depth).

<table>
<thead>
<tr>
<th>Concepts/Skills to be Assessed</th>
<th>Criteria Categories (Novice to Exemplary)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Novice 1</td>
</tr>
<tr>
<td>Lay out overall shape, width, and height in CAD (pencil first is optional) <em>(Possible 15 points)</em></td>
<td>Pencil sketch started <em>(1-4 points)</em></td>
</tr>
<tr>
<td>Lay out overall shape to dimensions in CAD <em>(Possible 15 points)</em></td>
<td>Pencil sketch started <em>(1-4 points)</em></td>
</tr>
<tr>
<td>Dimension width of line segment in CAD <em>(Possible 15 points)</em></td>
<td>Line segments not connected, double lines, over run corners <em>(1-4 points)</em></td>
</tr>
<tr>
<td>Dimension height of line segment in CAD <em>(Possible 15 points)</em></td>
<td>Line segments not connected, double lines, over run corners <em>(1-4 points)</em></td>
</tr>
<tr>
<td>Finish drawing, as shown, in CAD <em>(Possible 25 points)</em></td>
<td>Overall shape started <em>(1-10 points)</em></td>
</tr>
<tr>
<td>Neatness <em>(Possible 15 points)</em></td>
<td>Overall shape constructed <em>(1-4 points)</em></td>
</tr>
</tbody>
</table>

A = 66-100 points; B = 54-66 points; C = 30-54 points; D = 6-30 points