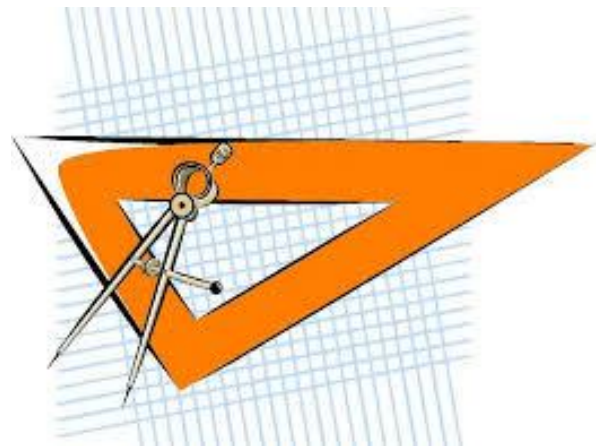


Intro to Design
Unit 2 – Representing Designs
Isometric and Orthographic Drawings
Duration: 10 Days



Curriculum Development in Technology Education
ITEC 8900
Summer II 2014
Prepared by: Larry Lambert

Title: Unit Plan – Unit 2: Representing Designs: Isometric and Orthographic Drawings

Essential Questions:

What type of drawings do engineers use to represent designs and how are they constructed and interpreted?

Learning Objectives:

At the conclusion of this unit, all students will be able to:

- list and identify the four basic styles of engineering sketches. (isometric, orthographic, oblique and perspective)
- accurately sketch copies of isometric and orthographic drawings.
- explain why a detailed sketch is a powerful communication tool.
- use appropriate verbiage while describing engineering drawings.

At the conclusion of this unit, most students will be able to:

- accurately sketch isometric images when provided with orthographic version and vice versa.
- define and use content-specific vocabulary, terminology, and jargon unique to engineering drawing.

At the conclusion of this unit, some students will be able to:

- to create an accurate, scale sketch of various geometric and everyday objects found in the technical drawing lab.

Assessments:

Formative Assessments will include:

- student participation and responses to questions asked during introductory lectures and lab experiences.
- observation of students at work on drawings
- evaluation of isometric and orthographic drawings produced by students during the activities

Summative Assessment

- Exam

Frameworks connections:

The following learning standards, which are covered in this unit, are from the Technology/Engineering Learning Standards for a Grades 6 through 8 found in the Massachusetts Curriculum Frameworks for Science and Technology/Engineering, 2006.

Engineering Design

Central Concept

Engineering design is an iterative process that involves modeling and optimizing to develop technological solutions to problems within given constraints.

2.1 Identify and explain the steps of the engineering design process, i.e., identify the need or problem, research the problem, develop possible solutions, select the best possible solution(s), construct a prototype, test and evaluate, communicate the solution(s), and redesign.

2.2 Demonstrate methods of representing solutions to a design problem, e.g., sketches, orthographic projections, multi-view drawings.

Communications

Central Concept:

Ideas can be communicated through engineering drawings, written reports, and pictures.

3.2 Identify and explain the appropriate tools, machines, and electronic devices (e.g., drawing tools, computer-aided design, and cameras) used to produce and/or reproduce design solutions (e.g., engineering drawings, prototypes, and reports).

Cross-Curriculum connections:

Common Core

Math:

Solve problems involving scale drawings of geometric figures, such as computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

Writing:

Standard 6- Use Technology, including the internet, to produce and publish writing and to interact and collaborate with others.

Materials:

Lab Equipment:

Computer with Microsoft PowerPoint installed for presentations

LCD Projector

Lab Computers with internet connection; one computer required for each pair of students.

Tape measures; one required for each pair of students.

Rulers; one required for each pair of students.

Consumables:

Sketching pencils

Erasers

Plain paper

Orthographic grid paper

Isometric grid paper

Resources:

Text:

Technology: Shaping Our World, By Gradwell, Welch and Martin, Goodheart-Willcox Company, Tinley Park, IL, 2000.

Internet:

- Sokolowski, G. (2004) Orthographic Projection #1, Wisc-Online.
<http://www.wisc-online.com/objects/ViewObject.aspx?ID=ENG19204>
- Ryan, V. (2011) Oblique projections:
<http://www.technologystudent.com/despro2/obli1.htm>
- Ryan, V. (2011) Isometric projections:
<http://www.technologystudent.com/prdes1/drawtec2.html>

Handouts: Copies included on the pages that follow:

- Engineering Grid Paper (from: <http://www.printfreegraphpaper.com>)
- Isometric Grid Paper (from: <http://www.printfreegraphpaper.com>)
- Practice Exercises (Orthographic to Isometric, Isometric to Orthographic)
- Intro to Design Exam

Vocabulary:

Isometric Drawing: all vertical lines are drawn vertically, but all horizontal lines are drawn at 30 degrees to the horizontal. Engineers use this type of drawing to communicate measurements

Oblique Drawing: the front side of the object appears flat in the picture plane and the sides and top of the object are at a 45-degree angle to the horizontal lines of the front side.

Orthographic Drawing: Two-dimensional (2-D) drawing that shows each side of an object. They are useful for showing the dimensions of a design.

Perspective Drawing: the lines of the object that move away from the viewer converge on an imaginary point called the vanishing point

Plan View: plan drawn as though the ceiling were removed

Scale: the ratio between the size of something and a representation of it.

Content Overview:

The material contained within this section is located on the EST Foundations's website, <http://www.estfoundations.com/background3-basic%20project%20skills-sketching.html>

Summary

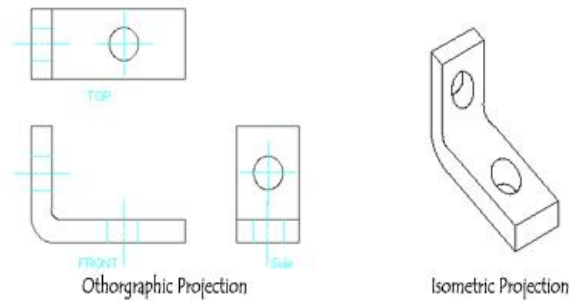
Without the ability to communicate well, engineers cannot function in a team and are of limited value to industry. Technical drawing and sketching are essential communication tools for engineers. Using established sketching conventions (orthographic projections and isometric sketches), students will learn how to quickly convey their design ideas to others.

Background

The ability to sketch ideas is not only *important* to engineers it is absolutely *essential*. Even if an engineer was stranded alone on an island, the ability to sketch would help to work out details in ideas and help to identify potential problems. Technical sketching and drawing does NOT require any artistic ability. Once one is made aware of the basic techniques, it is no longer the "ability to draw" that will limit his/her sketches. But rather, the limitation is one's "ability to think through the details of their design." In industry sketching is used to quickly document rough ideas and identify general needs for improvement. Technical drawing would be employed only for those ideas deserving a permanent record. Sketches and drawings are composed of the same basic information, but there is a tradeoff between time required to generate it versus the level of design detail (and accuracy). The basics of technical sketching can be learned in a single sitting. However, it will take considerable practice to achieve the fluency that really facilitates team discussions in the future. Don't be surprised if those who are new to sketching actually enjoy working on sketching assignments. It is an easy area for most students to achieve in.

Orthographic Projection is a generally accepted convention for representing 3D objects using multiple 2D views of the front, top, bottom, back, and sides of the object. In practice, the minimal number of views possible is used to describe all the details of the object. Usually, the Front View, Top View, and a single Side View are sufficient and are oriented on the paper according to accepted convention. Isometric Projection attempts to represent 3D objects using a single view.

Instead of the observer viewing the object perpendicular to the object, the object is rotated both horizontally and vertically relative to the observer.



There are rules and conventions to guide the creation of both types of projections. Additionally, either of them can be supplemented with various types of dimensions. Whether sketching or drawing, the goal is the same. The goal is to communicate the necessary detail to the intended audience.

Lesson Process Outline:

Day 1

Classroom Organization

The classroom setting for today's lesson requires PowerPoint running via an LCD projector and an internet connection, to be used by the instructor during presentation of the content.

Motivation Students and Activating Prior Knowledge

Motivating students will include discussions with students that will allow them to make the connection between the Engineering Design Process and the need for engineering sketches. Students will "Think, Pair, Share" this question in small groups.

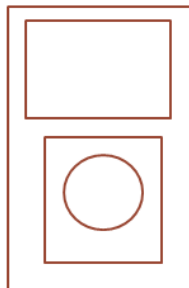
Activity

This activity will illustrate how much better a sketch communicates an idea than a verbal description.

Give students the following instructions:

1. Draw a large rectangle on your paper.
2. Draw 2 smaller rectangles inside the large rectangle.
3. Draw a circle inside one of the small rectangles.
4. Compare your design to your neighbors.

Are all the designs the same?
Does your design match this one?



Adaptations

Students on IEPs or with other special needs may be given additional assistance during the activity portion of this lesson. Students who require it will receive seating close to the point of instruction

Day 2

Classroom Organization

The classroom setting for today's lesson requires PowerPoint running via an LCD projector and an internet connection, to be used by the instructor during presentation of the content.

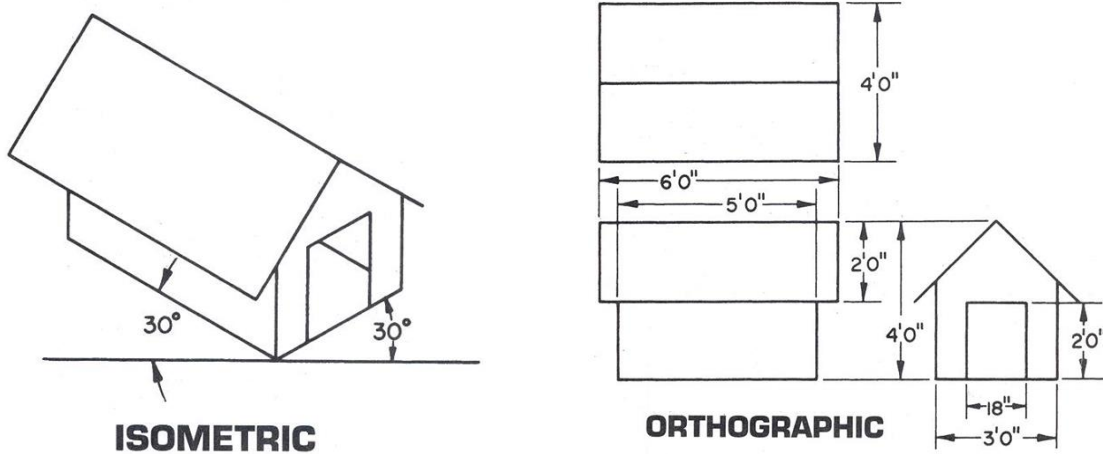
Motivation Students and Activating Prior Knowledge

Motivating students will include discussions that recap the content of the previous class. The question that will serve as the catalyst for these discussions is: *“Is a picture really worth a thousand words?”*

Method of Instruction

Important concepts to be introduced today:

Students will have Isometric and Orthographic images explained to them using the following drawings:



The following key concepts are part of the essential understanding students must develop.

Isometric projections

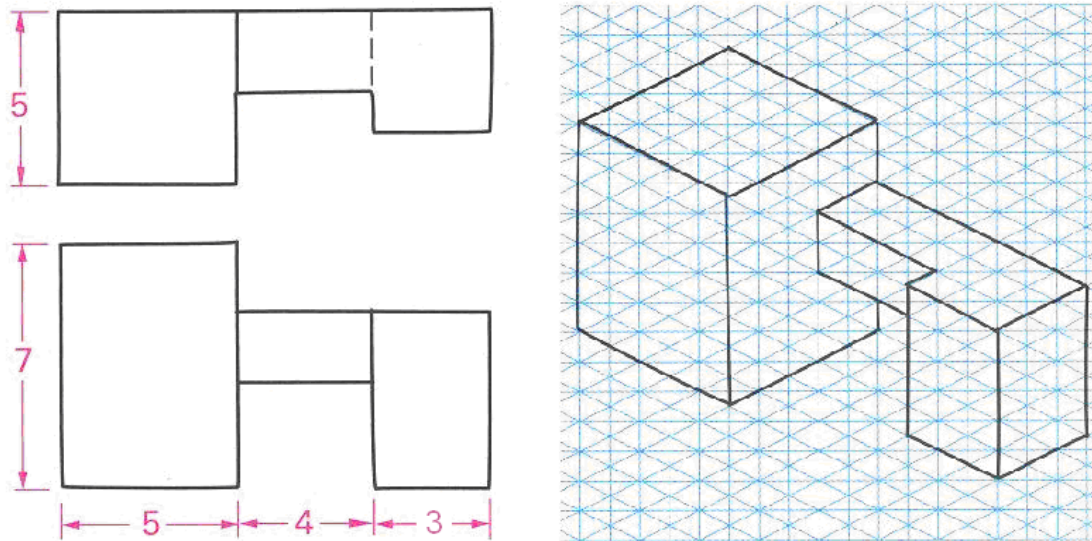
- Show three sides of an item in proportional dimensions.
- All vertical lines are vertical
- All horizontal lines are drawn at a 30° angle.

Orthographic projections

- Used to represent 3D items in multiple 2D drawings.
- Top, front, bottom, and side views may be used.
- The general rule is to use only the views necessary to show the details of the item.

Activity:

The teacher will lead the students, step-by-step, through the creation of the following drawings, explained the process of converting orthographic drawings to isometric and vice versa.



Adaptations: Students on IEPs or with other special needs may be given additional assistance during the activity portion of this lesson.

Days 3 and 4

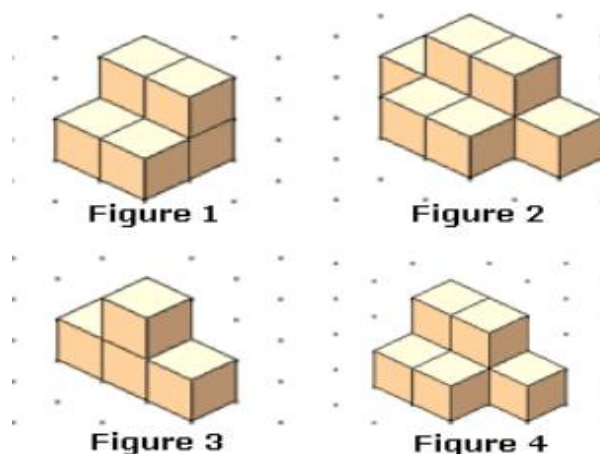
Classroom setting for today’s lesson requires PowerPoint running via an LCD projector. Discussions should begin with a recap of the previous class discussions

Important Concepts to be introduced today:

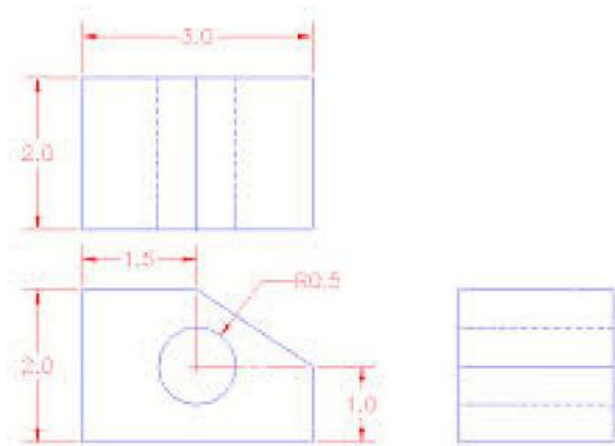
- Translating Isometric projections into Orthographic projections.
- Translating Orthographic projections into Isometric projections.

Activity:

The teacher will provide students with sets of isometrics and orthographic images with the expectation being that they will be expected to convert to the other type. The following are samples of the isometric images that might be used.



The following is an example of an orthographic drawing that might be provided to students for use in this activity.



Adaptations: Students on IEPs or with other special needs may be given additional assistance during the activity portion of this lesson.

Day 5, 6 and 7

Classroom Organization

Classroom setting for day 5's lesson requires a computer lab with an internet connected computer available for each pair of student.

Method of Instruction

Activity 1

Students will be asked to visit the following websites as a review of the material that has been covered to this point in time.

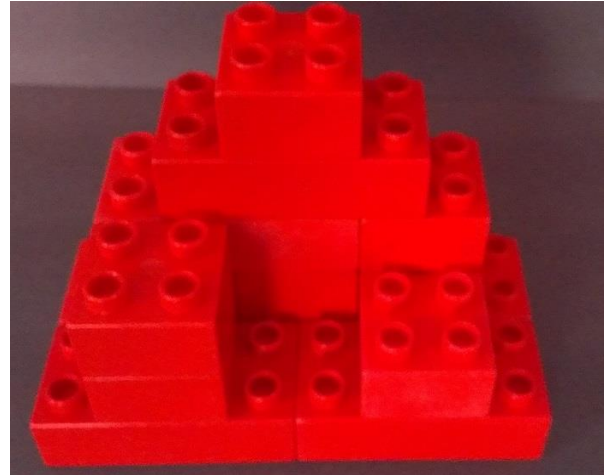
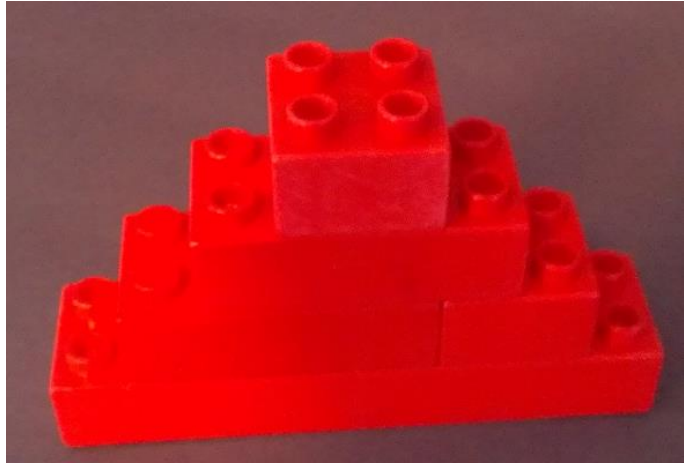
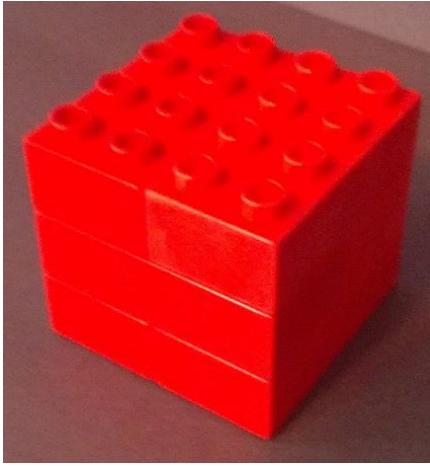
- Sokolowski, G. (2004) Orthographic Projection #1, Wisc-Online.
<http://www.wisc-online.com/objects/ViewObject.aspx?ID=ENG19204>
- Ryan, V. (2011) Oblique projections:
<http://www.technologystudent.com/despro2/obli1.htm>
- Ryan, V. (2011) Isometric projections:
<http://www.technologystudent.com/prddes1/drawtec2.html>

At the conclusion of reviewing the presentations, students will visit the website, <http://worksheets.tutorvista.com/3d-shapes-worksheets.html> in order to complete the online worksheet. Groups should “screen capture” the results of their worksheet and submit it.

Activity 2

Sets of Legos building blocks are required for this portion of the lesson.

1. The teacher will construct a variety of structures using Lego building blocks, similar to the ones shown below.
2. Students will then be required to sketch both the isometric and orthographic drawings that depict the structure.



3. Once students have developed an acceptable level of proficiency they will break into small groups and take turns constructing structures and sketching them, again in both isometric and orthographic projections.
4. After completing several rounds in this mode, students will then take the drawing produced by other groups and construct the structure using the Lego building blocks.

Adaptations

Students on IEPs or with other special needs may be given additional assistance during the activity portion of this lesson. Additional adaptations may be made in the application of the rubrics to the drawings produced as the result of activities. As a further adaptation, some requirements of these three lessons may be waived for students with special needs.

Day 8 and 9

Classroom Organization

Classroom setting for today's lesson requires PowerPoint running via an LCD projector. Discussions should begin with a recap of the previous class discussions followed by the introduction of the new activity.

Method of Instruction

Activity

For this activity, the teacher will identify a variety of items within the class/lab room.



This list of items will be provided to the students. The students will then use rulers and tape measures to measure the items. The students will then produce scale isometric and orthographic drawings of the classroom/lab articles.

Adaptations: Students on IEPs or with other special needs may be given additional assistance during the activity portion of this lesson. Additional adaptations may be made in the application of the rubrics to the drawings produced as the result of activities.

Day 10

After a brief review, the remainder of today's class is reserved for the summative assessment.

Adaptations: The following accommodations will be afforded to students on IEPs or others with special needs while taking the exam:

- Study guidelines and notes will be provided.
- Administration of the test in a small group setting.
- Clarification of general instructions.
- Test administrator will read selected words, phrases, and/or sentences as directed by the student.